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Overview

Rashid Amjad*

1. Introduction

Since the early 1990s, Pakistan's economy has continued to lose its earlier growth momentum, except for a brief spurt in 2002–06. This has now become cause for considerable concern and urgent policy action is needed to revive the economy and move it to a higher growth trajectory. This slowdown during a period of rapid globalization (at least till 2008) and unprecedented technological advancement has raised fundamental questions as to the growing lack of competitiveness, both at the global level as well as against cheaper and better-quality imports in the domestic economy. In addition, recurring balance-of-payments crises have forced Pakistan to frequently seek IMF assistance and resort to severe contractionary policies to restore macroeconomic stability.

To address these issues, the Lahore School of Economics held its 12th international conference on the Management of the Pakistan Economy on the theme "Technology, entrepreneurship and productivity growth: Where Pakistan stands and where it must go." An important feature of this conference was that it brought together leading scientists, economists, industry-level specialists, business leaders and policymakers both from within Pakistan and abroad to debate the direction the economy must take to break out of its current impasse.

This overview presents the main findings and policy messages that emerged from the conference, as contained in the papers in this volume as well as from the presentations, discussion and debates that followed. It is divided, as the conference so ably did, into macro-level issues, industry-level analysis, firm-level findings based on surveys (conducted primarily by the Lahore School) and policy conclusions and recommendations. What the overview tries to capture is the dynamics of the interaction between the macro, industry and (most importantly) firm level and through this, the constraints and economic opportunities the present situation offers. This provides a framework for devising prudent economic policies and creating

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an incentives structure to promote new investment that embodies the latest technology. This, in turn, will raise Pakistan's productivity and competitiveness in domestic and global markets.

In his opening address, Dr Bilal U. Haq reminded participants of the well-known but much forgotten advice of Prof. Abdus Salam that, "Unless you are very good at science, you will never be good at technology." Haq gave many examples, including from China, to show that the transfer of technology alone, without developing indigenous research and development (R&D) capabilities, has serious limitations especially when it comes to upgrading this technology or absorbing and adopting newer technologies in the same field.

This vital link between indigenously developed scientific know-how and its practical use in the creation of commercially viable new technologies by developing countries such as Pakistan was an issue that emerged repeatedly during the conference. An interesting concept put forward by Haq, which resonated in many of the presentations, is that of the "technopreneur" – a new breed of private firms that create as well as market their products in the first instance in the domestic market.

The theme "Where Pakistan stands and where it must go" is addressed in the papers by Irfan ul Haque, Rashid Amjad and Namra Awais, Mathew McCartney, and Nazia Nazeer and Rajah Rasiah. While Haque and Amjad and Awais trace the declining trend in productivity post-1990 in some detail, the theoretical models on which they draw have important differences, although these do not appear to change their overall findings. Amjad and Awais use a growth accounting framework that draws on the "new growth theory" to estimate total factor productivity (TFP) trends during 1980–2015, Haque remains skeptical of this approach, but draws broadly similar results of declining productivity based on estimates from the Asian Productivity Organization.

The strength of Amjad and Awais's paper lies in their detailed estimates of TFP, both overall as well as for the major sectors, broken down by different time periods over 1980–2015. Their results suggest that, not only did TFP decline after the 1980s, but the major slowdown in manufacturing after 1990 and in agricultural TFP was not compensated for by a corresponding rise in the services sector (as, for example, happened in India post-1990).

Where Haque and Amjad and Awais firmly agree is that the decline in productivity growth can be explained largely by the steep fall in investment levels (both public and private), especially after 2006. Drawing on Kaldor–Verdoorn's Law, both papers argue that new investment 'embodies' the latest knowledge, innovation and technical progress and that investment and productivity growth are thus closely related. Haque also draws a parallel with 'learning by doing' and the positive relationship between the growth of output and the growth of productivity via new investment.

Nazeer and Rasiah concentrate on the manufacturing sector and raise the important question (also discussed at earlier conferences) of Pakistan's premature deindustrialization. An interesting start is their definitions of premature deindustrialization (a decline in manufacturing productivity while still undertaking low-value-added activities) and the mature deindustrialization witnessed in developed economies (where the share of manufacturing in GDP falls, but its productivity continues to rise).

They compare Pakistan's experience of the manufacturing sector with that of East Asia (especially South Korea) and Southeast Asia (including Malaysia and Thailand). Here, they show that Pakistan's industrialization under import substitution in the 1950s and 1960s, while impressive, did not keep pace with that of South Korea and Taiwan (China). They blame Pakistan's failure to move from low-value-added to higher-value-added goods and the country's premature deindustrialization on two factors: its failure to develop a well-thought-through industrial policy and its inability to check the rise of a powerful 'rentier' industrial vested class, which continued to enjoy the benefits of a protected trade regime.

When Pakistan opened up its economy in the 1990s under the aegis of the IMF and World Bank, it got the worst of both worlds: opening up without any phased or sequenced plan as well as an economic environment where the exchange rate was overvalued due to the rapid growth in remittances ('Dutch disease'). In the end, one is still left with some questions as to what should have characterized Pakistan's industrial policy, despite the interesting lessons Nazeer and Rasiah draw from the East Asian and Southeast Asian experience.

Going somewhat against the grain of the earlier papers, McCartney argues that Pakistan's economic growth, which averaged around 5 percent over 1960–2015, is still respectable when benchmarked against most developing countries' experience. Given the poor levels of education and skills among its workforce, any attempt to move to higher-value-added and technologically advanced manufacturing was always going to be problematic. McCartney reinforces this argument by pointing to the troubled investment climate and the government's weak record of implementing sectoral industrial policies (e.g., the Textiles Policy for 2009–14). His conclusion is conservative and cautious – Pakistan should adopt a more gradual approach in moving up the value-added ladder. In this, it could learn from the example of Bangladesh in producing readymade garments in which its current comparative advantage appears to lie.

Maha Khan and Uzma Afzal's paper reinforces Pakistan's poor manufacturing experience by highlighting the lack of export diversification and the fact that its export basket still comprises low-tech, undifferentiated products. They argue, as Nazeer and Rasiah have done earlier, that Pakistan must come up with an industrial policy built on a strategic collaboration between the public and private sectors, although they do not spell out the main features and exact role or direction of such a policy.

Musleh Ud Din, Inayat Ullah Mangla and Muhammad Jamil plot Pakistan's poor ranking on the global innovation index and its low scores on high-technology exports and R&D expenditure. They present the interesting case of the telecommunication sector, where the adoption of prudent deregulation policies has led to rapid growth and modernization, but the subsequent adoption of tax and tariff policies has suffocated the growth of indigenous manufacturing firms in this sector.

They identify lack of entrepreneurship, poor access to finance and most importantly the dearth of world-class technological knowledge as the main reasons that Pakistan has relied primarily on foreign investment and imported machinery to fuel the growth of this fast-growing and dynamic sector. Two additional factors have discouraged domestic producers as well as growth in this sector: the discriminatory tariff regime under which taxes and duties on finished products are much lower than on CKD equipment for local producers and the withholding taxes on mobile services (charged to all users, of who less than 1 percent fall within the tax bracket). These measures have contributed to an overall decline in domestic assembly operations compared to the pre-deregulation phase.

Naved Hamid and Faizan Khalid not only bring out the growth potential of Pakistan's digital economy, but also show how this fast-growing sector has attracted international firms as well as Pakistani technopreneurs – most of them tracing their emergence to the large number of incubators that were set up post-2012. These incubators provide support services such as mentorship, stipends, office space, broadband Internet, training and funding opportunities. Having detailed a number of success stories, however, the paper fails to provide satisfactory answers to the question of why, despite all these positive developments, its share of new investment output and exports remains marginal.

The optimism found in Hamid and Khalid was also reflected in a presentation at the conference by Aezaz Hussain, a 'technopreneur' whose company Systems Ltd is among the largest domestic IT firms quoted on the Karachi Stock Exchange. Hussain identified a number of areas, including financial services, farmer extension services and support measures for increasing industrial productivity in which the IT sector could play an important role.

In an absorbing presentation on the growth of the tractor industry in Pakistan, Irfan Aqeel, managing director of Millat Tractors, showed how his firm had developed indigenous technology based on imported technology through licensing agreements with foreign firms. This had led to productivity gains and lower costs and had indigenized 90 percent of tractor parts in Pakistan.

2. The Firm Level

It is at the level of the firm that basic decisions on growth, investment (upgrading existing technology and/or replacing it with new technology) and the labor force (skilling, adding or downsizing) are taken. How do firms in Pakistan make these decisions? This critical question is addressed in a number of papers based on research and surveys undertaken by the Lahore School. This is where the conference added the greatest value, with results from the field providing much needed answers to many of the questions raised in earlier papers and discussions at the macro and industry level.

The results of a firm-level survey conducted in 2016 in conjunction with the Lahore Chamber of Commerce and Industry (of which the surveyed firms are members) presented by Mahvish Faran and Azam Chaudhry is a good starting point. Their study shows a vibrant private sector continually innovating and upgrading its technology. Almost 75 percent of the firms surveyed were engaged in technological upgradation, of which a large part is concentrated in the production process. Interestingly, most firms learn about new technology through the Internet, their customers and exhibitions. The role of public sector institutions and academics is found to be almost nonexistent in manufacturing, where firms also learn of new technologies through foreign suppliers of machinery. In services and retail, a large part of their innovation is in marketing activities.

In a survey of 431 textiles and apparel manufacturers conducted in 2013–15, Waqar Wadho and Azam Chaudhry give concrete proof to the earlier survey. Of this sample of firms, 56 percent had introduced technological and nontechnological innovations during this period. Over half their expenditure was on new machinery and equipment – through it, acquiring newer 'vintages' of capital. Market sources are the most important source of knowledge spillovers, with small firms relying on local market sources and large firms mainly on foreign clients and foreign suppliers. Almost 40 percent of the firms had introduced products new to the firm and their efforts were concentrated on improving the quality of their products, not just pursuing growth in sales as their most important objective.

In an interesting paper, Theresa Chaudhry and Mahvish Faran measure productivity and quality differences across three denim producers – a large firm producing for a major multinational brand, a medium firm catering to the export market (mainly European brands) and a small firm producing mainly for the domestic market. The paper presents in painstaking detail the results for measures of productivity (as cost per unit) across the three firms. Productivity in the medium firm was half that of the large firm, while the small firm only a fifth of the the larger firms. The study suggests there could be real productivity gains for the medium and small firms if they were to shift from piece rates for labor to time-determined wage rates (as the larger firm did). As to the choice of technology, which has a very important bearing on the quality of output, both high costs as well as lower sales act as barriers to the introduction of new technology.

In their study of the football industry in Sialkot, Tariq Raza shows that, despite intense competition (especially from China) in foreign markets they had earlier dominated, firms were reluctant to make part of their existing labor force redundant – and this stood in the way of increasing productivity and competitiveness. Similarly, in a study of the sports glove manufacturing industry, Saba Firdousi compares productivity across the four major firms that dominate domestic production. They find that the firms' main decision makers see the cost of switching from old to new technologies as being too high and their labor force as being relatively unskilled to work with new technologies.

3. Policy Issues

On the key question of how domestic firms can access new technology to reap productivity gains and increase competitiveness, the papers by Shaukat Hameed Khan and Sikander Rahim provide rich insights.

Pointing to Pakistan's dismal performance in patenting new inventions and technologies (the 978 applications filed with WIPO in 2014 by Pakistan are only 2 percent of the total filed by OIC countries), Khan makes a strong case for fostering technology entrepreneurship, given the "blurring boundaries between scientific research and technology application," especially in computers, IT and molecular biology. He points out that Pakistan has developed major technological capabilities in national government laboratories, especially in the strategic sectors, and these need to be shared with private sector firms.

Rahim traces Pakistan's poor record in promoting science and technology (S&T) and offers a pragmatic route for firms to climb up the value-added technology ladder. He shows that most multinationals break down their production process across regions and countries (global value chains) in search of lower wage-costs. Thus, by entering a value chain and establishing their credentials based on good performance, Pakistani firms could move up the value chain by training and upgrading their workforce (including through specialists from their multinational partners).

He argues that upgrading existing firms in low-value-added sectors such as textiles will not produce any real gains: the prices of these goods will remain low in international markets and reducing prices further will only benefit consumers in developed countries. However, he ignores the need for labor absorption in these labor-intensive sectors, given Pakistan's very high growth rate of the labor force. Rahim also shows little faith in the transfer of technology that takes place through foreign direct investment (FDI). His argument is that experience has shown that FDI only comes in to take advantage of Pakistan's protected market; it has hardly ever been a significant player in Pakistan's exports. As with many of the studies in this volume, Rahim rightly argues that the country needs to produce high-quality engineers and scientists as well as an educated and skilled labor force (with good literacy and numeracy skills and a basic knowledge of the sciences). Here, the role of the public sector could be important.

In his concluding remarks, the federal secretary for science and technology, Fazal Abbas Maken, outlined the strengths and weaknesses of

Pakistan's S&T capacity. As regards the former, besides an increase in the number of universities from 54 in 2000 to 174 in 2015, the areas he identified were agriculture and livestock, biology, biotechnology, pharmaceuticals, chemistry and IT. The weaknesses he cited include low government expenditure on S&T (as low as 0.29 percent of GDP), weak linkages between research, industry and academia, the lack of demand-driven research and the absence of high-tech-based entrepreneurship. As to new initiatives, he pointed to the establishment of S&T parks, tax incentives for firms carrying out in-house R&D and employing PhDs as well as subsidies to industry for upgrading technology.

4. Conclusion

Three key messages emerged from this conference:

1. While emphasizing the need to develop indigenous capacity in scientific research in public sector institutions and academia, the spillovers of this research to the private sector are almost negligible. In this context, the knowledge that has emerged in the development of major technological capabilities in government laboratories needs to be shared with the private sector urgently and under a well-worked-out policy framework.
2. Pakistan has had little success in formulating an industrial policy and (more importantly when done) in implementing it. One way of formulating a pragmatic policy to support the manufacturing sector could be to draw on some of the important findings that emerge from the papers on industry and firms in this volume as well as other studies, e.g., on tapping global value chains, credit and tax incentives for modernization and replacement, improving skills and education levels of the labor force, funding for job displacement and targeting growth in a few selected industries such as telecommunications.
3. As many of the papers point out, the rapid and encouraging signs of growth in the IT sector (in which Pakistan still lags far behind) through policies and incentives promoting the technopreneur has considerable potential.

Perhaps the most important message of the conference is that meetings such as these that bring together scientists, engineers, economists, industry specialists, business leaders and policymakers and draw on field research on the adoption of new technology in the private sector is the only way of coming up with a meaningful 'industrial policy.'

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Why Scientific Research is Imperative for Entrepreneurship and Sustainable Development in Pakistan

Bilal U. Haq*

Abstract

Indigenous scientific research is vital for a country's long-term economic growth. The simple transference of technology or acquisition of expertise ultimately has developmental limitations. Examples from the hydrocarbon industry clearly illustrate this paradox: oil-rich developing countries can afford to procure expert advice with ease, but rarely develop the new skills essential to make the next technological breakthrough or scientific paradigm shift. Underlying this failing is often the absence of a culture of open scientific enquiry. For resource-deficient countries, this is compounded by the dearth of infrastructure. Such countries argue that they cannot afford to finance scientific research, although this does not always require large investments up front. Software research and development is a good example, requiring primarily technical knowhow, skilled labor and a desire for innovative success. The deficit of scientific research in Pakistan stems from many of these factors, even though the requisite human resources are available in abundance. Innovation and entrepreneurship requires a special mix of encouragement and incentives from the government and industry. This paper outlines some of these issues based on the author's experience of several decades of research leadership and funding in the US and Europe, and his involvement in transferring advanced scientific knowledge to developing as well as developed countries.

Keywords: Scientific research, entrepreneuership, development, Pakistan.

JEL classification: O30, L26.

1. Introduction

This short paper contains a rather personal view of science and the economic good it can do nations that heed its promise. I have assembled these views over a period of several decades, both as a practicing research

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scientist and as a science facilitator at the US National Science Foundation (NSF), directing a major field of natural sciences, namely, marine and terrestrial geosciences.

This also includes my close involvement with research on global climate change (GCC), which affects all of us. The impact of climate change will be calamitous in countries located in the transition zone between the tropics and temperate latitudes, including Pakistan. Such changes will catch us unprepared if we do not plan in advance and could lead to critical and insoluble socioeconomic problems. My career-long active participation in the transfer of scientific knowledge and technology to both developing and developed countries has given me a vantage point from which to observe how science has been gainfully employed in the service of the public by some countries and what has gone awry in other, not so fortunate, ones.

2. Abdus Salam's Legacy in Promoting Science in Pakistan

Professor Abdus Salam, Pakistan's only Nobel laureate in science, was passionate about promoting not only theoretical physics, his own field of inquiry, but also other sciences in developing countries and especially in Pakistan, his much-loved native country. It was this passion for knowledge and the desire to promote it in less well-off countries that led him to propose the creation of an international center for theoretical physics under the aegis of UNESCO. Originally, he envisaged locating the center in Pakistan – a request the country denied, citing insufficient resources as an excuse. The proposed institution was eventually established in Trieste, Italy, which country provided the bulk of funding needed. What a great loss for our country and its science. Pakistan's political leadership has erred on the side of inanity ever since. Science, so important to the country's economic wellbeing, has been largely ignored. As a consequence, Pakistan is now among those countries that spend the lowest per capita on nonmilitary research in the world.

I met Professor Salam during his visit to Stockholm to receive the Nobel Prize in December 1979. I was a postdoctoral docent that year at Stockholm University and had the pleasure of attending the Nobel award ceremonies. I was also charged by my university to host Dr Salam for half a day and facilitate his meeting with resident Pakistani students. Dr Salam took time out to discuss each student's ongoing research individually. He tried to convey to our group his conviction that no country could prosper without indigenous science. He also expressed his frustration over the "brain drain" of bright minds to the West, given the lack of research resources in their own countries.

One could easily sense in him not only his passion for science, but also his great ambition to transfer advanced knowledge to countries such as his own. He reminded us that the pursuit of science and higher learning was entirely compatible with the teachings of Islam; it was incumbent upon us to disseminate knowledge to our countrymen and to anyone else who could put it to good use. My brief meeting with him left a great impression on me: I have tried to use him as a role model, especially (albeit in a smaller way) in my own pursuit to transfer scientific knowledge to where it might do the most good. It is time that Pakistan, like the rest of the world, acknowledged the greatness of Professor Salam and his generous role in inspiring a generation of scientists around the globe.

3. The Importance of Science

Science and its derivative, technology, lead directly to innovation, which is what powers countries' economic engine. Professor Salam is often cited as saying that, "unless you are very good at science, you will never be good at technology." The hydrocarbon exploration industry clearly shows that the transfer of technology alone – without developing local research and development (R&D) capabilities – has its limits. For example, oil-rich developing countries, such as those in the Middle East, can afford to buy the best expertise when needed, but usually fail to develop new technologies on their own because they have not fostered a local culture of free scientific enquiry or developed enduring infrastructure. Indeed, without indigenous scientific capabilities, no country can hope to prosper beyond a certain limit, where the use of knowledge is governed largely by expediency.

Scientific research is most often driven by scientists' passion for learning how Nature works. The process of inquiry into Nature generates new ideas that fuel economic growth and enable countries to remain competitive. Hence, the importance of indigenous scientific research and the process of investigation in itself. In the long run, it is not enough to just transfer technical knowledge from those who have it to those who do not. All countries need to develop their own infrastructure for scientific inquiry and discovery. Pakistan – notwithstanding a few bright spots – risks being left so far behind that it will have little hope of catching up with a rapidly advancing world both scientifically and economically.

4. The Example of China

The question that arises is what model Pakistan should follow if it is to realize some semblance of scientific parity with the developed world and the economic growth to which it aspires. The answer is staring us in the face. Not long ago, China was exactly at the same stage of development as Pakistan is now. In fact, at the time of the Cultural Revolution in the 1970s, matters worsened when much of China's existing scientific expertise and infrastructure were destroyed. The country had to rebuild everything from scratch.

Since the end of the Cultural Revolution, it has been my privilege to visit China nearly every year and monitor firsthand the growth of science and technology in the country and how it has fired the growth engine. I was also appointed visiting or honorary professor at several universities that sought my advice, for example, on creating a center of excellence in geosciences at Tongji University in Shanghai. This has given me the opportunity to closely observe the inner workings of their system.

It was impressive to watch China's phenomenal progress in science, along with its economic growth. Every year, Western science agencies have had to revise their estimates and predictions upward. Consequently, China has nearly caught up with the West in most sciences. Its institutions of higher learning house some of the most advanced scientific infrastructure and instrumentation. Chinese science today is an apt example of how academic ideas can be rapidly employed in technology and for practical application in the service of its people. This is the real story of achievement and China's grand entry into the entrepreneurial world.

How has China done it? The first step was a conscious decision on the part of its political leadership to promote science and catch up with the West in the shortest possible time. This purposeful resolution was followed by the equally important decision to invest preferentially in upgrading institutions of higher learning and scientific infrastructure, and to acquire modern instrumentation in all the sciences considered relevant to the country's development. To jumpstart the brainpower it needed, China decided to flood Western universities with government-funded doctoral students. China has been, and continues to be, the country with the most science students in foreign countries. Downstream, it has provided special incentives for its Western-trained scientists so that most of these invaluable professionals return home and are not frustrated by the lack of resources the country has to offer.

5. From Science to Innovation

The realization that there is a direct link between scientific research and entrepreneurship is relatively new. Not long ago, the academic world shunned the "industrial" or "commercial" stain and those professionals who opted to work for commercial enterprises were considered lost to science. This attitude has changed considerably in the last two decades. Today, universities fall over each other to attract industrial funding and to help students and faculty start up their own enterprises. As an example, the NSF, a bastion of fundamental academic research that has funded over 200 Nobel laureates (more than any other agency in the world), is breaking down the barriers between research and commercial development by funding major nodes or hubs of innovation in biotechnology, nanotechnology and computer science. This is a complete turnaround in thinking from just a few years ago and industrial participation in these hubs is an integral component of these plans.

It is often said that "today's pure science is tomorrow's innovation." This quote needs to be modified to "this morning's scientific idea is this afternoon's opportunity" in view of the rapid pace at which new ideas are translated into practical applications and as the speed of both adsorption and absorption of these ideas increases. This rapid conversion of ideas in pure science into innovative applications is the true "entrepreneur-ization" of science.

How do we encourage and sustain this trend? One well-tried method that has met with considerable success downstream has been to foster industrial-academic partnerships with mentors for young researchers from both sectors. This has worked particularly well in the hydrocarbon and chemicals industries, where qualified scientists and technologists can find immediate and innovative employment at the end of their academic training. Perhaps using the NSF's "innovation hub" model would help encourage such partnerships. This model has now been tried in a number of countries with great success, but also requires the government to play a very proactive role.

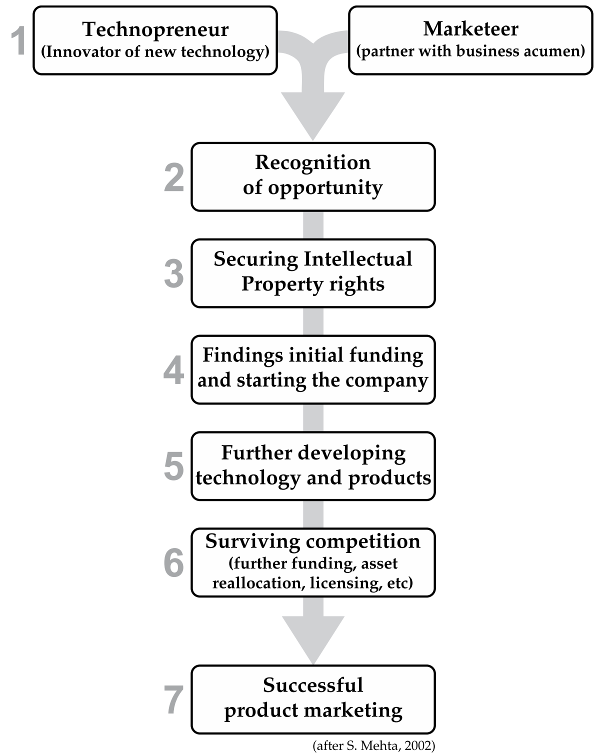
6. The "Technopreneur's" Path to Growth and Success

What about individual entrepreneurship? How can this be fostered? Essentially, it would work the same way as encouraging a broader culture of entrepreneurial innovation. The basis of nearly all individual entrepreneurial success lies in ideas couched in new technologies – hence, the term “technopreneur” – that take their cue from scientific advancements. This is exemplified in fields such as cybernetics, biotechnology, nanotechnology and medicine, where new findings are applied rapidly.

In computer science, and especially in software development, innovative talent often lies in the timely recognition that a new or existing technology can be applied afresh. This is where the individual initiative to use the technology as it has never been used before pays high dividends. Nevertheless, the technopreneur’s job is not a simple one. Entrepreneurial success requires partnering with someone who has the business acumen needed to market the product once the opportunity has been recognized. Numerous case studies show that most new entrepreneurial ventures fail because they lack a business component.

Figure 1, which illustrates the technopreneur’s path to success, shows that both stage 1 (the invention phase) and stage 5 (the development phase) need active scientific input. Securing intellectual property rights early (and guarding against copycats) may not seem very important to a new entrepreneur, but is indeed crucial to the venture’s long-term success. Many new enterprises are unable to get off the ground because they fail to obtain enough initial funding (stage 4), which requires convincing third parties to invest in their vision.

Figure 1: The technopreneur's path to successful innovation



Of course, there are no real substitutes for hard work in an entrepreneur's path to achievement. Entrepreneurial success requires (at least, initially) putting in long hours, employing the right people to help one and focusing on the products or services one will provide. Most well-known and successful online businesses were dreamt up by individuals who were extremely focused and refused to give up when faced with initial hurdles. An economically healthy country has an abundance of entrepreneurs who will thrive only if the state's policies encourage and foster new businesses with the right trade and tax incentives.

7. Science and Sustainable Development

The current German chancellor, Angela Merkel, during her tenure as minister for the environment, wrote an influential editorial in 1998 for *Science* magazine,[1] making several important points that are still relevant to sustainable development. She argues that, for a society to adopt a "socio-ecological" market economy while also aspiring to sustainable

[1] See: http://science.sciencemag.org/content/281/5375/336

development, it will have to discriminate better between economic growth and the simple exploitation and consumption of resources. The prevalent pure form of consumerism imperils natural ecosystems and diminishes our ability to preserve natural habitats.

This is where science must step in and provide new and innovative ways to ensure environmental sustainability and economic growth. While society in the developed world is shifting rapidly from a largely industrial base to a knowledge base, heavily polluting industries are being relocated to developing countries where environmental damage is rampant. These countries may end up having to spend large sums on cleaning up their industry (again, China is a good example here). This means that science and innovation will have to play even more important roles in the pursuit of sustainable development.

To achieve sustainability, in future we must constantly remind ourselves of the close link between Nature, society and the economy, and view development through the lens of natural ecological systems. Merkel points out that both policymakers and scientists will have to be cognizant of the links between ecological, economic and social factors when they seek solutions to development issues. She also warns that, in the long term, "progress" can work against us if it continues to be detrimental to Nature. Innovation and individual entrepreneurship will play important roles in development. Thus, sustainable development and entrepreneurship are strongly linked. Developing countries need to be vigilant about environmental degradation: where possible, they should opt for clean, knowledge-based technologies rather than giving in to the ultimately self-destructive allure of heavily polluting industries.

In her editorial for *Science*, Merkel lists four areas that she thinks deserve special attention from scientists and innovators: energy use, the closure of substance cycles, environmentally compatible mobility and biotechnology. Under energy use, she includes renewable energies (wind, solar, geothermal) and new propulsion technologies that will help reduce greenhouse gases. She points out that there are opportunities within existing technologies to design new, environmentally friendly production processes – technologies that optimize the use of resources with super-efficient, environmentally compatible production methods that reduce waste and promote sustainability.

What an enlightened attitude from this progressive, well-educated policymaker when compared to the conservative stance against science by politicians in many countries, including the US. Under the environmentally compatible mobility rubric, Merkel includes better traffic concepts and more energy-efficient automobiles that run preferably on less fuel or on nonpolluting fuels such as natural gas, electricity or hydrogen. In addition, more computer-efficient logistics for goods transportation could cut down transport distances.

Biotechnology innovations are well on their way to revolutionizing many fields, including medicine and therapy. Major advances are to be expected in resolving food shortages and ensuring cleaner industrial and agricultural production, environmental protection and pollution control. Many developing countries could easily build their own advanced capabilities in these areas in a short time and with relatively little investment. Agricultural research in Pakistan already has a strong biotech component and is considered world-class. This could be promoted in other related areas as well at the country's universities.

8. Pakistan's National Science, Technology and Innovation Policy

It is very commendable that policymakers in Pakistan have drafted a meaningful national policy on science, technology and innovation. The National Science, Technology and Innovation Policy (NSTIP) 2012 focuses on planning and management structures in these areas and identifies the need for (i) human resource development, (ii) indigenous technology development, (iii) technology transfer and the creation of absorptive capacity, (iv) international cooperation and (v) R&D in priority areas. Appropriately, it also highlights innovation as a key driver of economic activity.

With the exception of one important omission – cognizance of and planning for GCC – the NSTIP is a sound document that contains everything such a plan ought to have. For example, action items include increasing R&D expenditure to 1 percent of GDP by 2015 and 2 percent by 2020. The policy aims to restructure management systems to make them more efficient, strengthen monitoring, coordinate provincial reviews of science syllabi, build teachers' skills, equip science labs adequately and standardize training programs. It also aims to establish closer links between academia and industry R&D, import technical knowledge, develop reverse engineering capabilities and build Pakistan's capacity for technology transfer and absorption.

Better and wider international cooperation is also deemed essential. Among the priority "thrust areas" the NSTIP lists metrology, environment, health and pharmaceuticals, energy, agriculture and livestock, minerals, ocean resources, electronics, information technology, communications, material science, nanotechnology, lasers, photonics and engineering. All these goals are laudable and make for a comprehensive wish-list. But is it just that, a wish-list? For we have seen little action on this plan since 2012 when it was first published.

Higher literacy rates mean that countries have a greater pool of human resources from which to draw their scientific intelligentsia. Pakistan's expenditure on civilian R&D (0.67 percent of GDP) is too low for it to hope to catch up with developed countries (Table 1). For a country to build a solid base in sustainable scientific research, one that affects its economy positively and productively, it must spend at least 1.5–2.5 percent of its GDP on indigenous civilian R&D. Those that spend less on science are liable to be left behind the mainstream of scientifically well-positioned countries. Pakistan currently spends less than 0.7 percent on nonmilitary R&D, which is far too small an amount to address all the action items identified in the NSTIP. Its objective to increase this expenditure to 2 percent by 2020 will require a herculean effort on the part of policymakers.

Table 1: R&D expenditure and literacy rates for selected countries, 2015

Country	R&D, as a % of GDP PP	R&D per capita, in US$	Literacy rate, %[a]
Japan	3.67	1,260	≈99.0
US	2.70	1,275	86.0
Germany	2.40	861	≈99.0
China	2.08	248	96.4
France	1.90	641	≈99.0
India	0.90	37	71.2
Pakistan	0.67	15	58.0
	0.90[b]	20[b]	
Saudi Arabia	0.25	60	94.7

Note: a = the literacy rate is measured against a world average literacy rate of 86.1 percent; b = including military R&D.
Source: UNESCO Institute of Statistics.

8.1 Pakistan's Dilemma

Pakistan's low civilian R&D expenditure (among the lowest in the world) means that it cannot hope to catch up with the West any time soon; if this level of investment in science continues, it may even be left behind most Asian countries. The country also faces other constraints. Its low literacy rate – on average, 58 percent, with 70 percent among males and only 46 percent among females in 2015 – means that Pakistan has a very small pool from which to draw its intelligentsia, including scientists. The country's education system, both at the K-12 level and beyond, suffers from inadequate, outdated science curricula. Its research infrastructure, where it exists, is in a shambles (with some exceptions). There is also a perceived dearth of technicians and other professionals able to support sustainable scientific research. The biggest problem, of course, is the lack of political will to invest in science – this includes science and mathematics education, technical training and advanced research.

While the NSTIP addresses many of Pakistan's science needs, it almost completely ignores GCC, which could have ominous consequences for the country's food, health and economy. While the broader consequences of GCC are being debated by the world's scientific community, what is already clear is that these effects will vary considerably from region to region. Of course, for the same reason, solutions to GCC effects will have to be regional and local, not global. We cannot just import solutions from another region and apply them locally. We will have to find our own solutions. Ignoring this will catch us unawares and unprepared – with calamitous results for society and the economy. Indigenous research and inventory is urgently needed to chart local GCC effects because the associated economic and social setbacks will be severe.

The fact that the Himalayan glaciers that feed our rivers are retreating too rapidly is an example of just how urgent the situation is. As global mean atmospheric temperatures increase due to GCC, glaciers at high latitudes and high altitudes are retreating worldwide. They have already retreated by about 30 percent, on average, during the last century and are now retreating even more rapidly. Particularly in decline are the 15,000 odd glaciers of the Himalayas, which are retreating at 30 m/year, on average. These include the glaciers that feed all the rivers in India and Pakistan. At the current rate of retreat, predictions for the Subcontinent and the approaching water shortage are indeed critical.

8.2 Global Climate Change Predictions for Pakistan

That the climate is changing rapidly around the world is no longer a surprise to anyone. GCC is already underway and the debate on whether it is being caused by anthropogenic activity or is due primarily to natural factors is almost extraneous at this point. One detail that the climate research has established in recent years is that the way in which GCC affects different latitudes and regions will vary widely, depending on the geography and topography of the area. There will not be a uniform rise in the mean temperature everywhere, as is often conveyed by the commonly used label of "global warming" for these changes. The current preferred epithet used by climate scientists is "global climate weirding."

In the case of Pakistan, some likely scenarios under this climate weirding have already been foreseen, evident from ongoing events. First and foremost, water resources will become very thinly stretched all over the Subcontinent due to the permanent loss of the Himalayan glaciers. As mentioned above, mountain glaciers are retreating rapidly all over the world due to the temperature increase at higher altitudes; the Himalayan glaciers are no exception. This translates directly into the looming severe water shortage. An additional effect of this temperature rise at higher altitudes is that, during the winter monsoon months, much of the rain is not converted to snow. Instead, the water rushes down the rivers in the shape of severe floods – as recent years have amply demonstrated in Pakistan. This means that the climate in Pakistan will alternate between serious droughts and major floods with all their attendant detrimental consequences for society and the economy. Another prediction for the region is the spread of desertification further north into Punjab's prime food-growing areas. As is already evident, tropical diseases such as malaria, dengue fever and the Zika virus will spread to higher latitudes. Other infectious viral mutations that are unknown at present are also likely to increase (e.g., avian flu). Many of these effects are already underway.

Any socioeconomic plans we make for the country without taking into account the looming impact of GCC and necessary mitigation steps will be meaningless. When these events unfold, Pakistan's resources may be too thinly stretched; any immediate unplanned effort to counter a new event (not envisioned in our long-term economic plans) may not be possible. To prepare for all contingencies will require indigenous research by climate scientists in Pakistan working in close collaboration with economists, social scientists and policymakers. Climate science in the broader sense – not just metrology, but also modeling to hindcast as well as forecast GCC effects in the region – is an area in which Pakistan needs to train more graduates and first-rate researchers. Currently, this capability is nonexistent.

8.3 Potential Solutions

What are the solutions to Pakistan's dilemma, given the many constraints it faces? Earlier, I mentioned that we should try to emulate China, but it is not easy to follow a model that has a centrally managed political system: any articulation by Beijing or provincial leaders is almost immediately translated into public policy, while state agencies act on this equally rapidly and at the peril of their organizational health. We can learn a great deal from China nonetheless. Some of the steps Pakistan's policymakers could take – that have proven to produce positive results – include the following:

- Improve school and college science curricula, which are exceedingly outdated.
- Train school and college instructors in modern mathematics and science concepts.
- Train substantially more technicians in all fields of scientific research at polytechnic institutions; these service providers form the backbone of research labs and organizations.
- Introduce a significant (possibly tenfold) increase in government-funded PhDs abroad. For China, this policy has paid high dividends with relatively modest investment and been a key factor in enabling the country to catch up with the West in all major sciences in a fairly short time. China has flooded many Western universities with graduate students in the last three decades.
- China has also put in place considerable monetary inducements as well as facilities to attract expat Chinese scientists back home. Similar incentives could also be used in Pakistan to encourage some of the best minds in the world to return.
- Significantly increase science funding agency budgets (e.g., for the Pakistan Science Foundation and others) to a minimum of 1.5 percent of GDP and eventually to 2 percent of GDP.
- Longer-term plans should include an emphasis on target sciences that are considered socioeconomically important for the country.

- The US NSF model of hubs or nodes could be employed as academia–industry partnerships and as added incentives for innovation.

9. Conclusion

This short discussion of the importance of indigenous research for sustainable development concludes that, if Pakistan does not develop local capabilities in scientific research, especially in subjects considered relevant to its growth, it cannot achieve the kind of sustainable development to which it aspires.

While the NSTIP is a fairly comprehensive plan, it has not been fully promulgated and has already failed to meet its 2015 target of allocating 1 percent of GDP to expenditure on science and technology research. The policy also ignores the consequences of GCC, leaving Pakistan unprepared for the dire results that this may have. Indigenous research is urgently needed in this context. The rate at which the Himalayan glaciers, which feed Pakistan's rivers, are retreating illustrates this urgency, given the looming severe water shortage for the country.

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The Productivity Growth–Technology–Entrepreneurship Nexus: Implications for Pakistan

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Abstract

Labor productivity growth has received scant attention in Pakistan even though it is the foundation of rising living standards and a country's ability to compete in the world market. Productivity rises when producers invest and introduce new technologies to reduce production costs and improve the quality and range of goods produced. Competition among producers entails a constant search for areas of improvement, tapping new technologies and finding innovative ways to produce and deliver the output to consumers. This is entrepreneurship. The first part of the paper discusses productivity growth and its drivers. The second part explains the critical importance of technological progress and innovation in economic growth and the catch-up process. Entrepreneurship and how it might be stimulated in Pakistan is discussed next. The paper concludes with a few ideas on how science and technology might be promoted in Pakistan.

Keywords: Labor, productivity, entrepreneurship, Pakistan.

JEL classification: E24, O14.

1. Introduction

Productivity growth is the *basis* of rising living standards and a country's ability to compete in the world market. Productivity improves when producers seek ways to lower costs and improve the quality and range of goods and services produced. This entails tapping new technologies and finding innovative ways to produce and deliver products to the consumer – a task typically performed by entrepreneurs. They innovate, adopt and adapt new technologies in production and distribution and, in the process, raise productivity. However, in traditional neoclassical economics, productivity growth is not a dominant concern but rather incidental to producers' efforts to maximize profits. This paper attempts to elucidate the nexus of productivity growth, technological progress and entrepreneurship and examine its implications for Pakistan.

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2. Productivity Growth

A country's per capita income depends directly on labor productivity, as can be seen from the following two relationships:

Per capita income (Y/P) = *labor productivity* (Y/E) x *employment rate* (E/N) x *labor force participation rate* (N/P) (1)

where Y is national income, P is population, E is employment and N is the size of the labor force. Expressing equation (1) in terms of growth rates:

Growth of per capita income = growth of labor productivity + proportionate change in the employment rate + proportionate change in the labor participation rate (2)

The first relationship is simply an identity: per capita income is the product of labor productivity, the proportion of labor force employed and the proportion of active labor force in the population. The second relationship, derived from the first, states that the growth of per capita income is the sum of the growth in labor productivity and proportionate changes in the employment rate and labor force participation rate. In other words, per capita income can rise on account of an increase in any of the three factors on the right-hand side, i.e., labor productivity, the employment rate and labor force participation rate. Over the longer term, however, since unemployment and labor force participation rates change only within fairly narrow limits, the growth of per capita income depends primarily on growth in labor productivity.

A country's terms of trade also affect national real income. An improvement in the terms of trade is analogous to an increase in productivity because the country can obtain more in imports for a given volume of exports, i.e., the domestic resource cost. How the terms of trade move over time is not usually within a country's control and depends largely on exogenous episodes such as war, crop failures, new resource discoveries or mining disasters. Countries might *want* to move the terms of trade in their favor but they have few means available to make this happen on a sustained basis.

The overall growth of labor productivity is affected by an economy's sectoral orientation (some sectors tend to have higher labor productivity) and the growth in productivity of individual sectors, that is:

Overall productivity growth = Σ (*individual sectors' productivity growth* x *the sector's weight in GDP*) (3)

In other words, overall productivity rises both because individual sectors experience technological improvements and because the economy's structure moves toward more sophisticated, higher-productivity sectors. This simple and rather obvious proposition is at the heart of economic progress: as economies evolve, higher-productivity or higher value-added sectors gain in salience. However, the above relationship also shows that, because of their weight in the economy, traditional sectors remain dominant in the economy's overall performance in the earlier phases of development. How long this lasts depends on the pace of economic restructuring.

Another implication of Equation 3 is that, from the viewpoint of longer-term economic growth and development, the choice of industry does matter. Some industries simply have far greater potential for productivity growth, at least during certain phases of their evolution. This has been described graphically as a country having to choose between producing potato chips and microchips.

Whether productivity growth materializes through sectoral shifts or in-sector improvements, science and technology (S&T) capabilities are at the core of the change. Higher-productivity sectors generally, but not always, tend also to be technologically more sophisticated – aircraft manufacturing is more technologically challenging than garment production – while sectoral productivity growth materializes as technologically more advanced production processes come to be used. Occasionally, this can be phenomenal, as was observed during the revolutionary improvements in agricultural practices of the past 50 years.

There are three ways that productivity in a particular sector might rise. First, at any given time, individual industrial plants may operate at different levels of efficiency on account of organizational or management differences (the so-called "X-inefficiencies"). As lagging producers emulate the available best practice, overall sectoral efficiency will rise. Second, at any given time, different plants may employ machinery of different vintages since producers install and scrap equipment at different rates. Again, as more producers employ newer equipment, overall productivity will rise. Finally, there are the developments in the "state of the art": the introduction of new products and processes, typically resulting from research and development (R&D). It is only in this instance that *new* knowledge is being generated; the first two cases represent the result of knowledge diffusion. In the face of such developments, the "best practice" is not a fixed point, but rather a moving target and technological catch up is a challenge and a continuing process.

Thus, whether it is sectoral shifts or in-sector growth, the long-term growth in labor productivity is driven by technological progress.[1] There is, however, a real conflict here. While countries seek to realize steady improvements in living standards, which involves rising productivity, profit maximization on the part of producers may not necessarily be consistent with that goal. Producers want to control production costs; how that is achieved is generally of little concern to them. In the process, they often take shortcuts that hurt the longer-term economic growth. This issue is discussed further below.

3. Pakistan's Productivity Performance

Labor productivity performance receives scant attention in Pakistan, which is evident from the paucity of data on this critical metric. The last released census of manufacturing was conducted in 2006 and the data on value added in key industries for recent years are more or less just best guesses. By contrast, in advanced countries and particularly in East Asia, labor productivity is watched with great interest as it is a key indicator of competitiveness and overall economic performance. Indeed, Japan, which demonstrated that it was possible to catch up with the more advanced economies, established an organization specifically tasked to gather productivity data for Japan as well as its competitors. The Asian Productivity Organization, based in Tokyo, now covers the entire region and aims to support "member economies in acquiring practical, state-of-the-art tools and knowledge to foster productivity at industry and enterprise levels" (2015, p. ix).

The organization's data show that Pakistan's overall productivity registered the lowest growth of all Asian economies during 2000–11 – just a little over 1 percent a year – in contrast to China's 10 percent and India's 8

1 The standard neoclassical model of economic growth defines technological progress as total factor productivity (TFP), which is meant to capture the productive efficiency of all factors of production. However, TFP is typically measured by making stringent assumptions regarding the form and properties of the production function, itself an intrinsically flawed concept. TFP has been called "a measure of our ignorance" and estimates are entirely unreliable. The growth in labor productivity, which is conceptually more robust, can be taken to reflect technological progress since even when it results from more capital being used, it signifies technological progress (Salter, 1966; Dosi, Pavitt & Soete, 1990; Haque et al., 1995).

percent. With respect to productivity in manufacturing, Pakistan's growth at 2.3 percent a year, while not the lowest, makes it among the poorest Asian performers. The country data show that Pakistan's productivity level in manufacturing was half that of Indonesia and a quarter that of Malaysia in the early 1990s, but this gap widened considerably over time, especially with respect to Malaysia. In 2007, Malaysia was more than ten times as productive and Indonesia three times as productive as Pakistan (Haque, 2014). In other words, far from catching up, Pakistan fell far behind the other two Asian economies. The country's export failure and lack of competitiveness is thus largely attributable to its dismal productivity growth, especially in manufacturing, although a common perception is that the lack of diversification and concentration on low-technology industries is the principal cause (for a detailed discussion, see Haque, 2014).

While a number of factors could be held responsible for low productivity in Pakistan's case – power availability, other infrastructure weaknesses and, not least, the security situation – extremely low investment in physical and human capital must be considered the nub of the problem. With an investment rate of barely 15 percent of GDP, Pakistan ranks among the world's lowest investors. This means that Pakistan's capital stock is, on the whole, much older than its competitors', over time becoming increasingly so. Obviously, where investment rates have been high – as, for example, in China or India – the existing capital stocks are much younger and more efficient (Haque, 2014). In short, Pakistan needs targeted policies not only to foster adoption of technological improvements at the firm level, but also to achieve a higher investment rate at the macroeconomic level. There is urgency to this because the economy is currently operating far below its potential and continues to fall further behind other developing economies.

4. Technological Progress and Innovation

Producers' ability to introduce improvements in products and processes depends on the stock of knowledge and information they are able to access and use. However, a precondition for innovation is that producers are *seeking* improvement – actively looking for ways to improve the quality and range of products they produce – and do so while reducing production costs. Such producers are the classic Schumpeterian entrepreneurs.

In mainstream economics, technological progress has not gone beyond the status of an add-on. In the earlier neoclassical growth models pioneered by Robert Solow and others, technological progress was introduced as a scalar, a multiplicand that uniformly shifted upwards the constant-returns-to-scale production function. Thus, in effect, what was described as technological progress was just the unexplained part of the regression estimates of the production function.

Subsequently, the theoretical discussion progressed to include "learning by doing" – a concept Arrow introduced in 1962. This was an attempt to explain why producers fail to produce at the optimal level even when facing identical production conditions. The explanation for the observed variance in productive efficiency across producers was that it takes time to acquire the necessary experience and expertise to operate new equipment. While this idea was innovative at the time, it too was fundamentally static and explained a rather narrow issue.

The endogenous economic growth models of the 1980s led by Romer took the discussion of technological progress a little further and sought to explain why productivity rises, but provided little guidance to investors or policymakers. They failed to explain the historically observed general widening of income disparity across countries or the phenomenal success of some countries in catching up with the more advanced economies. The models were mathematically challenging and of little practical value and gradually faded away from the economic discourse.

The fact is that technological progress is difficult to "model" in the sense of generalizable and predictable behavior. Perhaps the foremost reason is that knowledge does not transfer easily and the sharers of knowledge often have differing views as to its economic significance. Thus, people tend to respond differently to a given piece of information and producers may have different notions as to what works and what may not. For example, among car manufacturers, some producers favor hybrids over fully electric cars and some continue with the traditional petrol engines. In short, producers tend to place different bets in the choice of technology.

Closely related is the fact that technological blueprints are just guides and require adaptation to local circumstances before being implemented. Thus, even when production techniques or designs can be borrowed, a great deal of plant-level innovation and ingenuity is involved in making them work at a new plant site. The transfer of knowledge across countries is particularly difficult because of differences in culture, legal or regulatory requirements and the natural environment. All these considerations present enormous practical and theoretical difficulties in incorporating knowledge and technological progress within traditional economic models. Where economists have tried, they have ended up drawing fairly bizarre conclusions.[2]

It is often difficult to distinguish between innovation and imitation, as both require accumulation of knowledge. The difference is that, in one case, the knowledge frontier is being extended, and in the other, the individual producer is striving to move towards that frontier. In both cases, however, learning has to take place and ideas require adaptation and modification to local reality. Moreover, while technological progress is crucial to productivity improvements and economic growth, it can also go in the opposite direction. An environment of rapid growth and global competition itself can and often does stimulate the search for new and improved methods of production and encourage scientific research. In this virtuous circle, economic growth and technological progress feed on each other. As Nelson (1981) notes:

> Just as a high rate of capital formation and a well-educated workforce stimulate technological advance, so technological advance stimulates a high rate of capital formation and motivates young people to acquire formal education (p. 1055).

Crucial to the learning is a certain level of understanding of science and mathematics. Scientific knowledge that enhances our understanding of the workings of the physical environment is the basis for technological progress. As Dr Abdus Salam observes:

> Three centuries ago, around the year 1660, two of the greatest monuments of modern history were erected, one in the West and one in the East: St Paul's Cathedral in London and the Taj Mahal in Agra. Between them, the two symbolize… the comparative level of architectural technology, the comparative level of craftsmanship and the comparative level of affluence and sophistication the two cultures had attained at that epoch of history. But at about the same time there was also created – and this time only in the West – a third monument, a monument still greater

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[2] An egregious case is that of Grossman and Helpman (1991), who view R&D as an economic activity subject to the law of comparative advantage. They argue that it would be a waste of world resources if countries seeking to catch up in technology were to subsidize R&D as they do not have a comparative advantage in undertaking R&D: "The inefficiency in world research implies a loss of world output, and in general every country finds itself sharing in the loss" (p. 341).

in its eventual import for humanity. This was Newton's *Principia*, published in 1687 (cited in Lai, 1987).

Apart from material progress, scientific and technological developments contribute to the quality of life, reducing morbidity and extending life expectancy. Even more significant is that science promotes the advancement of knowledge by fostering intellectual curiosity, sharpening observation of natural and social phenomena and promoting a culture of problem solving. All these factors contributed to the rapid advancement of the US and European economies during the last two centuries – a lead that remains more or less intact.

However, the science–technology, technology–economic progress links are far from unambiguous. There is, for example, no certainty that enhanced scientific education and research will readily yield commercially viable technologies (as, for example, was the case with the scientific achievements of the former Soviet Union) or that technological advances will immediately lead to more rapid economic growth (the revolutionary strides that information technology has taken in recent years have yet to translate into significant productivity growth). However, science also progresses through technological innovations: for example, the increasing sophistication of measuring instruments was an important contributor to the scientific advance. Similarly, the capacity of computers to handle increasingly complex mathematical problems as well as the Internet have greatly facilitated research.

Nevertheless, there is strong evidence of a close relationship between investment in S&T and economic performance. Several studies show R&D expenditures and economic growth to be closely linked (see Dosi et al., 1990; Fagerberg, 1988). Fagerberg finds that "to catch up with the developed countries… semi-industrialized countries cannot rely only on a combination of technology import and investments, but have to increase their national technology activities as well" (1988, p. 451).

Investment in education and skills is widely recognized as crucial to countries' ability to catch up with the more advanced economies. The East Asian economies provide a clear example of that. A number of studies show that countries that invested more in human capital (measured in terms of school enrolment rates), other things being equal, tended to grow faster than those that did not (see, for example, Barro, 1991; Baumol, Blackman & Wolff, 1989; World Bank, 1993). There is some evidence that the quality of education in science and mathematics is also a significant factor in explaining a country's economic performance. The high economic performance of Singapore, Korea and Japan during 1970–90 was seen to be associated with the top high school scores in science and mathematics.

In all these respects, Pakistan is a laggard. It ranks low in terms of general education, S&T capabilities and R&D by industry. According to the National Science, Technology and Innovation Policy (NSTIP) 2012, Pakistan has only 162 researchers per million of population, compared to 2,000–5,000 in advanced countries. Similarly, "technician-level manpower" is 64 per million, compared to 1,500–2,000 in advanced countries (Pakistan, Ministry of Science and Technology, 2012, p. 12). The policy document also notes: "As there was no real demand from industry, the R&D system of the country is oriented towards the supply side. R&D activity in the industrial sector itself is assumed to be negligible. This is in contrast to the industrialized countries where the industrial sector is a major contributor to the overall R&D effort of the country" (p. x).

There are several reasons for the current state of affairs. The first and foremost is that S&T in Pakistan, as in most other developing countries, has been largely the state's responsibility in the face of severely constrained administrative and financial capacity to carry out the task. At the same time, S&T has not been recognized as a central issue in the discussion and formulation of Pakistan's development plans and economic policy. The Planning Commission's Framework for Economic Growth issued in 2011 underscored the country's poor productivity performance, but saw the remedy in improving the quality of governance, market liberalization, deregulation and generally letting the government move out of the way of private enterprise. The fact is that Pakistan's business community has shown little Schumpeterian entrepreneurship and appreciation of the importance of S&T in economic advancement and international competitiveness. The next section addresses this issue.

5. Entrepreneurship

A country's economic prowess and international competitiveness depend on how its business firms perform in the world market. Their ability to generate and manage technological change – bringing to the market new products, lowering production costs – drives the growth in sales and profits. An economy dominated by technologically dynamic firms can be expected to prosper and grow faster. The postwar catch-up of the Japanese economy with the US and other industrial countries was nothing but a reflection of the stellar performance of its firms. Other major emerging market economies too – China, India, Korea, Taiwan – are known for their world-leading firms. On the other hand, Pakistan, a country of 200 million with a per capita income comparable to India's, cannot boast of a single firm being a significant player in the world market.

There is much to lament on Pakistan's industrial development performance. Industry is concentrated in textiles and very little diversification toward higher-productivity sectors has occurred over time. Productivity growth has been modest and Pakistani firms' performance in the world market has, with a few exceptions, lagged far behind that of their competitors. While other economies in Asia – Bangladesh, China, India, Indonesia – have taken strides in world exports, Pakistan's export-to-GDP ratio has declined over the past three decades and is now around 10 percent.

As to the causes of this sad economic record, researchers' default position has been to blame the country's over-protective regime, over-regulation and over-interfering government, which together are believed to have stifled entrepreneurship. According to Haque (2007):

> We see that entrepreneurship in Pakistan is seriously impaired by government policy, legislation and regulation. The government has continuously been of the opinion that investment especially at the large industrial level is entrepreneurship. As a result, it has been unable to promote genuine entrepreneurship and promoted cartelization and rent-seeking instead (p. 9).

This diagnosis leads to rather obvious policy prescriptions: to undo the prevailing policy and governance regime by liberalizing trade, deregulating and letting the government generally move out of the private sector's way. Under this policy environment, rent-seeking firms are expected to become efficiency seekers and profit maximizers, enabling the country to join the ranks of other star performers. This reasoning, however, is seriously flawed and has been questioned elsewhere (see, for instance, Haque, 2014, 2015). It is enough here to note that, while Pakistan is far from being a paragon of economic liberalism, it compares favorably with other Asian countries that performed well in recent times.

Over the years, the World Bank's doing-business indices (notwithstanding their deficiencies) have placed Pakistan ahead of China or India in several respects (Haque, 2014). According to Transparency

International's global corruption barometer for 2013, Pakistan ranks 34 while India ranks 54.[3] Pakistan has also taken steps toward market liberalization and deregulation over the past two decades. Protection has been lowered considerably and several state-owned companies privatized, the capital account is now virtually free and measures have been introduced to create a more business-friendly environment. Thus far, the fruits of these measures are hard to perceive. Critics argue that more needs to be done, but from the results so far, it appears that, not more, but something different, might be required.

A firm's performance depends on the drive and entrepreneurship of its managers and owners, whose decisions on investment, worker training, marketing and R&D reflect its responsiveness to technological challenges. Ethnicity is sometimes seen to be associated with entrepreneurship, but it is ultimately financial institutions and economic policy that influence investors' attitude to risk and innovation and whether they base their decisions on longer-term considerations or opportunities for quick payoffs.

There has been, over the years, a keen debate on the relative merits of the so-called Anglo-Saxon model, driven by stock market financing and shareholder value, against the traditional Continental or Japanese model, where banks play the dominant role in firm financing. Search for profit is central to the market economy, but what distinguishes the leadership of a successful firm in the long term is how that goal is pursued. Financial manipulation and other short-term measures of cost cutting, such as neglecting quality and worker training, may improve the firm's "bottom-line" but its survival ultimately depends on investments to improve its products, services and production processes. The question is whether it is possible to devise government policies, regulations and institutions that induce firms to invest in areas that are conducive to the country's longer-term growth and to seek profit opportunities in productive rather than unproductive rent-seeking. This issue is taken up in the concluding section.

6. Promoting S&T in Pakistan

For Pakistan to emerge as a dynamic and internationally competitive economy, considerable investment and a fundamental change in priorities is needed to build up local capabilities to generate and manage technological change. At present, these capabilities are totally inadequate

[3] http://www.bbc.co.uk/news/business-23231318

to meet the challenges of the global economy and the 21st century. The pace of technological change in Pakistan compares very poorly with the performance of some of its Asian competitors. This is the principal explanation for Pakistan's slow economic growth and faltering performance in the world market.

Promoting S&T requires, on the one side, business firms that are entrepreneurial in their actions and approach to investment decisions and, on the other, the available knowledge and information. To carry out the entrepreneurial firms' plans and investments, the availability of suitably skilled workers is a sine qua non. The goal of national development must be to promote technologically dynamic firms. Just as sports champions are created rather than selected, the careful nurturing of firms is key to their success in the world market. As a laggard in industrial development, Pakistan suffers from a host of disadvantages that call for government help and support.

The NSTIP 2012 is an ambitious, visionary document containing many useful ideas and proposals for promoting S&T in Pakistan. It suggests a number of institutional reforms, notably the re-composition of the National Commission for Science and Technology and its executive committee and the establishment of a high-level Pakistan Council for Science and Technology. The NSTIP also emphasizes the need to expand and improve the country's human resource base by improving syllabi and enhancing teachers' skills. Among its "thrust areas", the policy document accords highest priority to metrology, standards, testing and quality control, in which Pakistan's current status is fairly dismal. Environment, health and pharmaceuticals and several other areas are also underscored.

Sadly, however, four years have elapsed with little progress on any of these proposals. It is not even clear whether the government any longer accepts the NSTIP as a basic policy document. Nevertheless, the policy statement provides a good basis to start rethinking the national approach to science, technology and innovation. The foremost step in this process would be to foster much closer coordination of economic policy and focus on balancing the sources of supply (scientists and engineers) and demand for S&T capabilities (mainly the business sector). Specifically, the government has a critical role in:

- Promoting a commitment to national development among firm managers and owners

- Promoting a culture of technological improvement and upgrading within business firms
- Fostering a long-term strategic perspective of catching up with world leaders in the relevant industries
- Establishing closer employer–worker relationships to achieve higher productivity growth and improvements in product quality
- Ensuring that new firms can join the group of high performers while facilitating the exit of those that fail.

The National Commission for Science and Technology could provide the institutional setting for improved contact and interaction among the business, education and industry sectors to ensure demand-driven technology development and absorption. It could do so by making known to industry – through seminars, reports and other means of publicity – the work program and output of local research institutes. It could also organize seminars and conferences at Pakistani universities, colleges or even schools to expose them to the needs of business and industry. Equally important would be assistance and advice on how local R&D institutions could market their services to industry. An important resource to tap is the overseas Pakistani community of engineers, scientists and technology experts who are eager to serve Pakistan on an ad hoc basis.

The traditional approach to building up technological and scientific capacity, which relies on spreading education and developing R&D institutions, will yield results too slowly in a rapidly changing world. Pakistan, in the meantime, will have fallen further behind the more advanced developing countries. If it is to catch up with them, it will need to take shortcuts to developing local S&T capabilities and laying the foundations for a robust national system of innovation, enabling the country to leapfrog to the technological demands of the 21st century.

Pakistan has not only fewer scientists and engineers per capita than the rapidly growing economies, but the available S&T capabilities are also generally inferior and poorly used. A major reason for this is that neither the government nor the business community have been able to create a robust R&D infrastructure, notwithstanding several bright spots in research and innovative activity that call for scaling up and replication countrywide.

Since Pakistan's financial and administrative resources for promoting S&T can be expected to remain severely constrained, it will need to prioritize the development of S&T capabilities. To this end, the government has four areas of action at its disposal:

- *Macroeconomic policy*. Investment decisions are susceptible to the country's macroeconomic policy. Traditional stabilization measures are usually targeted at reducing demand, hurting economic growth, which in many cases becomes an endless process, as we have witnessed in Pakistan. The result is that, despite attempts at stability, inflation persists while economic growth is choked. However, it is often possible to adopt what are called "heterodox" policies that seek to ensure adequate public and private sector investment while achieving economic stability with economic expansion. The scope of such measures in Pakistan is discussed in Haque and Amjad (2012).
- *Financial system*. How investments are financed can be crucial both to their orientation and their pace. In the earlier phase of economic development, Pakistan had institutions that financed private investment. Under the sweep of neoliberalism, these development finance agencies (PIDC, PICIC) were allowed to wither away, even as private bank financing failed to fill the gap. Monetary policy in Pakistan is concerned only with the height of interest rates, but not the actual availability of financing for new investment ventures.
- *Industrial policy and incentives regime*. The successful industrialization of East Asia has demonstrated that industrial policy can be a very effective instrument for economic change. While times have changed and Pakistan's circumstances are different, there is much that the country can learn from the East Asian experience (Haque, 2014). Two things in particular are important. First, industrial policy is needed to create a common vision or direction for industrialization among firms. Second, while incentives are useful to help move investment decisions in the chosen direction, the government needs to devise and implement a system of rewards and penalties to ensure that the established economic goals and targets are realized.
- *Regulatory environment for domestic competition*. An important aspect of the East Asian experience, notably that of Japan, is the role played by domestic competition as the force behind national firms becoming strong competitors internationally. While the disciplining force of international competition is stressed in the development literature, it is the domestic competitive environment that is more relevant to industry. For one thing, a major segment of industry supplies primarily the domestic market. For another, the ease of entry and exit of firms in

the domestic market may offset the harm done by protection. Indeed, the rate of entry and exit of firms (and sometimes also entry plus exit) is a practical and useful measure of entrepreneurship.

Finally, there is the question of education in science and engineering. No country has developed without having an adequate supply of high-level scientists and engineers. As Dr Abdus Salam observed: "It is just impossible to talk only of technology transfer. One should talk of science transfer first and technology transfer later … Unless you are very good at science you will never be good at technology" (cited in Pakistan, Ministry of Science and Technology, 2012).

There is, therefore, a need to develop ideas on how educational institutions might respond to the emerging requirement for scientists and engineers. A critical issue that many other countries (including advanced countries) also face is what can be done to make the study of sciences, engineering and mathematics attractive fields at the school and university level. Paradoxically, many developing countries, including Pakistan, suffer from the problem of unemployed and unemployable scientists and engineers. This may be the result of poor quality or an unsuitable mix of available skills, which again calls for improving the quality of education as well as building closer relationships between businesses and the institutions engaged in science and engineering education.

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Pakistan's Productivity Performance and TFP Trends, 1980–2015: Cause for Real Concern

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Abstract

This paper reviews Pakistan's productivity performance over the last 35 years (1980–2015) and identifies factors that help explain the declining trend in labor productivity and total factor productivity (TFP), both of which could have served as major drivers of productivity growth – as happened in East Asia and more recently in India. A key finding is that the maximum TFP gains and their contribution to economic growth are realized during periods of high-output growth. The lack of sustained growth and low and declining levels of investment appear to be the most important causes of the low contribution of TFP to productivity growth, which has now reached levels that should be of major concern to policymakers vis-à-vis Pakistan's growth prospects.

Using the endogenous growth model, we examine the contribution of physical capital, human capital and TFP to labor productivity. The results suggest that, over these 35 years, the contribution of physical capital and education remains modest and there has been a declining trend in TFP growth. This shows that Pakistan's economy has not taken full advantage of the favorable technological developments and rapid globalization of the period. We also question the view expressed in recent studies that Pakistan's growth has been driven primarily by factor inputs, namely labor and capital, and not by TFP growth. The paper argues to the contrary that it is the lack of investment in and growth of the stock of capital embodying the most recent knowledge and technology that has inhibited TFP growth post-1990. Finally, there is an urgent need for further research to understand the dynamics of growth in services and to raise TFP in this sector as India has done post-1990.

Keywords: Growth, labour, capital, labour productivity, total factor productivity, Pakistan.

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1. Introduction

Since the 1980s, and until recently, rapid globalization – driven in part by the unprecedented pace of technological change, especially in information and communications technology (ICT) – has allowed several developing countries, including China and India, to take advantage of these developments and achieve exceptionally high rates of economic growth, even soaring to double digits. Unfortunately, Pakistan, which was among the ten fastest-growing economies of the world during 1960–90, has not been one of them.[1] This is despite the fact that, in many ways, Pakistan was a more open and globalized economy than either China or India in the early 1980s. While Pakistan's low and declining economic growth during 1990–2015 (except for a brief spurt in 2003–06) has been the subject of considerable rumination, an important factor responsible for this outcome, i.e., labor productivity, has not received the attention it deserves.

The importance of labor productivity is best captured by Nobel Laureate Paul Krugman: "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise output per worker" (1994). A closer examination of Pakistan's labor productivity trends is both revealing and deeply worrying. Compared to the 1980s, when labor productivity (defined as GDP divided by the employed labor force) grew at 4.2 percent per annum, by the 1990s this had plummeted to 1.8 percent, falling further to 1.3 percent during 2000–15. Since 2007, it has grown at just 1 percent. In India, the trend has moved in the opposite direction, with labor productivity growing to well over 5 percent during 2000–10.

Labor productivity, or output growth per worker, can be attributed to three major factors (ignoring arable land, which did not grow in this period): (i) increases in physical capital (machinery and related inputs), (ii) increases in human capital (measured by average years of schooling) and (iii) what economists term 'total factor productivity' (TFP), which measures the contribution of technological progress and more efficient use of existing resources.

While the contribution of both capital and labor has been marginal – for good reason, as we explain below – it is the continuing decline in TFP growth over the last 25 years that exposes many of the fundamental

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[1] Based on various issues of the World Development Report (World Bank).

weaknesses that bedevil the Pakistani economy. It is indeed ironic that, despite many attempts at economic reforms under the aegis of the International Monetary Fund (IMF) and World Bank, TFP growth has slowed down drastically, pointing to the little impact these reforms have had on improving economic efficiency when they were expected to have exactly the opposite effect. Clearly, the reform process – either due to its uneven pace or frequent reversals – has not delivered. This declining TFP growth also shows that, despite the widespread use of mobile phones and other ICT-driven gadgets, Pakistan has been unable to take advantage of the potential of extraordinary technological advancements we have seen in the last 25 years. Accordingly, we focus on the following questions:

- Why did the overall economy as well as its main sectors (agriculture, industry and services) not become more productive and efficient (in terms of a rising TFP growth) during 1980–2015 – a period of rapid globalization and technological change (especially in ICT), in which far-reaching reforms were undertaken under the aegis of the IMF and World Bank post-1990?
- What were the major contributors to the overall declining trend in productivity growth? Physical capital per worker, human capital (educational attainment) or TFP, which is expected to capture technological change, innovation and improvements in the basic efficiency of resource use?

To address these questions, we use the endogenous growth model and analyze the contribution of physical capital, human capital and TFP to overall labor productivity as well as that of the major sectors. Our main conclusion is that the maximum TFP gains and their contribution to growth are realized during high-output growth. This is because new investment (which drives growth) embodies the latest knowledge, innovation and technology, in turn raising TFP growth and its contribution to productivity and economic growth. The lack of output growth post-1990, except for a brief spurt in 2002–06, was a key factor holding back the favorable impact of the economic reforms undertaken as they coincided with downturns in economic growth. These downturns were as much a result of deflationary policies adopted to restore macroeconomic stability as the slowdown in the global economy after the financial crisis of 2008.

The study analyses separately the sources of economic growth in the three main sectors – agriculture, industry and services – and finds significant differences in factors, including the contribution of TFP to economic growth as well as in the dynamics of output, productivity and the TFP growth of each sector. Indeed, a sectoral approach is key to understanding and interpreting results at the aggregate level.

2. A Review of the Literature

A number of empirical studies have been conducted on developed and developing economies to explain how growth in output can be attributed to growth in factor accumulation and increasing factor productivity.

In an important study, Haque (1995) analyzes the behavior of labor productivity growth in manufacturing – taken to represent a country's competitive strength – across a sample of developing countries[2] for the two subperiods 1970–79 and 1980–89 (as pooled observations). He regresses it on output growth in recognition of Kaldor's (1967) test of Verdoorn's Law, which postulates a close relationship between the two due to increasing returns to scale as well as technological progress. Although the results are not as strong as Kaldor had found for industrialized countries for the 1960s, Haque's results confirm a positive relationship between the growth of manufacturing output and productivity growth.

Haque (1995) then regresses the residual between the observed and estimated values from the earlier regression on primary school enrollment and the investment rate. While he does not find a significant relationship with the former (possibly due to the small variation between countries), he does find a significant relationship with secondary school enrollment which, as he argues, is more relevant to the manufacturing sector. The investment rate is also a significant variable in explaining differences in labor productivity, although because of some collinearity between the secondary school enrollment and investment rates when used together, Haque's results show that the explanatory power of the regression does not significantly improve.

In a carefully crafted study, but using somewhat shaky data sources and measures of key variables, Mahmood and Siddiqui (2000) analyze the reasons for the "sluggish" growth of large-scale manufacturing during 1972–97 after the sector had grown rapidly in the preceding 20 years (1947–72), albeit starting from a small base. They work with the proposition that the main cause of this slowdown was the decline in TFP growth, which

[2] Argentina, Chile, Colombia, India, Korea, Malaysia, Mexico, Pakistan, Singapore, Thailand and Turkey.

they feel best captures the sector's state of competitiveness as well as an "ailing science and technology apparatus."

They test this hypothesis with TFP as the dependent variable against (i) knowledge capital (drawing on expenditure on research and development derived from the Planning Commission and Pakistan Council of Scientific Research, (ii) human capital (enrollment in professional colleges and vocational and technical education), (iii) technology transfers (foreign patents registered in Pakistan), (iv) (trade) openness (the trade-to-output ratio and export growth rate) and (v) policy changes to represent law and order and liberalized policies (using a dummy for the period of nationalization, 1971–77). While their results show a significant relationship between TFP and these variables, given that a number of these factors are already accounted for in the calculation of TFP, it is difficult to interpret the results as showing causality between the two.

The downturn in Pakistan's economy in the 1990s focused attention on the factors responsible for and the behavior and role of TFP growth in this process. It also marked a shift of emphasis to the overall economy as well as its major sectors rather than the earlier emphasis on manufacturing. Pasha, Ghaus-Pasha and Hyder (2002) cover the period 1972/73 to 1997/98, divided by the Five-Year Plan periods, but concentrate on the slowdown in TFP growth in the 1990s. They find a clear relationship between TFP and the growth of the economy, stating that the "economy grows fast when TFP has risen rapidly." For the overall period, they find that TFP growth was responsible for over 40 percent of the growth of the economy. Their sectoral analysis of TFP during 1992/93 to 1997/98 reveals wide variations in the performance of TFP within different sectors. While Pasha et al. provide the first study that highlights the importance of the services sector in slowing down overall TFP growth as well as leading to overall economic growth, they do not offer any convincing answers to explain the poor performance of the services sector.

In analyzing the determinants of TFP – both overall and for the major sectors – by regressing it (as the dependent variable) on a number of variables such as investment and human capital, Pasha et al. (2002) make the same mistake mentioned earlier. TFP is calculated *after* accounting for the contribution of variables such as capital (investment) or some variables are already taken into account (such as human capital) when calculating TFP: this renders the results spurious rather than establishing a relationship between the variables and TFP.

Khan (2006) concentrates on the macroeconomic determinants of TFP in Pakistan for different periods, covering the 1960s, 1970s, 1980s, 1990s and then 2001–03. Analyzing trends in TFP growth and its relationship with economic growth, he finds an even stronger association than Pasha et al. (2002), stating that "GDP growth and TFP growth follow *identical* behavior throughout the period of observation" (p. 351, emphasis added). He does not, however, pursue this finding further. Khan's regression analysis in identifying factors that affect TFP growth is not seriously thought through and suffers from the same drawbacks mentioned with reference to the earlier two studies.

Chaudhry (2009) calculates the TFP growth for Pakistan for the period 1985–2005. This is done separately for large-scale manufacturing (drawing on data from the Census of Manufacturing Industries), agriculture (using the Agricultural Statistics of Pakistan) and for the overall economy. In terms of its contribution to agricultural growth, his results show that TFP contributed 49 percent, labor 40 percent and the growth of other factors 11 percent. In contrast to agriculture, TFP contributed only 29 percent, labor 15 percent and capital stock an impressive 56 percent to large-scale manufacturing. For the economy as a whole, TFP grew by 1.1 percent a year with three quarters of this growth attributed to labor and capital stock. These sectoral estimates put Pakistan at par with, or above the average for, other developing countries, but lagging far behind the East Asian economies. Chaudhry therefore concludes that Pakistan witnessed input-driven rather than productivity-driven growth.

López-Cálix, Srinivasan and Waheed (2012) analyze the continuing steady fall in productivity growth (measured by TFP) that started in the 1990s and continued till 2010. They calculate and then interpret the contribution of capital, land, human capital (years of schooling) and TFP to labor productivity growth for three decades, 1980 to 2010, for the overall economy and the major sectors (agriculture, industry and services). Their main conclusion is that growth in output in Pakistan was driven mostly by increases in factor inputs, mainly labor and capital, rather than by increases in TFP.

They argue that the decline in TFP growth in the 1990s – a period of trade liberalization and other economic reforms – was not caused by trade liberalization, but by what they see as poorly sequenced economic reforms together with macroeconomic instability and the failure of policymakers to implement and sustain reforms. They argue that the spurt in economic growth from 2002/03 to 2005/06 did not result in the structural transformation of the economy and that TFP's contribution declined significantly in 2000–10. They conclude that, unless Pakistan's record in structural reforms improves, TFP will not improve and that "reform is fragmented and littered with a myriad of policy reversals."

The selected studies agree on the broad trend of a decline in the growth rates of labor productivity and TFP starting in the 1990s, but offer a wide range of interpretations, which we examine subsequently. These include the view that output growth in Pakistan has been driven by rising factor inputs and not TFP, and that the lack of consistent policies in implementing reforms explains why the economic reforms undertaken under IMF tutelage had such little impact. We are critical of the use of regressions to test the impact of different variables on TFP without thinking through why one would expect such a relationship to exist, especially since in many cases TFP either includes in its measure some of these variables or is calculated as a residual after accounting for the contribution of other variables. This has resulted in a number of spurious regressions and conclusions.

3. Growth Accounting

Despite the limitations of its assumptions,[3] the growth accounting framework pioneered by Solow (1956) is widely used to measure the contribution of factor inputs (mainly labor and physical capital) to economic growth and the residual (i.e., what cannot be explained by these factors) as measuring the rate of technological progress. Rather than viewing technological progress as an exogenous factor, as given in the original neoclassical growth model, Romer (1986) and the protagonists of the "new growth theory" view it as an endogenous variable resulting primarily from the contribution of human capital to economic growth.[4] This view is now incorporated in the recent growth accounting models.

3.1 Developing a Growth Model

In the original model, the basic neoclassical production function is:

$$Y = F(A, K, L)$$

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[3] For a detailed discussion on the extreme restrictions of these assumptions, especially those underlying the concept and calculation of TFP, see Haque (1995).

[4] As Romer (1990) states: "The most interesting positive implication of the model is that an economy with a larger stock of human capital will experience faster growth."

where Y is real output, K is capital stock, L is the size of the employed labor force and A is the residual term (TFP). This implies that growth in output comprises growth in factor inputs and TFP:

$$g^Y = \alpha g^L + (1-\alpha)g^k + g^{TFP}$$

where g^Y denotes the growth rate of output g^L denotes the growth rate of labour, g^{TFP} denotes the growth rate of total factor productivity, α is the share of labor in output and (1-α) is the share of capital in output.

As output and inputs are observed, then:

$$g^{TFP} = g^Y - \alpha g^L - (1-\alpha)g^K$$

The concept of TFP growth essentially incorporates technical change and improvements in economic efficiency in the use of factor inputs. The former involves adopting new technologies while the latter focuses on increasing the efficiency with which the available resources and factor inputs are used. Bosworth and Collins (2008) broaden the interpretation of TFP: according to them, it not only measures technical efficiency, but can also be attributed to several sociopolitical and economic factors such as government policy or weather shocks that determine the efficiency of factor use. Moreover, they highlight the fact that this measure presents the "proximate causes" of economic growth and, hence, provides a benchmark for analyzing economic performance.

Over the years, the research on productivity growth has evolved as researchers attempt different methodologies ranging from growth accounting to rigorous regression techniques. For this particular study, we utilize the growth accounting framework and assume a Cobb–Douglas production function with fixed factor shares, i.e., constant returns to scale and technical progress is assumed to be Hicks-neutral.[5] We also add to the earlier model human capital as an independent variable (Romer, 1990). Given the importance of agriculture for developing countries such as Pakistan, we add arable land to the factor inputs. Our model is, therefore, represented as:

$$Y = AK^{\alpha}R^{\beta}(LH)^{(1-\alpha-\beta)}$$

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[5] This means that, for a rise in output due to technical change, the contribution of inputs is equally divided, thus leaving the marginal factor productivities unchanged.

where Y, A, K, R and LH are real GDP, TFP, physical capital, arable land and human-capital-adjusted labor input, respectively. The latter is formulated by the interaction of L, which is the employed labor force, and H, which is human capital. This input captures increases in labor productivity as a result of educational attainment and is calculated by using the mean years of schooling and assuming that an additional year of education raises the level of productivity by a certain percentage – usually between 5 and 10 percent as per the empirical evidence (Bosworth & Collins, 2008). We assume that an additional year of education raises labor productivity by 7 percent, as done also by López-Cálix et al. (2012).

Following López-Cálix et al. (2012), our results are reported in terms of output per worker. This is done by dividing the entire production function by labor input (L) and taking logarithms on both sides of the function. The growth in real GDP per worker (Y/L) is further decomposed into the contributions of growth in physical capital per worker (K/L), growth in arable land per worker (R/L), increases in education per worker (H) and growth in TFP (A):

$$\Delta \ln\left(\frac{Y}{L}\right) = \alpha\left[\Delta \ln\left(\frac{K}{L}\right)\right] + \beta\left[\Delta \ln\left(\frac{R}{L}\right)\right] + (1-\alpha-\beta)[\Delta \ln(H)] + \Delta\ln(A)$$

Drawing on this equation or identity, output growth comprises the weighted growth in labor (employment) and labor productivity. The latter is the weighted sum of the growth in the productivity of physical capital, human capital, arable land and TFP. The contribution of each of these four variables to the growth of output is simply their value as a share of output growth.

The following factor shares are assumed:

Factor shares in	**Agriculture**	**Industry**	**Services**
Physical capital (K) α	0.25	0.55	0.20
Arable land (R) β	0.50	0.00	0.00
Human capital (LH) $1 - \alpha - \beta$	0.25	0.45	0.80

3.2 Data Limitations

It is important to keep in mind that the data for some of the key variables used in this study, especially labor and capital, can be termed robust at best rather than accurate or precise, and the results must also be interpreted accordingly. In the case of labor, the bulk of the labor force is still employed in agriculture (suffering from different degrees of underemployment) and almost two thirds of the urban labor force is employed in the informal economy.

In such a situation, it is difficult in many cases – except for those in formal sector employment – to differentiate between employment growth resulting from an increase in demand for labor and employment growth that merely reflects the pressure of an increase in supply, keeping in mind the absence of any available unemployment insurance or effective safety net. This means that all those entering the labor force or those of working age must work for a living with whatever meager earnings or hazardous working conditions this may entail. The absence of data on hours of work or the working poor further complicates the measurement of the employed labor force. In this study, the data for the employed labor force has been taken from various issues of the Labor Force Survey.

The challenges in measuring the stock of capital and its rate of increase in real terms also pose considerable problems, as a large part of this investment may not be recorded and captured in the national income accounts. We have estimated it using the perpetual inventory method by applying an annual depreciation rate of 5 percent to the existing capital stock and adding incremental investment. As a result of data limitations and assumptions in the growth accounting model in which the marginal productivity of labor remains unchanged, the contribution of labor to output growth may be exaggerated as well as the contribution of physical capital underestimated.

4. Pakistan's Growth Accounts: Trends in Labor Productivity and TFP

This section provides an in-depth assessment of Pakistan's productivity performance for the whole economy and for the major sectors (agriculture, industry and services).

4.1 Aggregate Growth

Pakistan's growth path during 1980–2015 has continued to follow a cyclical pattern, with periods of high growth followed by periods of low and stagnant growth ("boom and bust") as in the 1950s (low growth), 1960s (high growth) and 1970s (low growth). For the post-2000 period, rather than take separately the period 2000–10, we have broken down 2000–15 into two subperiods – 2000–07 (high growth) and 2008–15 (low growth) – so as to bring out the sharp differences in growth performance between the two. This division, as we discover in our analysis, has a clear advantage over López-Cálix et al. (2012) who look at the period 2000–10 together.

Pakistan's economic performance during the last 35 years (1980–2015), with an average economic growth rate of around 5 percent, can at best be termed anemic, with spurts of high growth that could not be sustained, followed by periods of low growth or economic stagnation. The results in Table 1 reflect the declining growth of output for the economy as well as the declining value of TFP over the years.

Table 1: Sources of economic growth overall, 1980–2015

	Growth in				Output per worker % contribution of			
Fiscal years	**Y**	**L**	**Y/L**	**Investment as % of GDP**	**K**	**LH**	**R**	**TFP**
1980-90	6.0	1.8	4.2	24.5	1.0	0.9	-0.2	2.4
1990-2000	4.4	2.6	1.8	21.9	0.5	-0.2	-0.3	1.8
2000-15	4.3	2.9	1.3	16.5	0.0	0.5	-0.2	1.1
2000-07	5.3	3.7	1.5	17.9	-0.1	0.4	-0.3	1.6
2008-15	3.2	2.1	1.0	15.0	0.0	0.6	-0.1	0.6
1980-2015	4.8	2.5	2.3	20.3	0.4	0.4	-0.2	1.7

Note: Y = real output, L = employment, Y/L = output per worker, K = physical capital, LH = human capital, R = arable land, TFP = total factor productivity.
Source: Authors' calculations.

Based on the growth accounting framework, these results show that, for the overall economy during 1980–2015, the TFP growth rate was 1.7 percent, which contributed 35 percent to the average economic growth rate of 4.8 percent (Table 1). The main contribution to output growth (52 percent) in this period was from increasing labor inputs (i.e., growth of employment). The contribution of physical and human capital at just over 8 percent for each is a clear reflection of the low and declining investment levels in this period and the continuing neglect of education in terms of resources allocated and the quality of education imparted. The negative contribution of arable land indicates water scarcity and insufficient investment in building water reservoirs.

Our results are reasonably similar to those of earlier studies. For a slightly shorter period (1980–2010), López-Cálix et al. (2012) estimate a TFP growth rate of 1.4 percent per annum, which contributed 28 percent to the average economic growth rate of 5 percent in this period. Labor contributed 54 percent, which is very similar to our result. The contribution of physical capital, on the other hand, in their study is much higher at 28 percent compared to our results, but the contribution of human capital at 8 percent is the same. The contribution of arable land is also negative by a small amount in both studies.

Chaudhry (2009) estimates the growth of TFP at 1.1 percent for the period 1985–2005, which contributes 27 percent to the average growth rate of 4.1 percent for this period. The respective contributions of labor and capital to output growth are 40 and 30 percent.

Pasha et al. (2002) cover the period 1972/73 to 1997/98 and find that TFP grew by 2.2 percent per annum, contributing 40 percent to the average output growth rate of 5.5 percent. While they do not separate the contribution of labor and capital to output growth, instead taking factor inputs as a whole, they do assess the growth of labor separately. Based on this estimate, it is possible to derive the contributions of labor and capital to output growth, which work out to 44 and 16 percent, respectively.

To summarize our results and those of the major studies cited:

- The rate of growth of TFP in our study as well as in López-Cálix et al. (2012) and Pasha et al. (2002) declines over time after the 1980s as does as the growth rate of output.
- The average contribution of TFP to growth[6] for the somewhat different time periods covered by these studies over 1972–2015 varies between around 30 and 40 percent. While this may be higher than the average for developing countries, it is significantly lower when compared with the original four "East Asian tigers" where, over 1975–1990, the contribution of TFP was 50–60 percent. This, in turn, pushed output growth to almost double the growth rate Pakistan achieved in the years we cover (see Sarel, 1996, on the performance of the East Asian economies).
- The more significant contribution to growth in output in Pakistan has stemmed from the growth of employment or labor inputs, ranging in different studies from 40 to 55 percent.
- The contribution of human capital is minimal at less than 10 percent in the two studies that calculate its contribution.
- The contribution of capital shows wide variations (between 8 and 30 percent) in the different studies. While this may reflect partly the

[6] Since our results and those of López-Cálix et al. (2012) show separately the (low) contribution of human capital to output growth, adding it to TFP growth would bring it closer to Pasha et al. (2002), who exclude it from their calculation of TFP.

difficulties of measuring capital, it also reflects the declining level of investment over the period, especially post-2000 when it fell to very low levels, hovering just around or slightly over 15 percent.

In evaluating the performance of TFP growth for Pakistan between 1970 and 2015, one needs to pay special attention to two important factors – low and declining investment levels and the high growth of the labor force at 2.8–3.2 percent in this period. In the case of the latter, the implied employment elasticity of growth (employment growth divided by output growth) for the period 1980–2015 is 0.52. This implies that there is a tradeoff between productive labor absorption and increases in labor productivity, given the very high growth of the labor supply. The challenge here is to find a growth path in which both labor absorption and labor productivity can be increased at the same time, as happened in Japan in the 1920s (Ishikawa, 1981) and during the "green revolution" in Pakistan in the latter half of the 1960s.

Turning to the decline in investment levels from low to extremely low post-2008, not only is this reflected in the low contribution of physical capital to productivity growth, but also in the relatively low and declining TFP growth over the period. The reason is that new investment embodies the latest cutting-edge technology and knowledge, which spurs both productivity and TFP growth. There is also a clear link between the growth of demand or increasing output and new investment to meet this demand. As Haque (1995) shows, there is a clear and reasonably strong relationship between output growth and productivity and between productivity growth and investment.

This version of what is now known as Kaldor–Verdoorn's Law also emerges from our results in Table 1, especially when we compare the 1980s with 2008–15, but also if we look at trends over the period and the results for the entire period 1980–2015. During the 1980s, physical capital contributed around 17 percent, human capital 15 percent and TFP 40 percent to an average output growth rate of 6 percent. The virtuous circle between rising demand or output growth drawing in new investment embodying the latest technology and raising TFP – which in turn pushes up labor productivity – emerges clearly during these years. It is also important to note that, during periods of high growth, human capital contributes significantly to output growth, which it does not do for much of the later period of low growth, implying that returns on human capital (measured by years of schooling) are best realized in a growing economy rather than one mired in low growth or stagnation.

What light do our results shed on increased efficiency driven by economic reforms pushing up TFP growth and this, in turn, pushing up overall labor productivity and shifting the economy onto a higher growth path? Given that, post-1989, for more than half the period up to 2015 the economy was under different IMF programs and many economic reforms were initiated, the results have been extremely disappointing. This is seen most clearly in the continuing decline in TFP growth starting in the 1990s when, compared to the 1980s, it declined by 25 percent and by almost 55 percent during 2000–15.

Why did this happen? To answer this question, we believe it is better to look at the more detailed sectoral findings and then build on these for plausible explanations. Such an approach is also now favored for studies investigating productivity trends in advanced economies (see, for instance, Dabla-Norris et al., 2015).

4.2 *Agriculture*

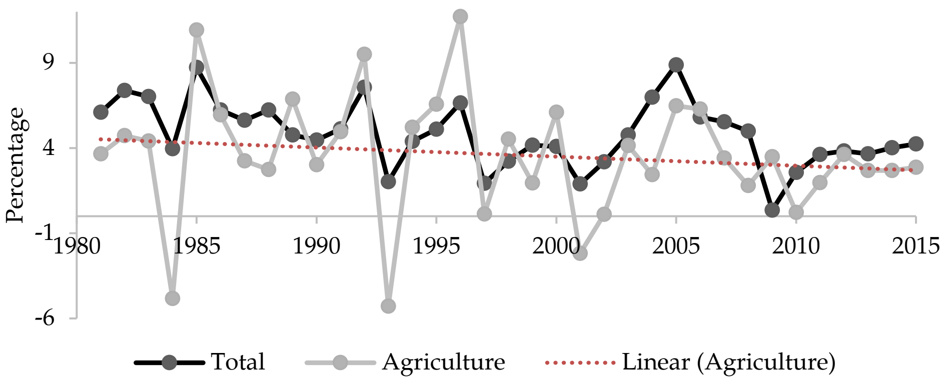
It may be a surprise to many, but Pakistan's economic performance still relies heavily on the performance of its agricultural economy (Ali, 2004). This is despite the fact that the share of agriculture in GDP has gradually fallen over the years and its share on average over the study period was around 25 percent.[7] However, almost half the country's labor force (around 45 percent) is still employed in this sector.

An important change that characterizes this period is the rising share of the livestock sector (including milk and related products), which now contributes almost 60 percent of the value added in agriculture, the remainder comprising the crop sector (near 40 percent) and forestry and fisheries (around 4 percent). The rural areas still provide livelihoods to over 60 percent of the population and the families that live there. A large proportion (almost 60 percent) of the remittance inflows from overseas workers, which increased manifold post-2001 and accounted for over 7 percent of GDP in 2014/15, goes to rural families. Agriculture has strong direct links with mainly rural small-scale industries as well as a fast growing rural services sector. It provides a major market for domestically produced consumer durables (motorcycles) and consumer goods such as soft drinks and cosmetics.

[7] The share of agriculture in GDP was 19.8 percent in 2015/16 and its share of the labor force was 43.7 percent (Pakistan Economic Survey 2015/16).

Figure 1 depicts the close association between the growth in total output (value added) and agricultural output (value added), even though this relationship has weakened as the share of agriculture in GDP fell from 32 percent in 1980 to 20.9 percent in 2015.

Figure 1: Growth rate of real output (total) and agricultural output



There are two important questions as regards the performance of the agriculture sector during the period we cover. The first is explaining the wide difference in output growth between 1980–2000 and 2000–15 (Table 2), when it fell by almost 40 percent. The second is the significant difference in the contribution of TFP to the high growth witnessed in the 1990s compared to the high growth of the 1980s, while the opposite holds in terms of the contribution of physical capital and human capital in the two periods, being high in the 1980s and very low in the 1980s.

Table 2: Sources of economic growth in agriculture, 1980–2015

	Growth in				Output per worker % contribution of			
Fiscal years	**Y**	**L**	**Y/L**	**Investment as % of GDP**	**K**	**LH**	**R**	**TFP**
1980-90	4.0	1.8	2.2	2.7	1.4	0.4	-0.7	1.1
1990-2000	4.4	1.8	2.6	1.9	0.4	-0.1	-0.6	3.0
2000-15	2.6	2.0	0.6	2.7	1.1	0.1	-1.0	0.5
2000-07	2.9	2.2	0.7	2.3	0.9	0.1	-1.1	0.8
2008-15	2.5	1.4	1.1	3.1	1.3	0.1	-0.4	0.1
1980-2015	3.5	1.9	1.6	2.5	1.0	0.1	-0.8	1.4

Note: Y = real output, L = employment, Y/L = output per worker, K = physical capital, LH = human capital, R = arable land, TFP = total factor productivity.
Source: Authors' calculations.

These differences in TFP contribution to output growth between the 1980s and 1990s also emerge in earlier studies. While, in our study, the contribution of TFP to agricultural output growth increases from around 30 percent in the 1980s to near 70 percent in the 1990s, Pasha et al. (2002) find that it increases from around 55 percent to near 80 percent for roughly the same periods. López-Cálix et al. (2012) show that the share of TFP growth in agricultural output growth, while not as pronounced, rises significantly from 30 percent in the 1980s to 55 percent in the 1990s. For the overall period 1990–2005, Chaudhry (2009) estimates that the agriculture sector's TFP grows at 1.75 percent, contributing to 50 percent of agricultural growth. This is fairly high, given that the years he covers include the drought years post-2000, which pushed down the average agricultural growth rate for this period to 3.6 percent.

It is not always easy to differentiate between the effects of policy reforms that result in increased use of factor inputs, spurring higher output, and technological advancements that push up the production frontier, thus raising TFP. The impact of these changes may be difficult to fully capture and assign to neatly divided timeframes. For example, a new technology may be introduced in a particular period, but its widespread use and the resulting productivity increase may occur in a subsequent period.

To a limited extent, studies of the performance of agriculture in the 1980s and 1990s provide interesting insights into the factors that pushed up output growth, although we cannot differentiate clearly between whether these were due to increased input use or TFP growth (see Ahmad, Chaudhary & Ilyas, 2008; Ali, 2004; Zaheer, 2013). According to these studies, an important reform of the 1980s was to increase significantly the share of credit available to farmers from banks (private as well as government-run or controlled) as well as giving small farmers easier access to credit. This substantially increased farmers' use of fertilizer and pesticide. Moreover, the liberalization of input distribution (which had been subject to many government controls) by encouraging private firms to distribute as well as produce these inputs made them easier to access. As part of these liberalization measures, the state-owned rice and cotton export corporations were abolished.

The 1980s also saw the introduction of new high-yield varieties of cotton, which more than doubled production from 3,280 bales in 1980 to 7,522 bales in 1990 and further to 10,000 bales in 1991, although in subsequent years production varied greatly due to pest attacks and unfavorable weather conditions. With cotton contributing almost 10 percent to agricultural GDP (and near 30 percent to all crops), this substantial jump played an important role in accelerating output growth in the 1980s and to a more limited extent in the 1990s. The removal of subsidies in the 1990s under the IMF reform program by raising the price of inputs such as fertilizer may have led to more efficient use of these inputs. Support prices for wheat and other crops were also raised in the 1990s, which improved the terms of trade for agriculture, resulting in higher profitability and therefore encouraging increased input use.

Another important development that started in the 1980s and gained momentum in the 1990s was the growth of the livestock sector (averaging over 5 percent). The sale of milk and dairy products became easier as private firms, including large multinationals such as Nestle, set up pick-up points for milk at or near farmers' doorsteps deep in the rural countryside. The government also played an important role in stimulating the growth of the livestock sector by introducing new breeds of cattle, including from abroad, as well as support services to farmers such as the availability of veterinary doctors and medicines for livestock and poultry in rural areas.

There was a sharp subsequent downturn in agricultural growth after the 1990s. The following decade witnessed successive drought years in 2000 and 2001 from which agriculture did not fully recover till 2007. Post-2008, a number of factors slowed down agricultural growth, including persistently hostile weather conditions, a sharp increase in energy prices that fueled large increases in fertilizer prices, subsequent power cuts that affected tubewell use and water availability, and the lack of public investment in developing new seed varieties. These counteracted the large increase in support prices for wheat in 2008, which had led initially to large increases in wheat production.

The sharp decline in TFP growth and low growth of output and labor productivity post-2000 reflect these unfortunate developments. Yet there are important lessons to be drawn from this overall period. The first is that the decline in TFP in agriculture post-2000 cannot be blamed solely on weather conditions, the unprecedented rise in oil prices in 2007 and crippling energy shortages post-2008. It was as much a failure to maintain the growth momentum generated in agriculture in the 1980s and 1990s when Pakistan witnessed a mini-green revolution due to new seed varieties in cotton and tremendous growth in livestock and dairy products.

Policymakers are much to blame for the cotton seed fiasco that resulted from the lack of a clear-cut policy on the development and distribution of BT cotton seed, introduced in 2002. This led to illegal imports of the seed from India and the resulting mix made the cotton crop vulnerable to persistent pest attacks. This is not only true for BT cotton, but also for other major crops, vegetables and fruits, as agricultural research institutions in Pakistan have shown little progress in producing new varieties of high-yield, pest-resistant seeds. This is unfortunate, given the substantial resources the government and donors have allocated to maintaining these institutions and funding their research. The same can be said for livestock, dairy and milk products, where the government has adopted inconsistent policies, an example of which was to favor the import of powdered milk at the expense of local dairy farmers in the livestock sector.[8]

We can now draw some conclusions from our results as well as the factors identified as having influenced output growth during 1980–2015:

- If the 1990s has been labeled a 'lost decade' for Pakistan's economy in terms of its poor growth, productivity and TFP performance, this was certainly not true of the agriculture sector, which showed high and robust growth in both the 1980s and 1990s.
- The subsequent near collapse of this sector in 2000–15, which our results clearly reflect, cannot be blamed solely on weather conditions and the increase in oil prices. It was as much due to inconsistent and, at times, unfavorable policies, including the lack of serious attention to developing pest-resistant, high-yield seed varieties.
- While it is difficult to clearly interpret our results on the extremely low contribution of physical and human capital to output growth in agriculture after the 1980s, in the case of human capital these values appear to reflect the poor quality – low education and skill levels – of the rural labor force, despite claims that rural education indicators had improved.

[8] "Speaking on a calling attention notice in the National Assembly the federal commerce and food security ministers agreed on the need for effectively curbing imports of skimmed powdered milk and whey powder to protect the interest of local dairy farmer" (*Dawn*, 23 May 2016, http://www.dawn.com/news/1260019).

- Our results indicate that the economic reforms carried out in this sector helped increase the availability and efficient use of factor inputs, especially fertilizer and credit, in the 1980s and 1990s.[9]
- The major reason we can find for the sharp rise in TFP in the 1990s is the more efficient use of inputs as a result of the removal of subsidies. It is more difficult to explain the low contribution of TFP in the 1980s, given that cotton production more than doubled due to new high-yield seeds, unless we suggest that the larger availability and use of inputs pushed down the contribution of TFP very significantly.
- Our results for the 1980s and 1990s tend to show that growth in agriculture is much more supply-driven than demand-led and that the relationship between growth of output, productivity and investment (Kaldor–Verdoorn's Law) found in manufacturing may not be applicable to agriculture.
- The rapid growth of the livestock sector and its increasing share of agricultural output (near 60 percent) means that far more policy attention should be diverted to this sector to encourage its growth in the domestic and export sectors as well as through direct support services for livestock and dairy farmers.
- The persistently negative contribution of arable land to agricultural growth in our results is a stark reminder of the low supplies of water and the need to develop new reservoirs to overcome existing shortages and meet future demand in the face of climate change and environmental concerns.
- There is a strong case for concentrating national research efforts and the limited available resources in agricultural research, where there is considerable scope for indigenous technological development, such as new seed varieties or high-yield breeds of cattle. Pakistan also needs to critically review the poor performance of its agricultural research institutions thus far, which is clearly a factor in the drastic slowdown in agricultural growth over the last 15 years.

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[9] Sabir and Ahmed (2003) also find that the removal of subsidies on fertilizer in the 1990s led to more efficient use of the input and this was reflected in an increase in TFP in the 1990s.

4.3 *Industry*

Manufacturing dominates the industry sector, contributing almost two thirds of industrial output.[10] It is considered the most dynamic component of not just this sector, but also the overall economy, given its inherent capacity to generate and absorb technical change and reap the gains of increasing economies of scale in large-scale production. Indeed, Chaudhry (2009) expresses concern that this view can lead to the neglect of the agriculture sector, which is seen as less susceptible to both these characteristics, and to development policies and expenditures geared to encouraging industrial growth at the expense of agriculture. To what extent have these expectations been realized in Pakistan after a period of rapid industrialization during the 1950s and 1960s?

Unfortunately, the performance of industry during 1980–2015 has (barring the 1980s) been disappointing, with its share of GDP increasing only marginally from 16.4 percent in 1980 to 20.4 percent in 2015. Similarly, its capacity to generate new jobs has been extremely limited: the sector's share of the total employed labor force increased from just 20.1 percent in 1980 to 22.6 percent in 2015.[11]

For the 1980s, the high growth rate of almost 8 percent in industry (Table 3) is accounted for by a relatively high TFP growth that contributes nearly 40 percent to output growth and 55 percent to productivity growth during this period. Investment levels were reasonably high in the 1980s and this is reflected in the significant contribution of physical capital (around 24 percent) to economic growth. The contribution of human capital remains marginal at near 10 percent and low, even negative, in subsequent periods. The contribution of labor is significantly lower than for the overall economy and other sectors at around 25 percent. The 1980s present therefore clear evidence of Kaldor–Verdoorn's Law of high growth resulting from high investment and this in turn driving both high TFP and productivity growth.

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[10] The other components of industry and their relative shares in 2015/16 are: mining and quarrying (12.2 percent), construction (12.2 percent) and electricity generation and distribution and gas distribution (12.2 percent). Manufacturing contributes 65 percent to industrial output, of which large-scale manufacturing accounts for almost 80 percent (Pakistan Economic Survey for 2015/16).

[11] For an analysis of the disappointing inability of the manufacturing sector to create productive, remunerative and decent jobs in Pakistan, see Amjad and Yusuf (2014).

Table 3: Sources of economic growth in industry, 1980–2015

	Growth in				Output per worker % contribution of			
Fiscal years	**Y**	**L**	**Y/L**	**Investment as % of GDP**	**K**	**LH**	**R**	**TFP**
1980-90	7.7	2.0	5.6	8.7	1.8	0.7	3.0	1.1
1990-2000	4.2	1.3	2.9	9.2	2.1	-0.1	0.9	3.0
2000-15	4.8	4.5	0.3	4.6	-2.1	0.4	2.1	0.5
2000-07	7.2	6.0	1.1	6.2	-2.2	0.3	3.1	0.8
2008-15	1.9	3.9	-1.8	3.0	-2.4	0.4	0.2	0.1
1980-2015	5.5	2.9	2.5	7.0	0.2	0.3	2.0	1.4

Note: Y = real output, L = employment, Y/L = output per worker, K = physical capital, LH = human capital, R = arable land, TFP = total factor productivity.
Source: Authors' calculations.

In sharp contrast, the 1990s saw a severe downturn in industrial growth and a fall of nearly two thirds in TFP growth, although the investment rate remains high – even slightly higher than in the 1980s. Interestingly, the contribution of labor to output growth is still low at only 30 percent while the contribution of physical capital doubles to 50 percent. Surprisingly, the contribution of human capital is negative.

The upturn that followed in 2000–07 saw the economy reach the industrial growth levels of the 1980s, but the dynamics of this growth revival remain difficult to explain: investment levels picked up and TFP growth shot up to levels slightly higher than the boom in the 1980s, but almost two thirds of industrial growth in this period resulted from the growth of the employed labor force. The contribution of physical capital falls to negative levels and the contribution of human capital, though positive, remains low. Clearly, there are data issues here, but what does emerge is the strong, positive relationship between high output growth and TFP growth.

The recent downturn that started in 2008 continued till the end of the period and is more easily explainable by low output growth, low investment levels, low productivity growth and very low TFP growth. The contribution of physical capital is negative, but human capital appears to play some part in the low growth that does materialize.

Among other studies on this sector, Chaudhry (2009) covers the period 1985–2005 for large-scale manufacturing and reports a TFP growth rate of 2.4 percent, which accounts for nearly 30 percent of output growth. Pasha et al. (2002) study manufacturing (large-scale and small-scale) from 1982/83 to 1987/88 and show a very high growth rate for TFP (6.6 percent), accounting for almost 80 percent of the growth in manufacturing output (8.1 percent) in this period. López-Cálix et al. (2012) report a TFP growth rate of 3.1 percent, which explains almost 40 percent of the growth in industry for 1980–90.

The sharp contraction in growth in industry in the 1990s – and within it, for manufacturing – is clearly reflected in the results of these studies. Pasha et al. (2002) show a dramatic decline in TFP and its contribution to the growth of output in this period at around 40 percent – less than half that of the 1980s. The same is true of López-Cálix et al. (2012), who find that TFP growth falls to 0.6 percent in the 1990s, accounting for 19 percent of the far lower productivity growth rate relative to the 1980s. Interestingly, Chaudhry's (2009) results for large-scale manufacturing over 1985–2005 are very similar to our results for the 1990s in terms of TFP and its contribution to GDP (29 percent), despite the fact that he shows a much higher growth rate for large-scale manufacturing for the period he covers.

Two key questions need to be raised regarding the performance of the industry sector during this period. The first is what key factors appear to drive output growth and the high contribution of TFP to this growth. The second – and this is related to the first – is why far-reaching economic reforms failed to have any real impact on the performance of this sector for most of the period post-1990.

In answer to the first, there is a clear and strong association between periods of high output growth and TFP growth, as witnessed in the 1980s and 2000–07. The relationship between output growth and investment growth is not as clear because the high level of investment in industry in the 1990s did not spur the growth of output or TFP. This reflects low capacity use and may well explain the subsequent surge in industrial growth in 2000–07 when the utilization of this excess capacity rather than physical capital drove higher growth.

While more detailed research on this sector is required, the message that emerges from our results is that economic reforms in industry per se are not enough to increase efficiency and drive growth. The reforms failed to deliver because the accompanying economic package under the IMF programs that were implemented suppressed domestic demand and, with it, the demand for industrial goods. Unless there had been a real increase in the demand for exports, as possibly happened in 2002–07, the reforms would fail to deliver.

While not denying the need for economic reforms that would make the industry sector more competitive in both domestic and global markets, these should be implemented in a phased manner as appears to have been done in the 1980s. The lack of a well-thought-out industrial policy under which the reforms being undertaken could be effectively implemented as well as monitored was sadly missing throughout the post-1990 period.

The key finding that emerges is that the high expectations of this sector as a major engine of growth, driven in turn by the growth of labor productivity and TFP, were not realized, except in the 1980s. Even the brief spurt in industrial growth in later years (2002–06) fizzled out. This was particularly disappointing as many countries, especially in southeast Asia, had taken advantage of the years preceding the 2008 financial crisis – of rapid globalization, an unprecedented expansion in global trade and advancement in ICT – to build up and expand industrial production through rapid growth in TFP.

4.4 Services

Over the years, as the share of services in national output and employment has increased to almost 60 and 35 percent, respectively, in 2015, it has become a primary driver of overall economic growth. During 1980–2015, the fluctuations in services sector growth were aligned with the growth of the whole economy.[12] Yet, despite the sector's growing economic importance, it has been subject to very little research, especially in terms of the forces driving growth (or lack of it) in services during the period we cover.[13]

Our results for the services sector show that, much like industry, after a period of rapid growth in the 1980s output growth slowed down, but the downturn in subsequent periods was not as pronounced, especially during 2008–15 (Table 4). Its average TFP growth over 1980–2015 was 1.5 percent and this contributed only around 25 percent to output growth over the years. Despite a relatively high investment rate compared to the other

[12] The major subsectors in services and their contribution to output in 2015/16 is as follows: wholesale and retail (30.9 percent); transport, storage and communications (22.5 percent); housing (11.35 percent); finance and insurance (5.5 percent); general government services (12.81 percent) and other services (17 percent).

[13] For an overview of the contribution of services to the economy, see Ahmed and Ahsan (2011).

two sectors, the contribution of physical capital was less than 8 percent in the 1980s and was lower, negligible or even negative in subsequent periods. Human capital contributed more than twice this amount to output growth in services in the 1990s, but its contribution has also declined and been lower, albeit unevenly, in subsequent decades. Pasha et al. (2002) find the performance of the services sector disappointing and their results indicate the negative contribution of TFP to services in the 1980s and 1990s.

Table 4: Sources of economic growth in services, 1980–2015

	Growth in				Output per worker % contribution of		
Fiscal years	**Y**	**L**	**Y/L**	**Investment as % of GDP**	**K**	**LH**	**TFP**
1980-90	6.6	2.8	3.7	13.0	0.5	1.2	1.9
1990-2000	4.5	3.7	0.8	10.9	0.0	-0.3	1.0
2000-15	4.8	3.2	1.5	9.2	0.0	0.6	0.9
2000-07	5.6	4.5	1.1	9.5	-0.2	0.7	0.5
2008-15	3.9	2.1	1.8	8.9	0.2	0.2	1.4
1980-2015	5.2	3.2	1.9	10.8	0.2	0.5	1.2

Note: Y = real output, L = employment, Y/L = output per worker, K = physical capital, LH = human capital, TFP = total factor productivity.
Source: Authors' calculations.

A comparison with India is instructive, where TFP in services has been the highest among the sectors post-1990 and within it, communication services has been a major propeller of growth (Mukherjee, 2013). As Table 5 shows, over the period 1980–2004, both TFP and physical capital growth contributed significantly to the growth of services sector output – 50 and near 40 percent, respectively. While the growth of the software industry (communications) contributed greatly to this growth in India, so too did financial services and retail trade. Clearly, Pakistan has not been able to absorb and use the rapid technological developments in ICT as India and other countries have done.

Table 5: Sources of economic growth in services in India

Period	Output per worker	Contribution		
		Physical capital	Education	TFP
1973-83	1.0	0.0	0.5	0.5
1983-93	2.7	0.3	0.4	2.0
1993-99	7.0	1.5	0.5	4.9
1999-2004	4.4	0.9	0.4	3.1
1980-2004	4.0	0.7	0.4	2.9

Source: Bosworth, Collins and Virmani (2006).

Why this is so needs further research, but the security situation has undoubtedly hindered Pakistan from taking advantage of growing and large markets for software exports and services, the back offices of which (as in the case of India) are located in the home country. The perceived risk associated with visiting these facilities by foreign firms (including much higher insurance coverage for their employees when travelling to Pakistan) has acted as a barrier, although some of these hindrances are being removed gradually as the security situation improves.

In Pakistan, as in India, the number of urban shopping malls has increased. Indeed, many large businesspersons are moving from industry or diversifying into setting up immense shopping malls, an example being the Nishat Group, which is setting up a large mall in Lahore.

An important conclusion that emerges from studies on Pakistan and India is that economic reforms that open up this sector to greater private participation,[14] free it from a host of government controls and allow the use of prime urban land[15] can all help greatly to unleash the sector's potential in Pakistan (see Mahfooz & Mahmood, 2015).

It may also be important to revamp the collection and computation of data on the services sector at the Pakistan Bureau of Statistics. Data for many of the subsectors is still indirectly derived, based on past assumptions of growth that are no longer relevant in most cases, primarily due to the use of ICT. The sector's current contribution to GDP may be significantly underestimated and the data likely fails to capture a growing unrecorded informal economy in services.

[14] As was done in telecommunications in the 1990s.
[15] Currently disproportionately in government use.

4.5 Reallocation Effects

The reallocation of resources from less productive to more productive activities is potentially an important source of growth. Using the Shapley decomposition methodology, changes in aggregate output per worker can be decomposed into changes in output per worker within and between sectors. The effect of an increase in output per worker within a sector depends on its share of total employment: a rise in labor productivity within a sector raises the average labor productivity. The reallocation of workers across sectors would increase average labor productivity only if the shift was from low-productivity sectors to high-productivity sectors.

Table 6 shows that, of the total increase in output per worker, services account for 46.6 percent, followed by industry (20.6 percent) and agriculture (18.8 percent). Again, this endorses the dynamism of the services sector.

Table 6: Decomposition of output per worker into within-sector changes in output per worker and inter-sectoral shifts, 1980–2015

	Contribution to change in total output per worker	
	PRs	%
Agriculture	18,924.3	18.8
Industry	20,711.3	20.6
Services	46,759.8	46.6
Inter-sectoral shift	14,051.3	14.0
Total change in output per worker	100,446.6	100.0

Source: Authors' calculations using the World Bank's Job Generation and Growth Decomposition Tool.

Inter-sectoral shifts account for a positive contribution of 14 percent over the span of 35 years. Although the figure is positive, implying that, on average, labor moved from lower-than-average-productivity sectors to above-average-productivity sectors, it is still quite low. Inter-sectoral shifts are usually associated with labor shifting from the subsistence or agriculture sector to industry and then services – the traditional path to economic development. However, in the case of Pakistan, employment growth in the agriculture sector has risen and the share of employed labor still averages 40 percent. In contrast, India's employed labor force has shifted from agriculture to services, although neither country has managed to create jobs in the industry sector, particularly in manufacturing. This reflects the 'productivity trap' in Pakistan by exhibiting the inability of the labor force to move from areas of low productivity to high productivity.

5. Conclusion

Despite the limitations inherent in the assumptions of the growth accounting model used as well as lack of adequate data, our results are robust enough to draw the following main conclusions.

The first is that there is a clear and strong association between output, productivity and TFP growth and that the maximum TFP gains and their contribution to growth are realized during periods of high-output growth. The second is that the dynamics of this relationship vary, especially between industry (which is dominated by manufacturing) and agriculture. In the case of industry, the cause is primarily output growth driven by higher levels of investment that bring with it new machinery embodying the latest knowledge and technology. This results in higher TFP growth and the larger contribution of TFP to output growth (as implied by Kaldor–Verdoorn's Law). In contrast, growth in agriculture is more supply-driven, with increased use of inputs and the introduction of high-yield seed varieties or diversification to higher-value crops or new subsectors such as livestock and dairy driving the growth of output, productivity and TFP. The contribution of physical capital to output growth is, therefore, relatively far lower.

There is considerable unrealized potential in TFP growth in services in Pakistan, as our comparison with India shows, and much scope for introducing economic reforms that would foster productivity growth through improved efficiency in factor use and incentives for introducing new technology (ICT). This is especially true of deregulation measures that would encourage more competition and private sector participation.

Our results do not support fully the view propounded by López-Cálix et al. (2012) that output growth in Pakistan has been driven primarily by increased use of labor and capital and not TFP growth (as in the East Asian economies), but that a major factor contributing to low TFP growth has been the abysmally low and falling levels of investment in the economy. The latter has affected the stock and vintage of physical capital and the contribution of labor has varied across time periods and sectors.

While there is considerable scope for economic reforms that would lead to higher output and TFP growth, the results of our study suggest that the gains from reforms can only be realized in a period of high-output growth. This may be a major reason that reforms were less successful in industry compared to agriculture.

The contribution of human capital to Pakistan's economic growth remains disappointingly low despite a major thrust to improve education and skills indicators, implying that these have still not reached the minimum threshold at which they could be a significant factor in driving economic growth.

Finally, there may be real gains if there was a shift in emphasis to research focused on the agriculture sector as well as a critical review of why existing research institutions in agriculture have failed to deliver tangible results.

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Costs, Capabilities, Conflict and Cash: The Problem of Technology and Sustainable Economic Growth in Pakistan

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Abstract

Growth in Pakistan has been surprisingly sustainable. GDP growth of 5 percent p.a. since independence and no recession since (at least) 1960 according to World Bank data represents a creditable performance when compared to all but the most successful developing countries. Pakistan has significantly transformed the structure of its economy during these same decades; in 1950 99 percent of its exports were agricultural goods and by the 1990s exports were largely manufactured goods. This very success indicates a growing constraint on sustaining growth into the future or the concern that Pakistan may be headed for a Middle Income Trap. Although there does exist scope for continued growth based on further structural changes - in particular the large number of people still employed in agriculture or the women not currently engaged in the labor force - for growth to be sustained a more intensive or productivity-oriented growth will be necessary. This paper first outlines the importance of productivity growth for sustaining GDP growth in Pakistan, then examines the historical and comparative productivity performance of Pakistan, and explores a number of case studies of successful technological change, particularly in South Asia, and finally attempts to draw some lessons for contemporary Pakistan.

Keywords: Technology adoption, productivity, political economy, Pakistan.

JEL classification: O14, O49, Q16.

1. Introduction

The word technology derives from the Greek word *technología*, which means 'systematic treatment'; it is derived from the word *tekhne*, meaning art or craft. This paper uses a similar broad understanding of technology, defining it here as the 'application of practical sciences to industry or commerce.' The examples of technology discussed in this paper range from new dies used in producing soccer balls (footballs) to new seed types in agriculture and new management practices in textiles.

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Long before the ancient Greeks derived the word 'technology', Pakistan was a global center of technological innovation. In the use of metal saws, drills and firing and glazing techniques, Harappa led the world in necklace technology between 3300 and 2800 BC (Kenoyer, 1997). Since then, Pakistan's technological record has been more mixed. The focus of this paper is to better understand that (contemporary) record of utilizing technology to boost productivity. The paper does not consider the impact of technology on, for example, working conditions, employment and the environment; the focus is more narrowly on growth rather than bigger questions of development and wellbeing.

This paper starts on an optimistic note. GDP growth in Pakistan has been surprisingly sustainable, averaging 5 percent per annum since independence. There has been no economic recession since (at least) 1960, according to World Bank data. This represents a creditable performance when compared to all but the most successful developing countries. Pakistan has significantly transformed the structure of its economy during these same decades: in 1950, 99 percent of its exports were agricultural goods and by the 1990s exports were largely manufactured goods. This very success indicates a potential constraint to sustaining growth into the future. Although there is scope for continued growth based on further structural changes (in particular, the large number of people still employed in agriculture or else the women not currently engaged in the labor force), for growth to be sustained, a shift to productivity-led growth will be necessary.

Section 2 outlines the statistical record of sustainable growth in Pakistan. Section 3 shows how economics represents technological change. Section 4 outlines the (poor) productivity record in Pakistan. Section 5 discusses four key constraints to technology adoption and absorption in contemporary Pakistan: resources (or cash), foreign direct investment (FDI) (costs), learning (capabilities) and conflict. Section 6 concludes by arguing that the outlook for Pakistan is pessimistic: it lacks the ability to mobilize resources or leverage FDI to transfer technology as well as the state necessary to either promote learning or control the conflict associated with technological change.

2. Sustainable Economic Growth in Pakistan

Contrary to the assumptions of many, economic growth in Pakistan since independence has been a model of sustainability. Since 1950, GDP growth has averaged around 5 percent per annum – almost exactly the same as in India. Table 1 shows that, over the last 20 or so years, GDP growth in Pakistan has not quite reached the levels of India and China, but compares favorably with other large Asian economies, including Indonesia, Thailand, Hong Kong and South Korea.

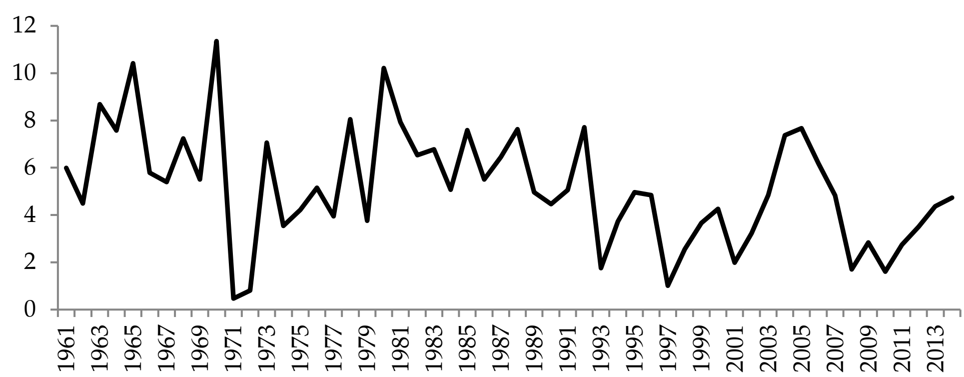
Table 1: GDP growth, 1990 to 2011

Country	GDP growth rate (%)
Pakistan	4.3
China	9.9
India	7.2
Indonesia	5.2
Thailand	4.1
Hong Kong	4.0
South Korea	4.0

Source: Asian Productivity Organization (2013, p. 18).

Figure 1 confirms that, while GDP growth has slowed on various occasions, particularly during the early 1970s, early 1990s and late 2000s, there has not been an economic recession (negative GDP growth) since at least 1960. India, by comparison, has had numerous recessions. Unlike most of the rest of the world, Pakistan has sustained positive growth through the 1973 and 1979 oil price shocks, the 1982 world recession and ensuing global debt crisis, the 1997 Asian crisis and the 2008 global financial crisis. The graph also demonstrates that GDP growth in Pakistan has fluctuated around a relatively narrow band, typically between 4 and 8 percent, and more recently between 2 and 4 percent.

Figure 1: Annual GDP growth in Pakistan, 1960 to 2015



Source: World Bank (2016).

For comparison, Figure 2 shows GDP growth in Malaysia over a similar time period. Average growth in Malaysia has been more rapid than in Pakistan, typically in the 5–10 percent range, but it has also been more unstable. There have been at least three recessions in Malaysia since 1960, most notably the –7.4 percent experienced during the Asian crisis in 1997.

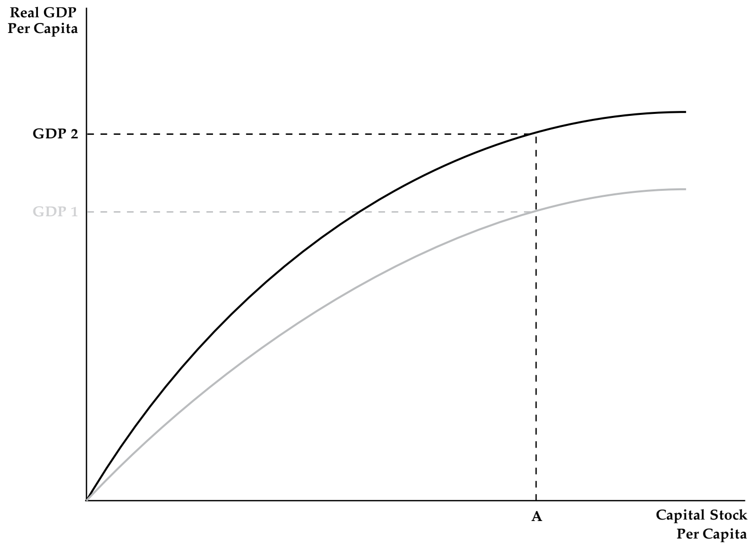
Figure 2: GDP growth in Malaysia, 1960 to 2015

Source: World Bank (2016).

3. The Representation of Technological Change

This section shows how economics represents the process of technological change and, in particular, how technology can overcome diminishing returns to investment and so, permit sustained economic growth. Figure 3 demonstrates the impact of technological change on GDP. At any given level of the capital stock (or quantity of land or labor), technological change leads to higher output (yield of land or labor productivity). At point A, sustaining growth through more investment becomes difficult whereas technological change, by raising the productivity of the existing capital stock, increases income from GDP1 to GDP2. This shows how technological change can help make growth sustainable.

Figure 3: Sustained growth and technological change

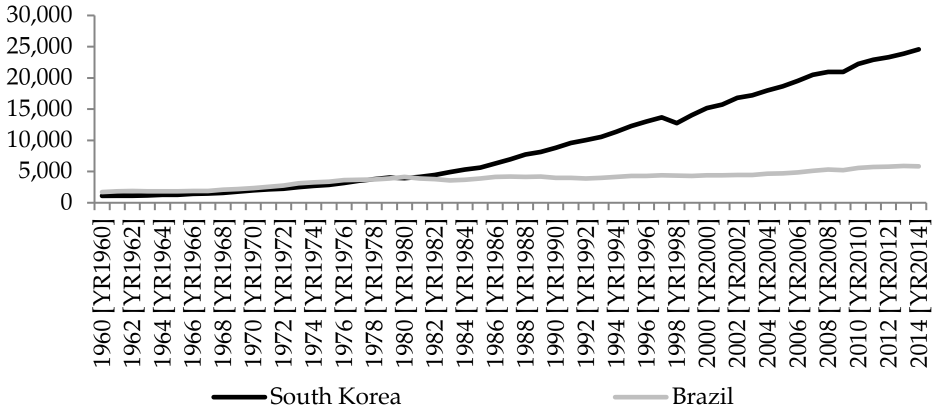


Note: Thanks to Rajat Raj for drawing the graph.

Figure 3 captures an important stylized feature of growth in Pakistan over the last several decades and for the next few decades. Growth in a low-income developing country such as Pakistan in 1950 can be sustained over several decades by raising the rate of capital accumulation (investment), particularly when that capital helps shift the structure of the economy away from low-productivity agriculture to higher-productivity industry. This broadly represents what happened in Pakistan from the 1950s to the 1990s or, more stylistically, up to point A in Figure 3. Once a country has made the transition from a poor agrarian economy to a low middle-income country (as had Pakistan by the 1990s), to sustain growth and avoid diminishing returns to investment requires a shift to growth based on productivity rather than ever higher levels of investment. Failing to make the transition has become known as being caught in a 'middle-income trap' (Kharas & Kohli, 2011; Felipe, Abdon & Kumar, 2012).

Figure 4 maps two alternative future scenarios for Pakistan. Both South Korea and Brazil experienced rapid economic growth in the 1960s and 1970s. After 1980, South Korea managed to sustain economic growth through a successful transition to productivity-led growth while Brazil saw its growth falter and GDP per capita remain stagnant for the next three decades at the middle-income level.

Figure 4: Brazil and South Korea, GDP per capita (constant 2005 US$)



Source: World Bank (2016).

4. Pakistan: Technology and Productivity

There has been a long debate in economics as to the extent to which total factor productivity (TFP) growth is determined by the adoption and absorption of new technologies and to what extent it is explained by other factors. Other factors may include access to better raw materials or improvements in the quality and motivation of the labor force. For the sake of this paper, I assume a close link between technology and productivity growth. This paper is concerned with sustainable growth; the other potential impacts on productivity are either one-off events (such as improving management practices) or themselves may run into diminishing returns (improving the education level of the workforce).

The evidence for Pakistan is pessimistic. Since at least the mid-1960s, it has experienced slow growth of productivity. There is supporting case study evidence to suggest that Pakistan has generally failed to upgrade to new technologies since at least the early 1970s within particular economic sectors. Productivity growth during the 1960s was quite rapid in rubber, tobacco, textiles, printing and publishing and electrical machinery, and only in the paper industry was productivity growth negative (Cheema, 1978). A more general index of productivity – TFP measured in two ways – for Pakistan confirms this rapid growth from the mid-1950s to the early or mid-1970s, followed by a continuous decline until the early 1990s (Wizarat, 2002, pp. 76–77). Table 2 shows that, between 1955 and 1991, growth in Pakistan was driven by more capital and labor and economies of scale while technological change/productivity had a negative impact.

Table 2: Sources of growth/decline estimates, 1955 to 1991

Sources of growth/decline	Percentage contribution
Capital	88.16
Labor	39.82
Technological change	–27.26
Economies of scale	42.86
Residual	–43.58
Total	100.00

Source: Wizarat (2002, p. 95).

Table 3 shows that, over the long term (1970–2011), TFP growth in Pakistan has been low. Of particular concern is the sharp slowdown of TFP growth in Pakistan in recent years while TFP growth has tended to accelerate in comparator countries.

Table 3: TFP growth, 1970 to 2011

Country	1970–2011 (%)	2005–11 (%)
Pakistan	1.4	0.6
Thailand	1.8	1.3
China	3.2	4.2
India	1.4	3.9
South Korea	1.7	2.4

Source: Asian Productivity Organization (2013, pp. 76–77).

A crucial part of this general failure of productivity has been the slow growth of labor productivity. Table 4 shows that labor productivity growth in Pakistan has long been much slower than in comparator countries and slowed down in recent years.

Table 4: Labor productivity growth, 1990 to 2011

Country	1990–2000 (%)	2000–11 (%)
Pakistan	1.9	1.3
China	8.9	9.3
India	3.0	5.5
Thailand	3.9	2.2
Bangladesh	3.3	1.0
South Korea	5.2	4.2

Source: Asian Productivity Organization (2013, p. 66).

In manufacturing, Raheman, Afza, Qayyum and Bodla (2008) find that TFP growth was very slow (0.9 percent per annum) between 1998 and 2007. This was promoted by technical efficiency (using factors more efficiently in production), but undermined by technical change (the very slow adoption of new technology). Importantly for Pakistan, its key export sector, textiles, suffered negative TFP growth in the weaving, spinning and composite subsectors. More specific case study evidence finds, for example, that small firms in Gujranwala are characterized by low levels of technical efficiency. The percentage of firms that are technically efficient ranges from a low of 18 percent in knitting mills to a high of 59 percent in saw and planing mills (Burki & Terrell, 1998).

Another study finds that technical efficiency did improve slowly over the 1990s in diverse sectors, including textiles, foods, industrial chemicals, iron and steel, drugs and pharmaceuticals, electrical machinery and nonelectrical machinery. It also finds, however, that large gaps in efficiency remained in these sectors by the early 2000s. In many other sectors, such as glass and glass products, transport equipment, tobacco, nonmetallic mineral products and other chemical products, technical efficiency continued to decline (Din, Ghani & Mahmood, 2007).

5. Pakistan: Constraints to Technology Adoption and Diffusion

Section 4 shows that there has been a longstanding productivity problem in Pakistan. Sustained economic growth over 50 years has occurred despite slow productivity growth since at least the early 1970s. This failure was hidden by the relatively high levels of investment that drove economic growth and structural change. The consequences of this failure are likely to be more evident in the coming decades. Pakistan has reached the lower middle-income level (point A in Figure 3) and there is now much less scope for further growth based on investment without productivity. The country faces a real risk of following the Brazilian path of stagnation rather than the Korean path of continued sustained growth (Figure 4).

This section examines four important influences on the pace of technology acquisition – and so, on productivity growth – and evaluates their likely impact for contemporary Pakistan. These are resources (cash), FDI (costs), learning (capabilities) and conflict. The paper will conclude that the outlook for Pakistan is pessimistic: its prospects may be more like Brazil than South Korea.

5.1 The Availability of Resources (Cash)

Much technology is 'embodied'. This means that new technology requires an act of investment for it to be used. For example, new and improved computing technology requires that a potential user invest in a new computer to access that technology. So, while investment and productivity growth are conceptually distinct (Figure 3), in practice there is a close link between the two.

There is broad evidence to demonstrate the importance of resource mobilization for investment and so, for technology acquisition.[1] A sample of 32 countries reveals the significant and positive impact of public savings on GDP growth (Krieckhaus, 2002). The stagnation of Brazil and rapid growth of South Korea (and Singapore) are both linked to distinct stories of savings. The slowdown of growth in Brazil after 1980 (Figure 4) is directly linked to a weakening of the central state and a rise in populist and politically motivated public spending, and hence to lower public saving and public investment (Weyland, 1998).

In South Korea, the government was successful in mobilizing tax revenue, which increased from 7 percent of the gross national product (GNP) in 1964 to 16 percent in the 1970s. This, combined with tightly controlled current expenditures, allowed government savings to increase from 0 percent of GDP between 1961 and 1965 to 5.5 percent between 1966 and 1970 (Kohli, 2004, p. 103). The government was also able to repress private consumption through policy measures such as controls on consumer loans and high rates of indirect taxation. Imports of luxury goods were banned or subject to high tariffs and inland taxes (Chang, 1993, p. 139). The private savings rate in South Korea increased from 6.8 percent of GNP between 1961 and 1965 to 18.0 percent between 1976 and 1980 (Kohli, 2004, p. 103).

In Singapore, public savings were generated by the government in two ways: by manipulating the prices charged by public utilities such as

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[1] It is not just a question of the volume of resources. There is good evidence of significant political interference in the allocation of these low levels of saving via bank lending in Pakistan. One estimate finds that politically influential firms – defined as a situation in which a firm director participates in an election – borrow 45 percent more and default 50 percent more than nonpolitical firms. The survey estimates that the economy-wide impact of this distortion amounts to around 0.3–1.9 percent of GDP a year (Khwaja & Mian, 2005, p. 1371). The accumulated impact over time of such misallocation is likely to be significant. Though not tying their results to just politically motivated lending and investment, Hsieh and Klenow (2007) estimate that aggregate productivity would increase by 40–50 percent in India were investment in capacity expansion to have been allocated as efficiently as in the US.

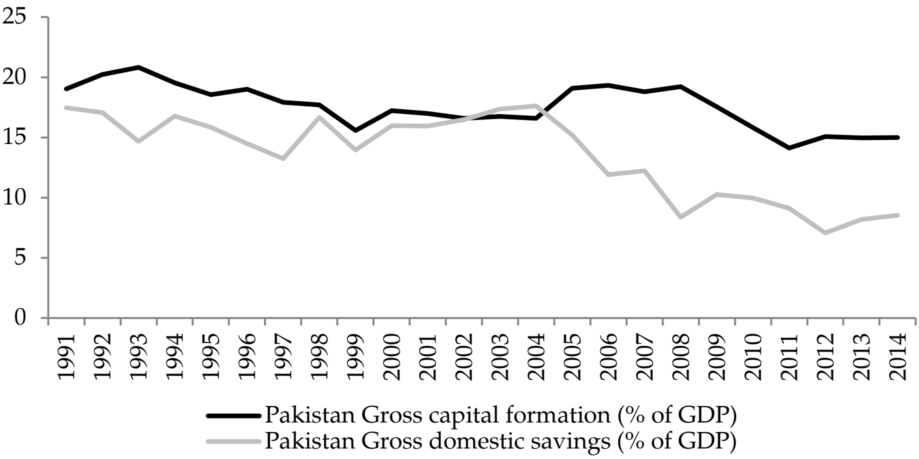
telecommunications to raise a surplus for the state (Huff, 1995, p. 745; Ermisch & Huff, 1999) and by controlling private consumption, which by 1995 comprised only 40.9 percent of GDP (by comparison, the lowest ever share reached by the USSR was 55 percent). The total savings rate rose from 6.7 percent of GDP between 1960 and 1966 to nearly 43 percent in the 1980s (Huff, 1995, p. 737).

In these successful Asian economies the link from public savings to economic growth is argued to have run through higher public investment in infrastructure, education and support to technology transfer and absorption from abroad (Nelson & Pack, 1999).

Pakistan has a much more mixed record in translating public savings and so public investment into productivity and so economic growth. Higher public investment did increase economic growth in the early 1960s and early 2000s, in the latter this was undermined by falling US aid after 1965 and in the latter by domestic political conflict and the 2008 global financial crisis. By contrast, sharp increases in public investment under Zulfikar Bhutto in the 1970s provided both infrastructure and cheap inputs to industry. This should have relieved constraints on industrial growth that had been widely noted by the late 1960s, but there was no increase in GDP growth. Bhutto's nationalization campaign and anti-private sector rhetoric undermined the confidence of investors, and led to a collapse in private investment that offset the growth benefits of higher public investment (McCartney, 2011).

The contemporary Pakistan experience is strikingly different. Figure 5 shows that a significant gap between investment (gross capital formation) and savings (gross domestic savings) in Pakistan opened up in 2005. At its peak in 2009, this amounted to around 12 percent of GDP. In 2014, it was still around 7–8 percent of GDP. This implies that Pakistan depends on generating a surplus elsewhere to fund investment.

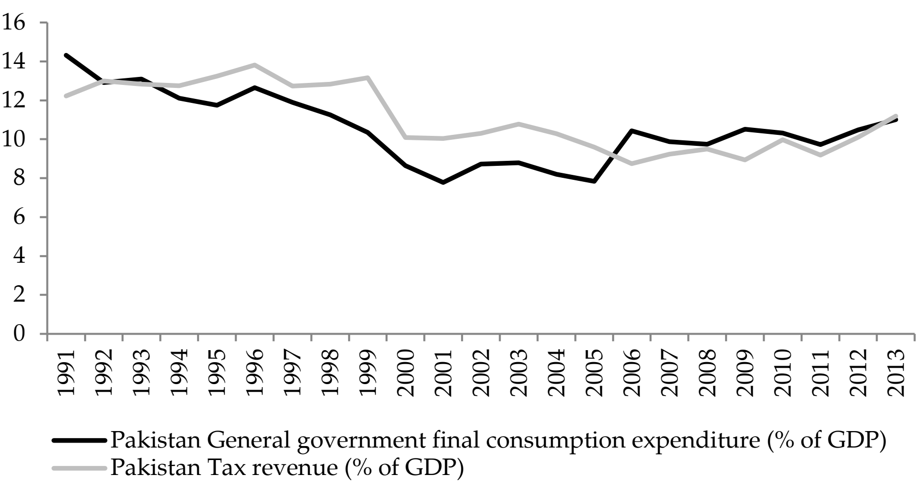
Figure 5: Savings and investment in Pakistan, 1990 to 2015



Source: World Bank (2016).

Figure 6 shows that this surplus is not coming from the government sector. Since the mid-2000s, a long-standing surplus of tax revenue over government consumption spending has turned into deficit. This means that the government has to borrow to fund all its investment and even some of its consumption spending.

Figure 6: Government consumption and tax revenue in Pakistan, 1990 to 2015



Source: World Bank (2016).

Together, Figures 5 and 6 imply that Pakistan is structurally dependent on external resources to fund domestic investment and so, to acquire any technology embodied in that investment. In the 1970s, this structural imbalance was met through remittance transfers from Pakistanis working overseas, mainly in the Gulf region. In the 1980s, it was met through foreign aid linked to Pakistan's alliance with the US against the intervention of the USSR in Afghanistan. In the 1990s, the accumulation of expensive foreign debt helped close the gap. In the 2000s, this deficit was initially met through sharply rising levels of FDI and remittances and, to a smaller extent, by debt forgiveness linked to Pakistan's support for the US-led 'war on terror' in Afghanistan. After 2008, it was met increasingly through foreign borrowing (McCartney, 2015).

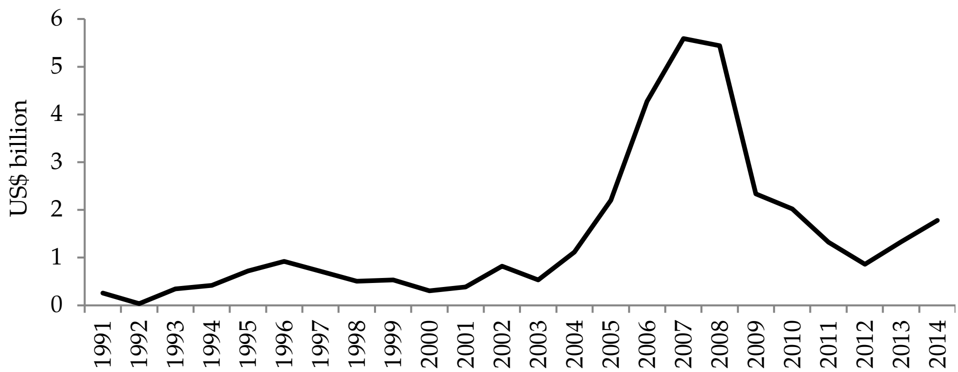
The first constraint to Pakistan's ability to shift to productivity-led growth is either to raise sufficient savings and tax revenue domestically or to hope for a favorable international geopolitical situation that enables a long-term stable transfer of resources from abroad. Given the very longstanding failure to mobilize tax revenue in Pakistan and the vagaries of the global geopolitical environment and associated aid flows, there is no easy solution (McCartney, 2012).

5.2 FDI and Technology Transfer (Costs)

FDI may lead to technology transfer among local firms that can imitate or copy that technology. Workers trained by a multinational may transfer knowledge to a local firm or start their own firms and take with them the relevant technological know-how. The magnitude of such positive spillovers from FDI has been found to depend on local skill endowments, the capability of local education and research institutions, the technological capability of local firms and the provision of infrastructure (Lall, 1992; Gorg & Greenaway, 2004). There is ample evidence that successful developing countries have long leveraged FDI as a source of technology transfer; these include Japan (Johnson, 1982), South Korea (Mardon, 1990), Singapore (Huff, 1995; Ermisch & Huff, 1999) and Ireland (Ó Riain, 2000).

Pakistan has recently had an excellent opportunity to leverage FDI to acquire new technology. Figure 7 shows that there was a boom, if temporary, in FDI inflows to Pakistan after 2003.

Figure 7: FDI net inflows in Pakistan (current US$)



Source: World Bank (2016).

As noted above, technology transfer from FDI has been found to depend on, among other things, the stock of educated and skilled labor. In 2003/04, as the FDI boom started, only 52 percent of the population of Pakistan aged 10+ years were literate, including 40 percent of females (Khan, 2009). There are also concerns with the quality of education beyond the minimal criteria of literacy. The 2003 Learning and Educational Achievement in Punjab Schools project found that, by the end of grade 3, less than 20 percent of its sample of 12,000 children could understand a simple written sentence in the vernacular and less than 10 percent could graphically represent simple information (bar charts) compared to over 70 percent internationally. In summary, "close to one-half of the three million born in Pakistan will leave school unable to add, subtract, multiply or divide, unable to read and write simple sentences in Urdu; and unable to read a short word like "BALL" in English" (Das, Pandey & Zajonc, 2012, p. 232).

Pakistan also fails with regard to the vocational education that could have created the practical skills needed to absorb technology from FDI. By the mid-2000s, it had 3,125 technical and vocational institutions with a total enrolment of 256,000. The curriculum had little relevance to the evolving labor market and practical training was near absent. The Government Polytechnic Institute in Karachi, the oldest such institute in existence, offered training in 17 different trades, but by mid-2009 was in a state of disrepair (Khan, 2009).

Many authors agree that developing countries such as Pakistan are, today, severely constrained in their ability to leverage FDI to promote technology transfer.[2] Wade argues that developing countries are now more "tightly constrained in their national development strategies by proliferating regulations formulated and enforced by international organizations" (2003, p. 621).

The agreement on trade-related investment measures (TRIMs) that emerged from the Uruguay Round of GATT-WTO trade negotiations in the mid-1990s aimed to remove those 'trade and investment distortions' which, argue Chang and Wade, have long been used by developing countries to promote investment and technological absorption by national firms. An example would be local content agreements by which FDI firms are compelled to source an increasing proportion of their inputs from local firms over time.

These concerns are overstated. TRIMs prohibit measures that (i) require particular levels of local sourcing by an enterprise, (ii) restrict the volume or value of imports that an enterprise can buy/use to the volume or value of products it exports, (iii) restrict the volume of imports to the amount of foreign exchange inflows attributable to an enterprise and (iv) restrict the export by an enterprise of products to a proportion of the volume/value of local production (Di Caprio & Amsden, 2004).

This list of restrictions leaves open various other routes to promoting domestic industrialization and technology acquisition. Developing countries can support their own industries, target national champions and promote general national competitiveness in the name of 'promoting science and technology'. Various subsidies are permitted for R&D (including innovation and technological upgrading), disadvantaged subnational regions and environmental upgrading (Weiss, 2005). The main constraint is not international law but domestic politics and "the most coercive part of the new international economic order is informal" (Amsden & Hikino, 2000, p. 110). Rarely do contemporary developing countries – certainly including Pakistan – have a committed faction among the political and civil service elite capable of articulating and promoting an industrial policy to promote technology absorption.

A recent example of this failure is the Pakistan Textiles Policy 2009–14 produced by the Ministry of Textiles. This was an explicit effort to boost technology acquisition. The policy recognized numerous of the constraints faced by the textiles industry, such as the lack of adequate infrastructure

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[2] See McCartney (2014) for a more extended discussion.

and skilled labor, and that the regulatory framework increased the cost of doing business. The plan lacked any clear focus. It was less a plan than a long list of aspirations, including to "develop state-of-the-art infrastructure facilities"; to "increase the supply of efficient human resources"; to "evolve a legislative framework that sets standards for each stage of processing" with a view to "increasing productivity" and "improving quality", thereby "ensuring optimum utilization of resources"; to "promote R&D" to "achieve product diversification", "technological advancement" and "increased productivity throughout the value chain", specifically in the "quality and diversity of fibers"; and to "encourage exports by meeting the demands of competition, technology and higher labor productivity".

This effort was costed at US$8 billion (largely for the private sector) over five years and a government-sponsored 'Textiles Investment Fund' was promised. Areas for government funding were to include the modernization of machinery and technology, removing infrastructure bottlenecks, enhancing skills, better marketing and the use of IT. The funding was all-purpose to encourage manufacturers in all subsectors to modernize their machinery and technology. This aim did not target the key market failure in the risk associated with learning and technology acquisition (Section 5.4). Funding was not targeted at risk but at "reducing the cost of financing to international levels and ensuring adequate availability of credit for such purposes". Support was also promised "to attract joint ventures, mergers and FDI for expansion and upgrading in the sector". The policy subsequently fizzled out in response to budget cuts and pressure from the International Monetary Fund to reduce public spending. Resources are needed to promote technological change (Section 5.1).

5.3 Technology and Learning[3]

Simplified models of technological transfer assume that technology is freely available to all countries/firms. More labor-abundant countries, for example, will select labor-intensive technology to take advantage of their low wages; once selected, this new technology can be either costlessly absorbed or else any learning period is predictable and automatic (Lall, 1992, 1994). In reality, markets within which international technology transfer takes place are subject to various market failures, such as asymmetric information, the market power of technology producers, and externalities in learning (Lall, 1992, 1994; Hoekman, Maskus & Saggi, 2005).

[3] This section is largely drawn from McCartney (2014).

Given these market failures, there may be a valid case for intervention on the infant industry basis whereby industries or firms that have the potential to be competitive need nurturing through the early stages of learning. Much of the technological and organizational knowledge necessary for competitiveness is tacit knowledge embedded in routines. Effective production requires a mix of formal or codifiable knowledge (can be communicated in words/symbols) and uncodifiable knowing-how-to embedded in unconscious and often complex routines (tacit knowledge) (Khan, 2013a). It takes time to experiment and integrate new machines into production in an optimal manner and requires learning-by-doing. The key market failure is, therefore, a financing problem – that period of risk and loss making that has to be financed while learning-by-doing is taking place. Own investment by the firm will be limited to the availability of retained profits and the owner's willingness to undertake the risk.

In theory, private investors could be lured by the prospect of future profits and finance that loss making. In reality, this does not often happen. Private investors are happy to finance investment in known sectors where the market is assured and the methods of production are standardized. In Bangladesh, for example, survey evidence shows that there is no shortage of bank finance, which is readily available for established technologies and entrepreneurs (Khan, 2008). In the World Bank (2007) Enterprise Survey, only 17.7 percent of Pakistani firms surveyed reported access to finance as a major constraint, compared to 33.4 percent in other South Asian countries and 29.7 percent across 135 countries.

Learning to use new technology to raise productivity requires significant effort by managers and workers (Khan, 2011). A firm could contract with a bank to supply this requisite effort in return for lending and repay the loan from future profits. Accurate disclosure of profits and enforcing the rights of outside investors (such as banks or shareholders) is difficult to ensure in a developing country. In theory, enforcing the rule of law, reducing corruption and increasing transparency can help enforce such contracts, but this is likely to take a long time.

In Bangladesh, survey participants were asked which mechanisms of good governance reforms would solve their problems – such as a more efficient stock market allowing them to raise funds – and "they universally agreed that these conventional mechanisms were implausible even in the medium term" (Khan, 2008, p. 21). In Pakistan, less than 1 percent of firms in 2007 financed investment by equity or stock sales (World Bank, 2007). In practice, banks try to protect themselves by requiring high-quality collateral and high interest rates from borrowers, which passes on the risk from the bank to an entrepreneur-owner. Survey evidence in Bangladesh confirms that firms were concerned about the high interest rates even for loans backed by good collateral, the combination of which shifted the risk of delay and problems with new technology to the borrower (Khan, 2008).

A second solution would be to target incentives more closely to the mechanics of the learning failure. A firm could obtain a subsidy or cheap credit that would allow it to engage in learning-by-doing. The conditions of rent withdrawal would need to be clear from the outset so that owners and managers feel compelled to put high levels of effort into learning (Khan, 2013b). In 1960s South Korea, technology was mainly transferred to large firms (chaebols) that received various forms of subsidies (often cheap credit) and protection from imports to give them an opportunity to expand production. Increased production was closely linked to learning-by-doing as subsidies and protection were conditional on firms meeting export targets, reducing costs and absorbing new technologies. The state maintained a credible threat to remove these incentives should firms fail to meet their targets. The balance of power between the state and chaebols was such that inefficient firms were not able to protect their subsidies if the state wanted to withdraw them (Khan & Blankenburg, 2006).

The state needs to have administrative capacity and political willingness to allocate subsidies that are contingent on learning and to remove them in the event of failure. For South Korea, those successful preconditions are usually framed in terms of it having been a 'developmental state'. A developmental state is defined as "states whose politics have concentrated sufficient power, autonomy and capacity at the center to shape, pursue and encourage the achievement of explicit development objectives, whether by establishing and promoting the conditions and direction of economic growth, or by organizing it directly, or by a varying combination of both" (Leftwich, 1995, p. 401).

Table 5: Declining state capacity in Pakistan

Measure of governance	2006/07	2014/15
Quality of institutions	3.5	3.2
Judicial independence	3.3	3.8
Favoritism shown in decisions of government officials	3.1	2.6
Wastefulness of government spending	3.5	2.6
Reliability of police	3.1	3.1

Source: World Economic Forum (2006, 2014).

5.4 *Technology and Conflict*

Economic development is about shifting resources from low- to high-productivity areas. During the course of development, the share of the labor force working in agriculture may decline from 90 to 10 percent of the total and land is reallocated from small farms to large farms, to urbanization and to factories. Technological change will also create losers among those whose skills become obsolete, often as a task becomes mechanized. Such workers will lose the status of being skilled craftsmen and perhaps descend into the ranks of unskilled manual laborers (Chang, 1999).

There are two ways of thinking about how such conflict arises. The first relates to New Institutional Economics. Here there exist two agents or groups with different incentives. For example technological change will boost profits for employers but make the skills and hence employment of workers obsolete. Institutional economists would trace the problem to missing institutions, either formal or informal. In the above example the formal institution of an employment contract would give workers job security. Certain of continued employment workers would have no incentive to resist the adoption of the new technology. The firm would implement the new technology and re-deploy the displaced workers elsewhere in the firm and ultimately share the higher profits associated from producing with the new technology. The second relates to the processes of political and social change. For many developing countries, politics after 1945 was characterized by conflict, structured variously through ethnicity, class and geography and manifest through riots, coups, alienation, the loss of authority by the formal legal system and decline of broadly based political parties. There was a decline in political order measured by the declining effectiveness, authority and legitimacy of government. Huntingdon argues that, "in large part it [conflict] was due to rapid social change and mobilisation of new groups into politics and slow development of political institutions" (1968:4). Social and economic change such as urbanization, increased literacy, industrialization, and expansion of the mass media had extended political consciousness, multiplied political demands, and increased political participation. The new elites of civil servants and teachers employed by the central government undermined traditional sources of political authority, the secular and religious leaders of the villages, and traditional social networks based around family, class and caste. Economic development also created newly wealthy groups not assimilated into the existing social order. The primary problem of politics and resulting conflict was the slower development of political institutions relative to social and economic change, "economic development and political stability are two independent goals and progress toward one has no necessary connection with progress toward the other." (Huntingdon, 1968, p. 6).

History, though, has demonstrated two means to overcome opposition to technological change: repression of those opposed or a more inclusive form of compensation to the losers. The most famous example of organized opposition to technological change was that of the Luddites. This name recalls a movement that started in Nottingham, England, in 1811 and spread rapidly over the next two years. The participants (allegedly led by Captain Ludd) smashed wool and cotton mills, believing that mechanization had deprived them of employment. The Luddites were brutally suppressed by the government and many participants were executed or transported to Australia (Easterly, 2001a, p. 182). The losers in this case were brutally repressed by a state that used its coercive capabilities to support the process of technological change.

The reallocation of agricultural land from small, low-productivity farms to either larger commercial farms or urban-industrial usage is a key aspect of long-term structural change and the ability of an economy to utilize new technology in farming or industry. Land reallocation offers a contemporary example of both repression and compensation. China has solved this problem by repressive means. One estimate suggests that 20 million farmers were evicted from agriculture as a consequence of land acquisition between 1996 and 2005. This land grab permitted about 5 percent of arable land to be transferred to nonagricultural use, which was crucial in supporting China's growth, based on the export of manufactured goods. The Chinese state has intervened brutally to support the process through the deployment of police and the military. China's ministry of public security acknowledges that 87,000 public order disturbances broke out in 2005 alone, a large proportion of which were due to such land grabs (Sarkar, 2007).

In Vietnam, the same process of land transfer has relied more on compensation. During the 1990s, Vietnam allocated state-owned land to households through laws in 1988 and 1993 that formally codified this process first and then sought to deal with ensuing problems. These related to local governments that continued trying to control the process of land (re)allocation, the short duration of use rights, lack of transferability and continuing difficulties with using land as collateral. The new laws established the right to inherit, transfer, sell, lease and mortgage land use (though not full ownership) and to receive compensation in case of government expropriation (Deininger & Jin, 2003). Between 1993 and 1998, the land market had become active. By 1998, 27 percent of households surveyed had received use rights to new land plots through purchase, exchange, inheritance or allocation, and 13 percent had sold, exchanged or returned land.

The land was not just grabbed by politically well-connected groups. Rather, the land market worked to reallocate land to more productive farmers through market sales or renting it out by less to more productive farmers (the compensation) (Ravallion & Van De Walle, 2006). The increased security in the land rentals market enabled many to leave rural areas confident they could retain ownership-control of land assets. Between 1993 and 1998, the share of households with at least one member with an off-farm job increased from 30 to 55 percent. This formed the pool of labor for employment in the country's rapidly growing export industries (Deininger & Jin, 2003). This process is reminiscent of many of the arguments made by De Soto (2001), that giving formal ownership titles to informal sector housing, land and business assets will enable their new owners both to turn them into collateral to access banking loans and also give them incentives to undertake long-term investment to improve those assets. Or as De Soto argues, turning dead capital into productive capital.

Contemporary India has (so far) tried and failed to implement both repression and compensation in land transfers. Formal powers of compulsory acquisition were established in India by the Land Acquisition Act 1894, which utilized the concept of 'eminent domain', enabling the state to make compulsory purchase of private assets for public purposes, with compensation linked to market prices. This law was reincarnated as the 2005 Special Economic Zone (SEZ) Act that set a framework for state governments to acquire land for industrial estates. By 2008, 404 SEZs had been approved, covering 54,280 acres. After being launched, many SEZs then stalled in response to massive political protest: these included the Salim Group's petro-chemical SEZ in Nandigram (West Bengal), the

Reliance Group Multipurpose SEZ near Mumbai and the US$12 billion POSCO steel SEZ in Orissa (Levien, 2011).

Public infrastructure projects, notably the Sardar Sarovar dam on the Narmada River in Gujarat, also attracted protest. Most famous was the Tata Nano project in West Bengal to build a US$2,000 car for the Indian mass market. The state-run West Bengal Industrial Development Corporation identified 1,000 acres for Tata; this was estimated to affect the land rights of 12,000 owners (Mohanty, 2007). The government tried to devise a relatively generous compensation scheme, but failed to convince the owners it would be paid. It also failed to include those unregistered sharecroppers and landless households who were dependent on working the land for their livelihoods. By July 2006, the highway bordering the Singur site was blocked by protestors. By September, the police began resorting to violence; in November, Special Forces had been sent in to protect the site (Mohanty, 2007; Sarkar, 2007).

In response, the central government put together the first policy on resettlement and rehabilitation in 2004, which was revised in 2007 after these widespread protests. It re-emerged as the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013 and came into force on 1 January 2014. The legislative tendency was to increase the attention given to more carefully quantifying the costs and benefits to society at large and the impact on affected families in a participatory and transparent manner. Whether it will work in a similar manner to Vietnam remains to be seen.

A case study by Atkin et al. (2015) of the hand-stitched soccer-ball (football) cluster in Sialkot gives a specific example of this problem for contemporary Pakistan. This micro-level case study raises interesting questions about how best Pakistan can learn from historical and contemporary examples on how best to promote technological change when workers resist it. Options are to resort to repressive measures, that is to introduce the new technology and sack workers who oppose its adoption (China style), or else to introduce the technology via a process of consultation and compensation through ensuring that the benefits are shared between employer and employee (Vietnam or India style). The issue identified in Atkin et al. (2015) is that the 130+ firms in the industry cluster have been very slow to adopt a new technology (a new die) that offers a significant reduction in mean costs relative to existing (low profit) margins and would occur in an industry facing highly competitive international markets (mainly China) producing a relatively standardized product, using a simple, standardized production process. Atkin et al. hypothesize that the explanation for this puzzle is related to incentives within the firm. The new die reduces the productivity of cutters and printers during the initial period as they learn to use the new technology. As cutters and printers are generally paid a pure piece rate, their real wage would likely fall in the short run, giving them an incentive to resist the new technology. Atkin et al. argue that a new labor contract compensating workers for the short-run loss in productivity and committing employers to share the gain in long-run productivity (or reduced costs) would help diffuse the new technology.

The problem with viewing technology change as just a technical question of optimal contracts is the underlying political economy. Workers in Pakistan do not generally have written contracts and even if they did, they would not be enforceable in court. As of May 2009, for example, there were more than 100,000 cases pending before the Karachi city courts and 110 judges to try them in a city of 17 million people (Lieven, 2011). Any change in contracts would have to rely on the trust between employers and workers. Without detailed fieldwork on the Sialkot case study, it is difficult to make a specific judgment. In general, though, labor relations in Pakistan are characterized by a lack of cooperation, absent long-term relations and high turnover of labor, which together undermine the credibility of any such long-term promises (Amjad, 2005; Lieven, 2011). What, then, are the broader constraints relating to repression and compensation that were discussed in the opening part to this section?

There are many mechanisms that successful developing and developed countries have used in the historical and contemporary eras to 'solve' the problem of conflict and technological change. The lifetime employment in large Japanese firms that helps ensure workers will eventually benefit from any new technology (Francks, 1999, chap. 12) is not viable in contemporary Pakistan, given the high labor turnover and informality that characterizes most employment.

Other examples include high levels of trust in society that can help employers make credible promises to share the future benefits of technological change with workers (Fukuyama, 1996); well-functioning labor markets and a well-developed social security system that mitigates the downside of technologically induced unemployment (Rodrik, 1998); a corporatist economic structure that enforces a sharing of the economic gains of technological change between labor, corporations and the state (Calmfors & Driffill, 1988); a well-developed legal system that enables workers to negotiate and enforce contracts to ensure they will benefit from technological change in the long run (Easterly, 2001b) and strong trade unions that are able to enforce a sharing of the benefits of technological change with current employees (Miyamura, 2011). It is beyond the scope of this paper but, hopefully, part of a forthcoming research agenda to detail why each of these is not relevant for contemporary Pakistan.

In South Asia, the most important institution to bind different groups into a long-term project of compensation has been the political party. The best example of this is the Congress Party in India, principally between independence and the mid-1960s, the main feature of which was an elaborate system of factions at every level of political and government activity through which Congress functioned (Menon, 2003, pp. 24, 48). The party provided a system of coordination between the various levels through vertical faction chains that "provided a subtle and resilient mechanism for conflict management and transactional negotiations among the proprietary classes" (Bardhan, 1984, p. 77).

The Congress provided a well-defined network for the distribution of the spoils of office, institutionalized procedures of transaction and absorbed dissent by co-opting leaders of subordinate classes (Kothari, 1964). In power between the 1950s and 1980s, Congress monopolized patronage resources right down to the village panchayats, sugar cooperatives, banking corporations and state-allocated resources such as licenses, fertilizer, seeds and road construction. Even those losing out in the short run had an incentive to remain within the party and hope for benefits in the long run. The central leadership provided a system of mediation, arbitration and inter-level coordination in the party.

The Congress system allowed groups losing out from the pattern of economic development to be incorporated and compensated at minimal cost. A good example is the demobilization of a militant labor movement in the late 1940s (Chibber, 2003, chap. 4). After 1945, India faced an explosion of strikes and union activity as real wages were eroded by postwar inflation. In December 1947, a tripartite conference was held to end hostilities. The result was a set of labor laws that undermined the potency of collective bargaining by making unions dependent on state patronage and also engineered a split in the union movement. A new federation, the Indian National Trade Union Congress (INTUC) was formed and affiliated to Congress. Every affiliated organization was compelled to submit to arbitration when industrial disputes were not resolved by negotiation. Under government patronage, the INTUC grew rapidly to become the largest labor organization in the country. Labor and union leaders were absorbed into the Congress party, strike activity quickly dropped down to prewar levels and radical labor ceased to be a threat.

Without the distraction of union opposition, the government was better able to pursue its development strategy. This strategy combined efforts to mobilize resources through regressive excise duties to fund large increases in public investment in the 1950s to the 1970s in heavy and chemical industries. This, in turn, helped drive economic growth and industrial diversification (McCartney, 2009). While real wages failed to increase during these years – resources being devoted instead to savings, taxation and investment – workers did receive employment protection, leave, holidays, promotion, wage scales and employment that were regulated by government legislation. The party system enabled the state to focus on long-term growth and compensate those losing out.

The long-standing contrast with Pakistan is striking. While the Indian Congress system retained flexibility in incorporating a diverse array of elites into its ranks, in Pakistan, the Muslim League was more inclined to confront those who contested its hegemonic claims.[4] The well-organized system of factions of the Congress contrasted with the lack of organizational machinery linking the central leadership of the Muslim League with those exercising power at the provincial and local levels (Jalal, 1990). The monopoly of patronage resources held by the electorally dominant Congress contrasted with the electoral collapse of the Muslim League soon after independence. In the 1954 East Pakistan provincial election, the ruling Muslim League won only 10 out of 309 seats.

The importance of the political party as a means to control the conflicts associated with economic growth and technological change has been widely discussed in the case of India. These efforts, among various others, include the state-level differences relating to poverty reduction (Harriss, 2000), policy implementation (Swaminathan, 1990) and developmentalism by state-level governments (Sinha, 2005) in the recent growth and development success of Bihar (Kumar, 2013) and long-standing welfare success of Kerala (Heller, 1996).

Research related to Pakistan, save the perceived failure of the Muslim League in the years after independence, remains limited. One exception is Lieven (2011) who discusses the Karachi-based MQM in some

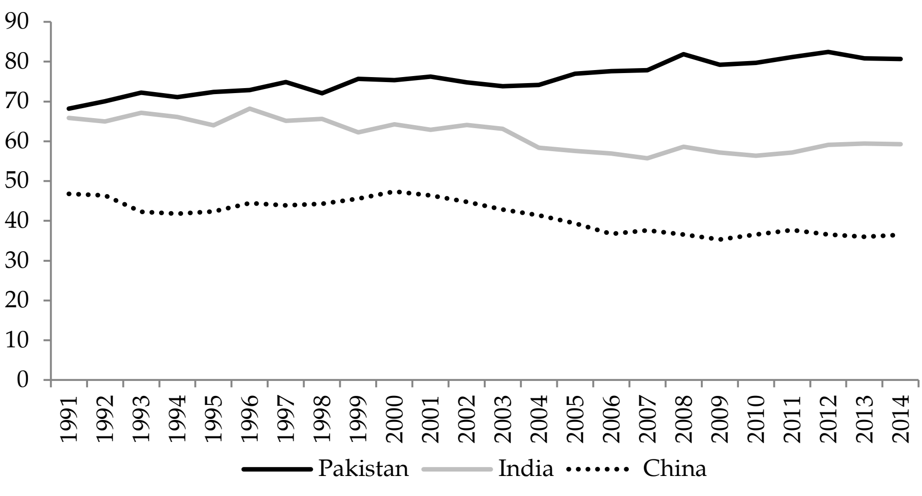
[4] This section draws from McCartney (2011).

detail. The MQM utilize a mixture of brutality, mobilization, incorporation and compensation to achieve long-term development goals. The MQM, he argues, is very well organized with a strong leadership and clear ideological appeal. The party has shown a capacity to use this to promote long-run economic growth and technological upgrading in Karachi, particularly in regard to communications.

These failed efforts at both incorporation and repression are evident in contemporary Pakistan and contributed to the failure to sustain the incipient economic boom that began in 2003. Around 2003, economic growth surged to over 7 percent for several years. This was related to the rebalancing of the economy away from consumption to investment. Investment surged from 16–17 percent of GDP in 2003 to 23–24 percent of GDP in 2007; the macroeconomic space for this increase was created by efforts to control consumption.

Figure 8 shows that consumption as a share of GDP stabilized or declined in Pakistan around 2000. The shock of the 1999 coup briefly cowed civil society and allowed the incoming Musharraf government this degree of autonomy to restrain consumption and boost productive investment (McCartney, 2015). In India, an equivalent growth boom was supported by a more determined control of consumption, which permitted investment to rise to 35 percent. In China, the squeeze on consumption and rise in investment was even more marked.

Figure 8: Household final consumption expenditure as a share of GDP



Source: World Bank (2016).

After 2002, society began reasserting itself and forced Musharraf under growing political pressure to boost populist consumption. In the 2002 elections, an Islamic alliance (the MMA) came to power in Khyber Pakhtunkhwa and won almost 12 percent of the national vote and 62 National Assembly seats (from 342). The PPP emerged as the biggest party but won less than 26 percent of the vote, while the hastily assembled collection of co-opted pro-military notables in the pro-Musharraf PML-Q won around 25 percent of the vote and the PML-N under Nawaz Sharif won less than 10 percent. The vote marked an extreme fragmentation of politics, with each province being won by a different political grouping. Musharraf's new political grouping had comprehensively failed to integrate even the elites, let alone other civil society organizations such as labor, the middle classes and religious groups.

In 2003, the US attacked Iraq and support for the government continued to fall rapidly; it was no surprise that Musharraf declined to step down as army chief of staff in 2004. In terms of reforms "on most key issues he backtracked under pressure from his own right-wing allies and the mullahs" (Hussain, 2010, p. 183). By 2007, massive opposition to Musharraf had emerged with the lawyers' movement, which originated in attempts by Chief Justice Iftikhar Chaudhry to place limits on Musharraf's power in early 2007. The former's consequent dismissal led to a protest movement of lawyers (Lieven, 2011).

The early focus of the Musharraf government on long-term structural reforms, reducing deficits and boosting investment dissolved into a populist effort to buy off growing political opposition. Bank lending went increasingly into lending to consumers rather than funding industrial investment. In the early 2000s, imports and pricing of petroleum products had been deregulated and an automatic price adjustment formula for consumer prices of petroleum products linked with international prices was adopted (Husain, 2003). As Musharraf's popularity declined in the later 2000s, consumers were instead protected from rising oil prices and consumer prices restrained through substantial government budget outlays on subsidies. The wages of public employees were increased. The central government budget went into sharp deficit. Efforts at both incorporation and repression had failed; consumption increased, investment fell and economic growth dropped back to its longer-term average of around 4–5 percent.

6. Conclusion

This paper has demonstrated that Pakistan has a long-term productivity problem. Though productivity is influenced by many factors, one of the most important is the ability of a country to absorb, adapt, diffuse and successfully utilize new technologies. This paper has looked at long-term influences on that process, focusing on resources (cash), FDI (costs), learning (capabilities) and conflict. In each case, the paper concludes that Pakistan is ill positioned to overcome these specific constraints. Long-term sustainable growth of 7+ percent, as was experienced briefly in the years after 2003, looks unlikely. Pakistan faces an economic future more like that of Brazil than that of South Korea.

Rather than striving to learn from the impossible – Pakistan is not going to construct a South Korean developmental state of 1961 vintage – Pakistan can look instead to the practical. Bangladesh is similar to Pakistan in terms of corruption, weak governance institutions and an intensely politicized, but not ideological, policymaking process by weakly organized political parties. The state has in response decentralized and delegated much policymaking to private organizations such as the Bangladesh Garment Manufacturers and Exporters Association (BGMEA) and the Bangladesh Knitwear Manufacturers and Exporters Association. The delegation of authority to the BGMEA to issue trade (import) customs certificates streamlined the process for garment manufacturers to acquire imported raw materials and technology. To facilitate export financing without government subsidies in 1986/87, the government implemented a back-to-back letter of credit (L/C) system that reduced the problems of financing working capital for garment manufacturers.

The system works in a way that does not require garment manufacturers (or the government) to invest money to open import L/Cs or to pay the fabric suppliers from their own resources. This system is not vulnerable to the budget constraints that undermined the 2009 textiles policy in Pakistan. The operation of the back-to-back L/C ensured garment exporters almost 70 percent of the working capital they needed. Most garment exporters agree that the L/C is the most important factor responsible for the rapid growth of garment exports (Ahmed, Greenleaf & Sacks, 2014). The state has turned its attention to working within annual growth of around 5 percent and channeling the resources generated into improving social welfare, such that Bangladesh is now increasingly discussed as a human development success story (Drèze & Sen, 2013). If a middle-income trap beckons, then a long-term residence there need not be so bad.

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The Diversification and Sophistication of Pakistan's Exports: The Need for Structural Transformation

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Abstract

While export diversification is considered to foster export growth and enhance GDP growth rates, this diversification has not translated into higher exports for Pakistan. In addition to diversification, the country must undergo a structural transformation of its exports to upgrade to a more sophisticated export basket. This entails shifting its comparative advantage from primary to manufactured exports and, further, from a labor-intensive to a more capital-intensive productive structure. In order to explain Pakistan's paradoxical situation, this paper analyzes Pakistan's orientation in the 'product space' as it affects the process and rate of structural transformation. In addition, we assess the sophistication of Pakistan's exports based on their complexity and technological sophistication. Our analysis refutes the traditional argument that diversification leads to greater exports and faster economic development. It also shows that the bulk of the country's productive capabilities are concentrated in the periphery of the product space, which is very weakly connected to the tightly packed industrial core. The export basket is neither complex nor technologically sophisticated, producing low-tech undifferentiated products. It seems that Pakistan is left with few nearby options for structural transformation, leaving it without a path to other, more sophisticated areas in the core of the product space. We argue that accelerating the process of structural transformation will require revisiting industrial policy, strengthening the country's institutions and strategic collaboration between the public and private sectors.

Keywords: Pakistan, structural transformation, technological sophistication, diversification, product space, growth, exports.

JEL classification: F1, F10, F19, F43, O14, O33.

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1. Introduction

According to the recent trade literature, expanding exports coupled with their structural transformation is conducive to sustained economic growth (see, for example, Hausmann & Klinger, 2007; Herzer & Nowak-Lehmann, 2006; Iwamoto & Nabeshima, 2012). Structural transformation, which includes export diversification and product sophistication, is seen as the new engine of growth. It involves the movement of export products up the sophistication chain from primary to manufactured exports that are labor-intensive and eventually on to more resource-intensive products.

The mix of goods exported by a country directly affects economic growth. Improvements in the quality and diversification of these exports reflect structural change (Felipe, 2007). Given a certain level of income, a more 'sophisticated' export basket is indicative of that country's economic growth (Hausmann & Klinger, 2008). This implies that countries usually maintain an export basket that is commensurate with their levels of income. Countries that are able to export products exported by richer countries, i.e., have a more sophisticated export basket, given their level of income, experience accelerated growth. Countries that specialize in unsophisticated export baskets, given their own levels of income, experience sluggish economic performance and find themselves 'stuck' in a low-growth trap.

The evidence suggests that Pakistan has long produced less diversified and less sophisticated products, which are also produced by other low-income countries. This posits an important question. Does the lack of diversification explain Pakistan's weak export performance? We try to answer this by examining the links between export diversification, structural transformation and export growth.

The rest of the paper is organized as follows. Section 2 looks at Pakistan's patterns of export diversification in comparison to India and draws a link with its export performance. Sections 3 and 4 explore alternative and more sophisticated approaches to analyzing the structural transformation of Pakistan's exports. Section 3 looks at its orientation in the 'product space' and identifies several problem areas. Section 4 analyzes the sophistication of Pakistan's export products based on (i) the complexity of exports and (ii) their technological sophistication. Section 5 concludes with some observations, followed by a brief discussion of the prospects for reinvigorating structural transformation for the country.

2. Does Export Diversification Lead to Export Growth?

This section looks at Pakistan's patterns of export diversification relative to India and links these to its export performance.

2.1 Pakistan's Export Diversification

Export diversification pertains to the production and trade of a variety of commodities spread over different sectors of the economy (Ali, Alwang & Siegel, 1991). This implies that having a more diverse export basket fosters export growth and enhances GDP growth rates (Hesse, 2008; Samen, 2010). The channels through which export diversification might positively affect growth include: (i) the Prebisch–Singer hypothesis, which relates to improving the terms of trade by expanding production and diversifying trade commodities (Prebisch, 1962; Singer, 1950); (ii) the 'portfolio effect' by which expansion into varied export sectors can reduce instability in export earnings (Ferreira & Harrison, 2012); and (iii) enhanced aggregate productivity levels due to knowledge spillovers (Herzer & Nowak-Lehmann, 2006). Thus, diversification provides protection against the risks associated with economic instability and volatility in foreign exchange earnings.

Most studies look at the structure of exports to analyze the industrial structure of developing countries. Thus, the export structure of a country may be a good proxy for its industrial structure (see, for instance, Hamid & Khan, 2015; Hausmann, Hwang & Rodrik, 2005; Hausmann & Klinger, 2007, 2008; Lall, Weiss & Zhang, 2005). To understand export structure, the most widely used methodology is by Hausmann et al. (2005), who use a weighted average of the income per capita of the exporters of that product, known as the PRODY, and a weighted average of the income level of the country's export basket, known as the EXPY. PRODY denotes product-level sophistication, which is not indicative of technological sophistication per se. EXPY denotes the level of sophistication of the export basket as a whole and is also a proxy for the country's exports complexity. Given that there is insufficient data to compute PRODY and EXPY for Pakistan's exports, the subsequent sections look at alternative approaches to explaining structural transformation.

From the recent trade literature, it is evident that Pakistan's export performance has stagnated. Felipe (2007) applies the methodology developed by Hausmann et al. (2005) to compare exports between 1986 and 2004. His findings show that Pakistan is producing exports that are also produced by 'ever poorer countries'. Its EXPY or export sophistication has not shown any improvement and its index in 1986 (4,664) is almost the same as in 2004 (4,628). Similarly, Reis and Taglioni (2013) apply the same methodology and conclude that Pakistan's export basket has not shown any real improvement relative to its comparator group[1] and that, over the past two decades, the country has consistently maintained a 'poorer' export basket, given its level of income.

Hamid and Khan (2015) analyze Pakistan's industrial structure by adapting and applying the industrial sophistication index developed by Lall et al. (2005) to the Pakistan Standard Industrial Classifications in the Census of Manufacturing Industries. They conclude that Pakistan's industrial performance has been poor because (i) its industry has shown a decline in sophistication over time, (ii) there has been no clear movement between sophistication levels and (iii) level 1, the lowest level of sophistication, constitutes about 50 percent of the value-added share of Pakistan's large-scale manufacturing industry.

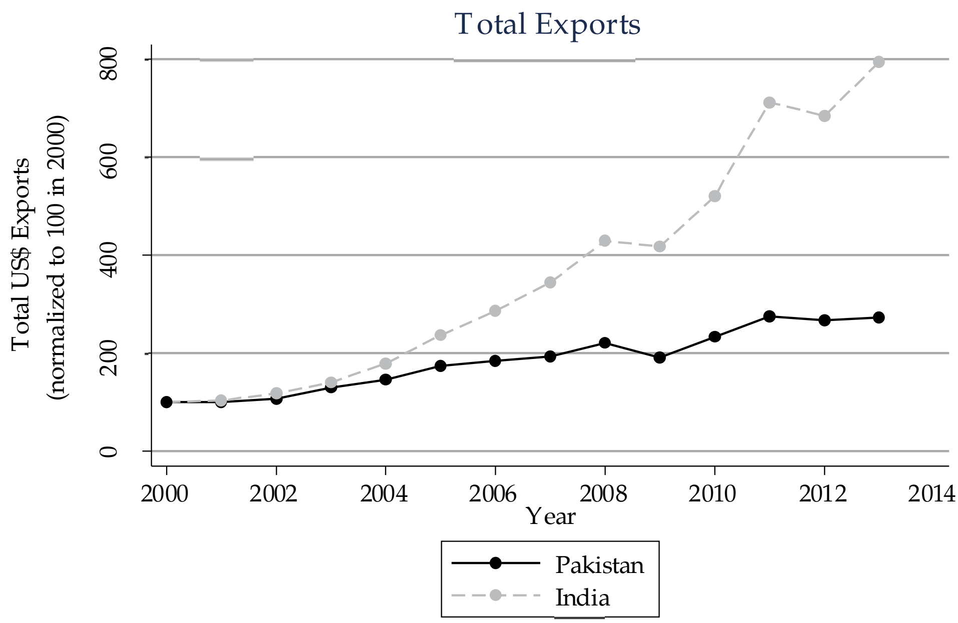
2.2 Can Pakistan's Poor Performance Be Explained by Lack of Diversification?

We compare Pakistan's trade performance with that of India to show how the former is becoming irrelevant in the global arena. Analyzing the performance of Pakistan's exports from 2000 to 2013[2], Figure 1 shows that its total exports are far lower in value relative to India. Not only does Pakistan lag behind India in terms of export growth, but the gap between the two countries' exports is also seen to be increasing. In 2000, the value of India's exports (US$43.2 billion) was approximately six-fold that of Pakistan (US$7.95 billion); by 2013, the value was 11.4 times that of Pakistan (US$292 billion versus US$25.6 billion).

[1] The comparator group for Pakistan includes China, Indonesia, India, Sri Lanka, Malaysia, the Philippines and Thailand (Hausmann & Klinger, 2008).

[2] This analysis has been inspired by a presentation by Dr. Atif Mian (Princeton University) at an International Growth Centre briefing to the finance minister in 2011. Our paper furthers the analysis by using a different industrial classification and more recent data.

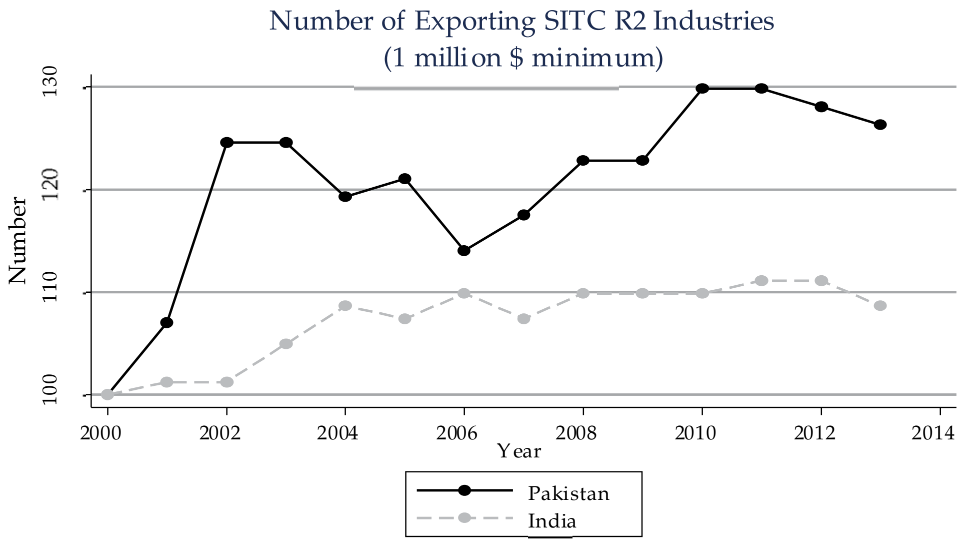
Figure 1: Performance of total exports, India and Pakistan



Note: Total exports have been normalized for the base year 2000.
Source: Authors' calculations based on data from the United Nations Commodity Trade Statistics database, accessed 21 March 2016.

In line with the premise that export diversification has a positive impact on export performance, we analyze the degree of diversification for Pakistan and India. This will help establish if Pakistan's weaker export performance, in comparison to India, can be explained by its lack of diversification in exports. In order to look at the pattern of diversification, we use export data based on the Standard Industrial Trade Classification (SITC) (Revision 2) from the United Nations Commodity Trade Statistics database. Figure 2 shows that, between 2000 and 2013, Pakistan became more diversified than India. Over this period, the number of export sector industries is much greater for Pakistan than for India. However, the trend line for India does not show a very steep gradient – particularly post-2004, the number of exporting industries is fairly constant. Thus, even though Pakistan has become more diversified than India over the years, the latter continues to perform far better in terms of total exports (see Figure 1).

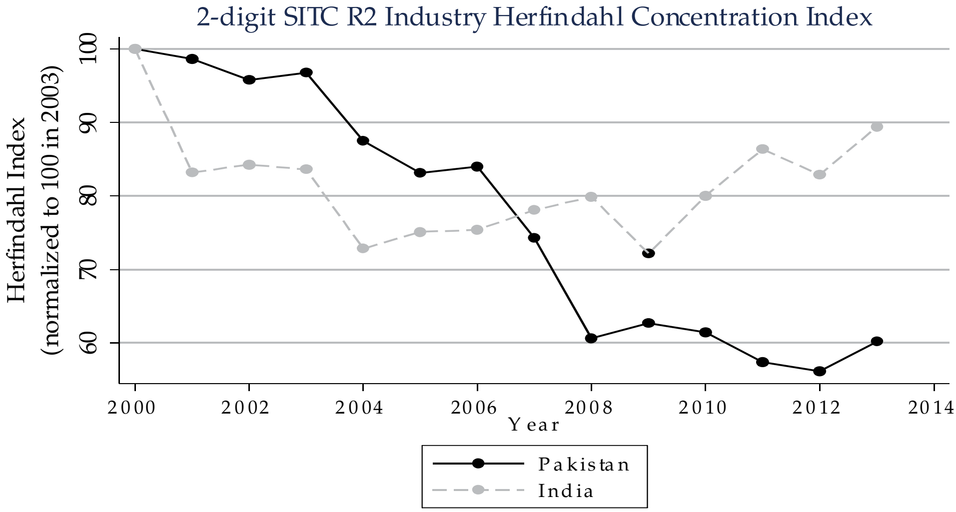
Figure 2: Number of exporting industries contributing at least US$1 million to export earnings



Note: Base year = 2000.
Source: Authors' calculations based on data from the United Nations Commodity Trade Statistics database, accessed 21 March 2016.

The concentration ratio (geographic or product concentration) is also used to measure diversification. We calculate the Herfindahl concentration index (HCI) for Pakistan and India, using data from the UN Comtrade database (SITC, Revision 2). The HCI is an indicator of the concentration of industries in the export market: the greater the index score, the more concentrated the market is. Figure 3 shows that, post-2004, there has been a continuous decline in the index for Pakistan. This confirms the visual analysis in Figure 2, suggesting that the number of products is increasing, indicating greater diversification. However, the HCI for India follows an upward trend, indicating that the country's exports became less diversified after 2004.

Figure 3: 2-digit SITC (Revision 2) industry HCI



Note: Total exports have been normalized for the base year 2000.
Source: Authors' calculations based on data from the United Nations Commodity Trade Statistics database, accessed 21 March 2016.

To sum up, Pakistan seems to have diversified into more varieties of export categories than India, which is concentrating more on fewer sectors. Yet India's export growth is much higher than Pakistan's and follows a rising trend. This refutes the traditional argument that diversification necessarily leads to greater exports and faster economic development. Instead, we observe that, in addition to diversification, the nature of exports are significant in achieving accelerated growth (Hausmann & Klinger, 2008; Hausmann et al., 2005).

If not diversification, then *what*? To answer this, Sections 3 and 4 explore alternative explanations for Pakistan's poor export performance, including (i) the nature of export products explained through the concept of 'product space' and (ii) the sophistication of export products explained through economic complexity and technological sophistication.

3. The Nature of Exports: Product Space

The evidence suggests that, in order to achieve development, product diversification is not enough. The country must also undergo a structural transformation of its exports to upgrade to a more sophisticated export basket. This entails diversifying into newer and more sophisticated products. Pakistan's export performance in comparison to other countries in the region is alarming. According to Hausmann and Klinger (2008), its relative position has worsened since the 1960s, so much so that the country now has the lowest level of export sophistication among its comparators.

Product space is a network of the connections of all proximities linking pairs of commodities that are most likely to be co-exported by many countries (Hausmann et al., 2013). A country's location in the product space is particularly important as it affects the process and rate of structural transformation. This, in turn, depends on shifting the relative comparative advantage (RCA) from labor-intensive to capital-intensive products, achieved by investing in physical and human capital. However, the inability to diversify remains as each product involves highly specialized inputs that are not necessarily adaptable to other products. Transformation in a country's productive structure depends on the level of its factor endowments and on how easily its product-specific capabilities can adapt to other products, as signified by the country's location in the 'product space' (Hidalgo, Klinger, Barabasi & Hausmann, 2007).

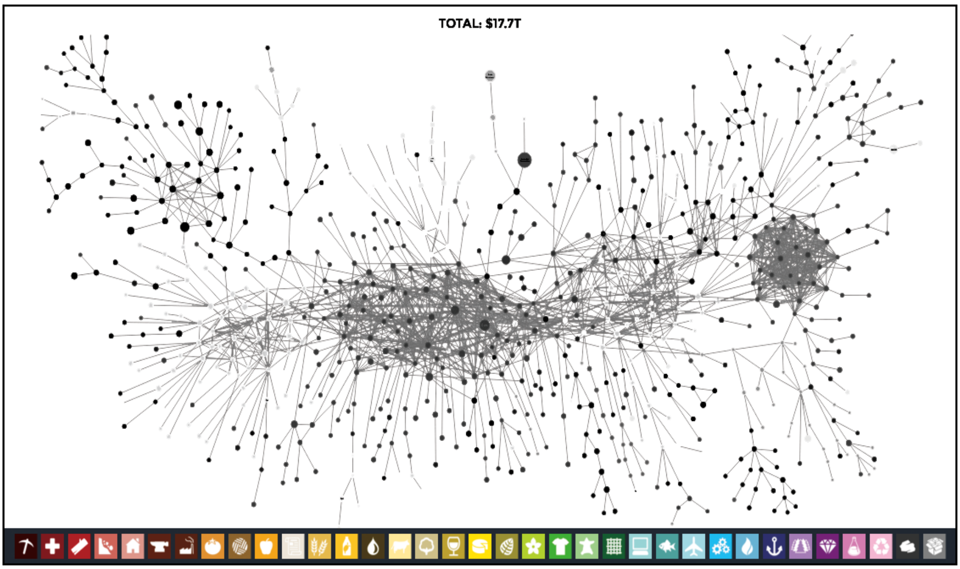
Diversifying into new products requires varying degrees of substitutability and new inputs, for example, specialized skills, research and development (R&D) and infrastructure. These barriers are lower for nearby products that require less adaptation of existing capabilities. Thus, in order to achieve the transformation, a country needs to identify products in a heterogeneous – as opposed to a homogeneous – product space so that moving to nearby products or diversifying is easier (Hausmann & Klinger, 2007).

3.1 Structure of Product Space

The structure of product space is particularly important as it affects how easily a county can achieve the structural transformation of its products. This structure can be explained with a metaphor, wherein the products are trees in a forest, which represents the product space. The trees (or products) are at a certain distance from one another based on their capabilities; the distance between trees indicates the similarity of their required capabilities. Firms are the monkeys that live in these trees. At large, new activities are more likely to be developed in a tightly connected product space in which monkeys already live (i.e., where firms are already producing), as fewer and similar capabilities will be required to add newer products to the export basket (Felipe, 2007; Hausmann et al., 2013). On the contrary, if a country specializes in exporting peripheral products, then moving to newer products, i.e., restructuring, will be difficult because it will require accumulating very different capabilities, thus impeding the process of structural transformation.

Figure 4 visualizes the shape of the forest or product space, showing export opportunities for the world in 2013. The size of the total world market is US$17.7 trillion (The Observatory of Economic Complexity, n.d.).

Figure 4: Product space of world exports, 2013



Source: The Observatory of Economic Complexity database, accessed 22 March 2016.

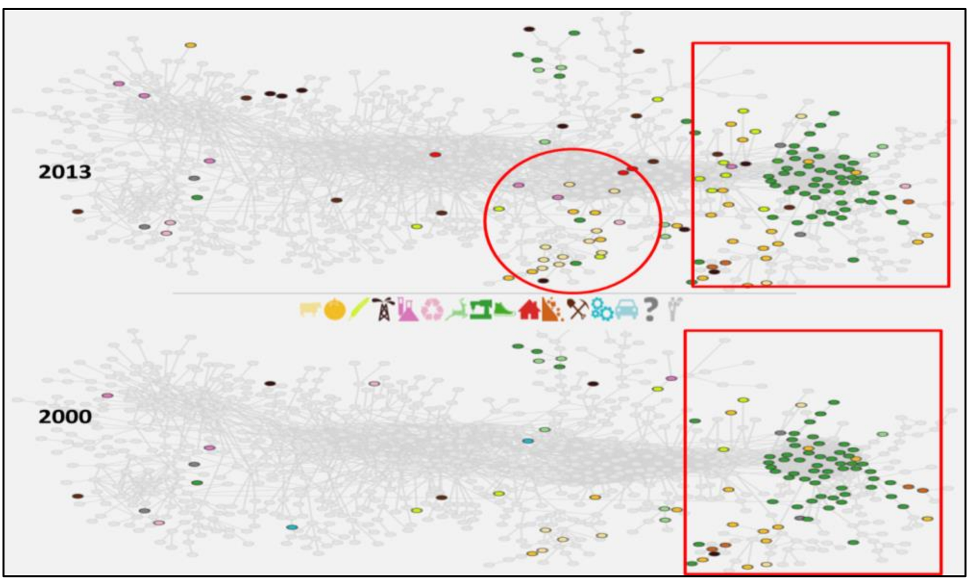
Each node in Figure 4 is a product. These products are connected by grey lines that represent the possibility of the products being co-exported. The product space has a core of closely connected products that are more likely to be co-exported and a periphery where products are weakly connected and require different production capabilities.

The color of a node represents the technological intensity of the product. The blue nodes, which lie mostly in the core, represent high-tech products such as machinery, electrical goods and transportation. The purple nodes lie mostly in the periphery and represent low-tech products such as chemicals and allied industries and plastics and rubber. The green nodes, also in the periphery, require low technological intensity and represent products such as textiles, garments, footwear and leather. The red and orange nodes represent resource- and agro-based products such as wood, glass, minerals, petroleum and chemicals. The yellow nodes represent agro-based products such as vegetable and animal products. To sum up, the core of the product space mostly comprises technologically sophisticated products, while the periphery represents low-tech, less sophisticated products. Thus, movement toward the core from the periphery implies structural transformation and favorable diversification.

3.2 Structure of Pakistan's Product Space

The product space of Pakistan's exports in 2013 (Figure 5) reveals that its orientation is largely peripheral. There is almost no production in the tightly packed industrial core of the product space where structural transformation is easier. Instead, the bulk of the country's productive capabilities is concentrated in the periphery, in the green nodes that represent sectors such as garments, textiles and footwear. While this cluster is tightly connected within itself, it is very weakly connected to the rest of the space. Thus, Pakistan is left with few nearby options for structural transformation around these sectors. This also leaves the country without a path to other, more sophisticated areas in the core of the product space.

Figure 5: Product space of Pakistan's exports, 2013 and 2000

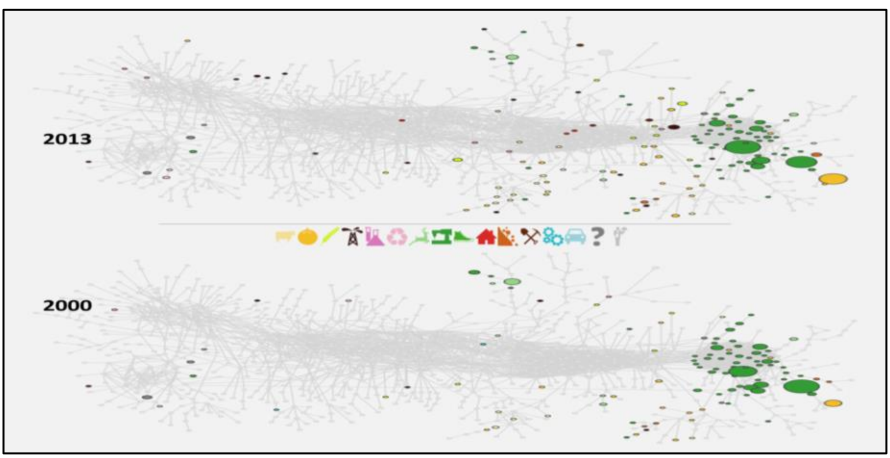


Note: Each node is a product that Pakistan exports, with an RCA index greater than or equal to 1, i.e., when its share of the country's export basket is greater than its share of world exports.
Source: The Atlas of Economic Complexity database, accessed 22 March 2016.

It is important to analyze Pakistan's location in the product space over the years. Figure 5 compares its position in 2000 and 2013, indicating that there has been no significant shift in Pakistan's exports, not has it acquired new areas of the product space. Pakistan has also been unable to diversify into more technologically sophisticated products toward the core of the product space. The only change we see is the addition of a few black nodes, representing mineral products such as chromium ore, and red nodes representing precious stones and jewelry in the periphery. Moreover, a new cluster of orange nodes has developed in 2013; these are mainly primary products such as animal and vegetable products with little or no significant contribution to exports. Overall, Pakistan's RCA seems to lie in peripheral products that require few capabilities. While structural transformation is easier for high-income countries located at the core of the product space, the diffusion to nearby peripheral products is relatively ineffective for poorer countries such as Pakistan.

Structural transformation requires not just an increase in the value of a country's exports, but also some movement toward more sophisticated products. While the value of Pakistan's total exports has more than doubled from US$7.95 billion in 2000 to US$25.6 billion in 2013 (The Atlas of Economic Complexity, n.d.), a closer look at the composition of exports is crucial because this directly affects patterns of specialization (Hidalgo et al., 2007). Figure 6 visualizes the product space similar to Figure 5, but with the size of each node representing the export share of that product in Pakistan's total exports.

Figure 6: Product space (export share) of Pakistan's exports, 2013 and 2000

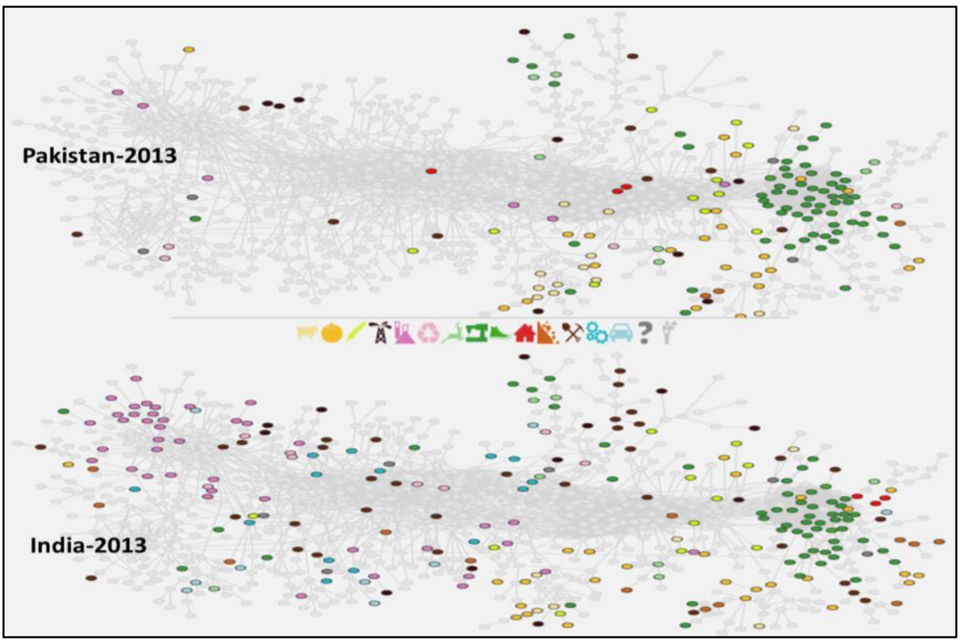


Note: Each node is the export share of the product relative to the country's total exports.
Source: The Atlas of Economic Complexity database, accessed 22 March 2016.

The green nodes constitute the largest share of the country's exports; these represent resource-based products such as textiles and garments. Following the green nodes are the yellow nodes, which also constitute a major share of total exports – again, representing primary exports such as rice.

A comparison of the structure of product space for India and Pakistan (Figure 7) in 2013 shows that India's exports are more spread out compared to Pakistan, thus making the movement to more sophisticated products at the core more likely.

Figure 7: Structure of product space: Pakistan and India, 2013



Note: Each node is a product that Pakistan exports, with an RCA index greater than or equal to 1, i.e., when its share of the country's export basket is greater than its share of world exports.
Source: The Atlas of Economic Complexity database, accessed 22 March 2016.

To return to our initial argument about diversification, in Section 2.1 we argued that diversification does guarantee not good performance in exports, as demonstrated by our analysis of the HCI (Figure 3). While Pakistan is more diversified than India, Pakistan's position in the product space suggests that its exports are concentrated in the periphery, making it difficult to diversify further under the existing structure of production. On the other hand, while India's exports are less diversified according to the

HCI, its position in the product space is more amenable to shifting production toward more sophisticated products at the core of the product space. This suggests that a country's location in the product space is key. India seems to have found a path of movement from the periphery toward the core of the product space. This export diversification, coupled with structural transformation, is what has resulted in economic growth and trade development for India. The primary nature of exports and location in the periphery without linkages to the core of the product space is one explanation for Pakistan's poor export performance.

4. Export Sophistication

The second approach focuses on the sophistication of Pakistan's exports by looking at their economic complexity and technological sophistication to see if this explains the country's poor export performance.

4.1 Economic Complexity

Hausmann et al. (2013) describe economic complexity as a measure of the intricate network of interactions and productive knowledge that a society mobilizes. The embedded knowledge or capabilities of a society are crucial to production and, therefore, the type of products produced in a country depends on the knowledge it has accumulated. Knowledge can be explicit or tacit. Explicit knowledge is obtained from external sources and transferred easily; tacit knowledge, on the other hand, is hard to embed in people and entails a long, costly process. It is the lack of tacit knowledge that restricts growth and development.

There is a causal relationship between knowledge and development – countries bearing complex knowledge are capable of producing complex products, and these are also the most prosperous economies (Hausmann et al., 2013). Therefore, "economic complexity is not just a symptom or an expression of prosperity: it is a driver" (Hausmann et al., 2013, p. 27). Moreover, economic complexity can be measured by the degree of diversity and ubiquity in the products exported, which in turn are crude measures of the capabilities available to a country (Yaméogo, Nabassaga & Ncube, 2014).[3] Diversity is defined as the number of products exported with a comparative advantage, whereas a product's ubiquity is the number of countries that can produce that product.

[3] See Hausmann et al. (2013) for details on the derivation of different economic complexity measures.

Economic complexity can be measured by analyzing the mix of products a country is able to make and can be increased by moving toward producing, and becoming competitive in, more complex products. Thus, a diverse and complex mix of products is synonymous with a diverse and complex economy. In 2000, Pakistan had an economic complexity index (ECI) of –0.8 and ranked at 94 out of 125 countries in the world. In 2013, not having improved much in terms of complexity, with an ECI of –0.66, Pakistan ranked at 89 out of 124 countries in the world (The Atlas of Economic Complexity, n.d.).

While the ECI is a number unique to each country and measures the average complexity of its products, the product complexity index (PCI) is a number unique to each product that measures its level of complexity (Yildirim, 2014). We use export data at the 3-digit SITC level (Revision 2) from the UN Comtrade database to list the top ten export products, based on their export share. Data from the Atlas of Economic Complexity yields PCI values for the period 2000–13 for the top ten exports in 2013. The average PCI scores for this period and the export share of the products are presented in Table 1, where the products are ranked according to their PCI value and not their export share.

Table 1: Average PCI scores (2000–13) and export share of top ten exports, 2013

SITC code	Product	PCI	As % of exports
651	Textile yarn	-0.21	9.06
848	Articles of apparel, clothing accessories, nontextile headgear	-0.37	2.79
842	Men's and boys' outerwear, textile fabrics, not knitted or crocheted	-0.61	4.21
843	Women's, girls' and infants' outerwear, textile, not knitted or crocheted	-0.70	2.94
846	Undergarments, not knitted or crocheted	-0.81	3.50
658	Made-up articles, wholly or chiefly of textile materials, n.e.s.	-1.40	14.51
845	Outerwear, knitted or crocheted, not elastic or rubberized	-1.07	3.20
61	Sugar and honey	-1.08	2.26
652	Cotton fabrics, woven (not incl. narrow or special fabrics)	-1.47	11.11
42	Rice	-1.98	8.40

Note: The table shows the PCI scores (in descending order) for Pakistan's top ten exports in 2013, accounting for 62 percent of its total exports.
Source: Authors' calculations based on the following data: (i) PCI values from The Atlas of Economic Complexity: http://atlas.cid.harvard.edu/rankings/product/2013/, accessed 15 March 2016; (ii) export values from the United Nations Commodity Trade Statistics database, accessed 21 March 2016.

The PCI index ranges from 2.2 to –3.2 for 1,220 products; a high value indicates a relatively complex product while a low PCI represents a less complex product. Table 1 shows that the PCI values for the country's top ten exports range from –0.21 to –1.98. The negative range indicates that Pakistan's top exports rank poorly in terms of PCI. This implies that these products are neither complex nor sophisticated and do not require advanced technologies. Therefore, there is a need to transform these products into higher value-added products generating greater foreign exchange revenue and improving domestic employment.

4.2 Technological Sophistication of Exports

Technology plays a significant role in trade patterns. According to Lall (2000), the evolution of export patterns is dependent on the following: the interaction of technical progress internationally, degree of exposure to foreign competition, local capabilities and the rate of increase in wages. Moreover, different export structures have different implications for the growth and industrial development of a country. Technologically intensive structures offer better growth prospects owing to products with greater export demand, more scope for the application of scientific knowledge and spillovers in new skills and knowledge. Countries with simple technological structures, such as Pakistan, experience slower growing markets with limited learning potential and little scope for technological upgrading and, therefore, fewer spillovers to other activities (Lall, 2000).

According to Nixson (1990), developing countries adopt rapid industrialization strategies that start with relatively simple technologies that have the potential to be labor-intensive and absorb excess labor. Therefore, establishing a broad, robust industrial base is not only crucial for development, but also for long-term growth. Rodrik (2006) states that a dynamic industrial base can result in sustained growth. While Felipe (2007) argues that Pakistan is experiencing "relative stagnation in the manufacturing sector", an updated study by Hamid and Khan (2015) describes the situation as much worse: not only is the manufacturing sector experiencing stagnation, it may also be on the path to "premature deindustrialization."

Studies show that countries with complex productive structures have the advantage of producing goods that other countries cannot. This is because the required human and physical capital along with technological and institutional capabilities is not available everywhere. Therefore, rich countries tend to export complex or more sophisticated products while poor countries are restricted to exporting primary, low-tech products (see, for instance, Hidalgo & Hausmann, 2009; Hausmann et al., 2013).

Based on Lall's (2000) technological classification of exports, we identify three main categories: primary products, manufactured products and other transactions. Manufactured products are further categorized as resource-based, low-technology, medium-technology and high-technology manufactures. According to Lall, technological intensity is a combination of the innovation taking place in R&D as well as the ability of an economy to reduce costs and achieve economies of scale. The categorization does not reflect the level of technology involved in production activities and upgrading over time. Activities at different levels of technological complexity can fall under the same product category for the purpose of aggregation. Therefore, while we are able to roughly ascertain which category a product falls under, we cannot distinguish between quality differences or the processes involved in production.

Using this categorization, we categorize Pakistan's exports based on export data from UN Comtrade at the 3-digit SITC level (Revision 2). Figure 8 shows the trend in Pakistan's export performance on the technological front for the period 2000–13. Pakistan relies heavily on exporting low-technology products, which constitute the biggest share of its total exports, followed by primary, resource-based, medium-technology and high-technology products, respectively. These low-tech products have simple skill requirements and are undifferentiated; they compete mainly on price, making labor cost an element of cost competitiveness. They represent the green cluster of nodes in the periphery of the product space (see Figures 5 and 6).

The share of primary exports has risen over the years and stands at almost 18 percent of exports in 2013. Moreover, high-tech and medium-tech products, which are located at the core of the product space, do not contribute significantly to Pakistan's total exports. The greatest share ever achieved for high-tech products was 1.54 percent in 2007, but this has never exceeded 2 percent of total exports. The share of medium-tech products also remains below 10 percent.

Figure 8: Pakistan's export performance, 2000–13

Source: Authors' calculations based on data from the United Nations Commodity Trade Statistics database (accessed 21 March 2016), applied to Lall's (2000) technological classification of exports.

Figure A1 in the Appendix uses SITC 3-digit (Revision 2) data from UN Comtrade to classify exports by technological intensity and share of total exports. In 2013, within the category of low-tech (LT1) products, the largest share of exports (56.8 percent) was that of textiles, garments and footwear. The figure further illustrates that, within primary products, rice constitutes 8.4 percent of total exports, followed by dried fruit (1.7 percent) and cotton (1.3 percent). Agro-based exports, constituting 5.5 percent, are dominated by sugar and honey. Similarly, lime, cement and building products dominate the resource-based 'other' (RB2) category. Medium-tech 'process' goods constitute only 6 percent of total exports and woven manmade fabric, along with alcohols, phenols and their derivatives, are more than half of this category. The share of high-tech products is less than 2 percent of total exports.

Based on these numbers, it is clear that Pakistan's exports are restricted to low-tech products that are based on primary resources and involve a low level of technology in manufacturing. In addition, the diminishing share of low-tech products and the growth of primary exports is cause for concern because it suggests deteriorating terms of trade in the future (see Table A1 in the Appendix for a detailed description of the products exported under each category).

5. Some Observations and the Way Forward

Studies show that the differences in specialization patterns across countries are economically meaningful and determine the quality of countries' export baskets (Hausmann et al., 2005). Pakistan's export performance can be described as paradoxical. While its exports have become more diversified over the past decade, this diversification has not translated into higher exports. Our understanding of why diversification has not paid off for Pakistan is explained by the location of its exports in the product space. Pakistan's exports lie in the peripheral region – in order words, Pakistan is not located in the densely populated area of the product space, leaving it without a path to diversifying exports into a more sophisticated structure of production.

Pakistan's export basket is neither complex nor technologically sophisticated. Producing low-tech, undifferentiated products implies that these products compete on price, with labor costs being a major element of cost competitiveness. By not moving up the value chain, Pakistan is facing competition from lower-income countries exporting low-tech products at more competitive wage rates (Felipe, 2007; Hausmann & Klinger, 2008; Haque, 2014). Meanwhile, countries in the comparator income group have explored the product space and moved to new, high-wage, capital-intensive activities.

Weak institutions pose a public good problem whereby firms are unable to keep private the benefits of opening up to new export markets: any activity is quickly imitated, leading to an "entrepreneurial gamble" (Cadot, Carrère & Strauss-Kahn, 2011). Moreover, Pakistan's industrial policy does not appear to be in consonance with its export policy. For instance, to produce sophisticated products, it would have to reduce the cost of intermediate inputs. In the case of imported intermediary goods, the import policy needs to be revisited. The current import policy is on the opposite track – in March 2016, the Pakistan government doubled the regulatory duty on iron and steel imports to 30 percent.[4] Such taxation is discouraging for the engineering industry, which lies at the core of the product space.

[4] https://www.thenews.com.pk/print/107228-Govt-doubles-regulatory-duty-on-iron-steel-imports-to-30pc#

Furthermore, we must be cognizant of the future of the existing top exports. According to the Pakistan Economic Survey for 2015/16, cotton manufactures account for 55.4 percent of Pakistan's total exports. However, globally cotton constitutes only 33 percent of apparel consumption because synthetic fibers are a substitute for cotton with about a 60 percent share. The policy of heavy taxation or restrictions on the import of synthetic products needs to be revisited for Pakistan to produce textile products that are higher up on the value chain and growing in demand.

Instead of just 'picking the winners', as Felipe (2007) aptly puts it, Pakistan's industrial policy needs to create broad-based incentives for exporters and involve public–private partnerships that will encourage private entrepreneurs to take risks and invest in new activities by sharing the cost of R&D. This will help identify any market failures that impede structural transformation and further transform the economy by allowing institutions of change to evolve.

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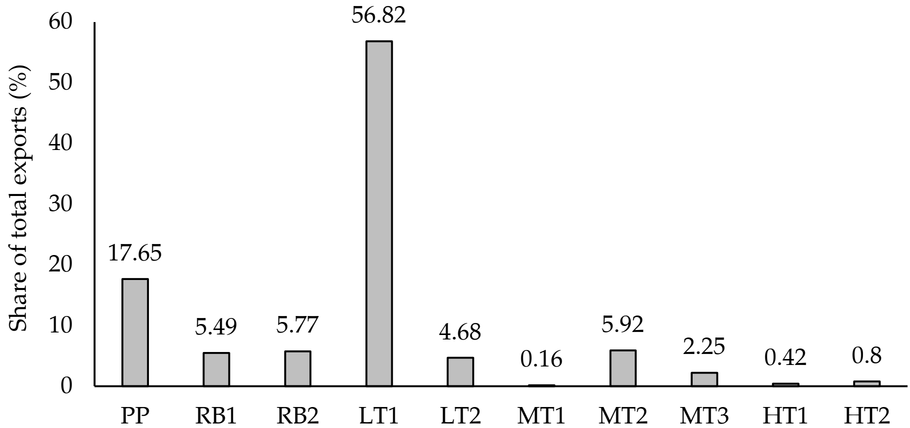
Appendix

Figure A1: Technological classification of exports as a share of total exports, 2013



Note: Based on SITC 3-digit, Revision 2 classification.
PP = primary products, RB1 = agro-based products, RB2 = other resource-based products, LT1 = textiles, garments and footwear, LT2 = other low-technology products, MT1 = automotive products, MT2 = process products, MT3 = engineering products, HT1 = electronic and electrical products, HT2 = other high-technology products.
Source: Authors' calculations based on data from the United Nations Commodity Trade Statistics database (accessed 21 March 2016) applied to Lall's (2000) technological classification of exports.

Table A1: Technological classification of exports, 2013

Commodity code/description		Trade value (US$)	Export share (%)
Primary products (PP)			17.650
1	Live animals for food	15,942,863	0.053
11	Meat: fresh, chilled, frozen	212,498,500	0.846
22	Milk and cream	91,861,370	0.366
25	Eggs, birds: fresh, preserved	7,240,980	0.029
34	Fish: fresh, chilled, frozen	217,609,529	0.866
36	Shellfish: fresh, frozen	102,539,411	0.408
41	Wheat etc., un-milled	39,173,847	0.156
42	Rice	2,110,992,349	8.403
43	Barley, un-milled	66,233	0.000
44	Maize, un-milled	30,661,850	0.122
45	Cereals n.e.s., un-milled	150,373	0.001
54	Vegetables etc.: fresh, simply preserved	237,581,508	0.946
57	Fruit, nuts: fresh, dried	434,135,873	1.728
71	Coffee and substitutes	124,394	0.000
72	Cocoa	1,521	0.000
74	Tea and mate	14,133,202	0.056
75	Spices	62,531,000	0.249
81	Feeding stuff for animals	91,288,501	0.363
91	Margarine and shortening	675	0.000
121	Tobacco: unmanufactured, refuse	23,900,103	0.095
211	Hides, skins, excl. furs: raw	742,573	0.003
222	Seeds for soft fixed oils	65,625,901	0.261
223	Seeds for other fixed oils	5,343,348	0.021
232	Natural rubber, gums	43,491	0.000
244	Cork: natural, raw, waste	9,895	0.000
245	Fuelwood n.e.s., charcoal	755	0.000
246	Pulpwood, chips, wood waste	19,838	0.000
261	Silk	140,706	0.001
263	Cotton	313,412,688	1.248
268	Wool (excl. tops), animal hair	15,924,451	0.063
271	Fertilizers, crude	1,627,457	0.007
273	Stone, sand and gravel	83,304,558	0.332
277	Natural abrasives n.e.s.	67,593	0.000
278	Other crude minerals	122,506,513	0.488
291	Crude animal materials n.e.s.	48,771,728	0.194
292	Crude vegetable materials n.e.s.	30,671,741	0.122
322	Coal, lignite and peat	309,968	0.001
341	Gas, natural and manufactured	430	0.000
681	Silver, platinum, etc.	8,681	0.000

Commodity code/description		Trade value (US$)	Export share (%)
682	Copper, excl. cement copper	42,888,752	0.171
684	Aluminum	601,713	0.002
685	Lead	11,262,657	0.045
686	Zinc	766,471	0.003
Resource-based products			11.259
RB1: agro-based			5.487
12	Meat: dried, salted, smoked	73,457	0.000
14	Meat: prepared, preserved, n.e.s. etc.	1,268,989	0.005
23	Butter	516,565	0.002
24	Cheese and curd	31,165	0.000
35	Fish: salted, dried, smoked	12,981,337	0.052
37	Fish etc.: prepared, preserved, n.e.s.	11,377,934	0.045
46	Wheat etc., meal or flour	209,006,254	0.832
47	Other cereal meals, flour	5,498,103	0.022
48	Cereal etc. preparations	74,670,038	0.297
56	Vegetables etc.: preserved, prepared	27,997,278	0.111
58	Fruit: preserved, prepared	53,411,599	0.213
61	Sugar and honey	568,391,733	2.263
62	Sugar: candy, nonchocolate	73,401,798	0.292
73	Chocolate and products	207,018	0.001
98	Edible products, preparations n.e.s.	25,255,041	0.101
111	Nonalcoholic beverages n.e.s.	7,538,772	0.030
112	Alcoholic beverages	33,994	0.000
122	Tobacco: manufactured	2,496,753	0.010
233	Rubber: synthetic, reclaimed	5,209,904	0.021
248	Wood: shaped, sleepers	18,123	0.000
251	Pulp and waste paper	220,500	0.001
264	Jute, other textile-based fibers	20,035	0.000
269	Waste of textile fabrics	39,562,166	0.158
423	Fixed vegetable oils, soft	195,945	0.001
424	Fixed vegetable oils, nonsoft	4,203,298	0.017
431	Processed animal/vegetable oils etc.	150,613,833	0.600
621	Materials of rubber	1,929,974	0.008
625	Rubber tyres, tubes etc.	7,334,099	0.029
628	Rubber articles n.e.s.	1,153,388	0.005
633	Cork manufactures	287	0.000
634	Veneers, plywood, etc.	5,251,928	0.021
635	Wood manufactures n.e.s.	11,426,948	0.046
641	Paper and paperboard	77,064,943	0.307
RB2: other			5.772

Commodity code/description		Trade value (US$)	Export share (%)
281	Iron ore, concentrates	4,793,215	0.019
282	Iron and steel scrap	14,221,794	0.057
287	Base metal ores, conc. n.e.s.	116,160,351	0.462
288	Nonferrous metal scrap n.e.s.	125,160,317	0.498
289	Precious metal ores, waste n.e.s.	25,752	0.000
323	Briquets, coke, semi-coke	289,313	0.012
334	Petroleum products, refined	525,964,153	2.094
335	Residual petroleum products n.e.s.	641,998	0.003
411	Animal oils and fats	55,702	0.000
511	Hydrocarbons n.e.s., derivatives	15,156,846	0.060
514	Nitrogen-function compounds	252,024	0.001
515	Organic/inorganic compounds etc.	99,037	0.000
516	Other organic chemicals	680,093	0.003
522	Inorganic elements, oxides, etc.	10,633,564	0.042
523	Other inorganic chemicals etc.	22,436,237	0.089
531	Synthetic dyes, natural indigo, lakes	6,239,897	0.025
532	Dyes n.e.s., tanning products	104,980	0.000
551	Essential oils, perfumes etc.	982,418	0.004
592	Starch, inulin, gluten, etc.	19,500,502	0.078
661	Lime, cement, building products	552,598,949	2.200
662	Clay, refractory building products	2,484,030	0.010
663	Mineral manufactures n.e.s.	14,810,927	0.059
664	Glass	8,642,368	0.034
667	Pearls, precious, semiprecious stones	5,273,650	0.021
689	Nonferrous base metals n.e.s.	75,686	0.000
Low-technology products			61.503
LT1: textiles, garments and footwear			56.823
611	Leather	528,955,798	2.106
612	Leather etc., manufactures	14,978,822	0.060
613	Fur skins: tanned, dressed	297,282	0.001
651	Textile yarn	2,275,512,911	9.058
652	Cotton fabrics, woven	2,790,070,484	11.107
654	Other woven textile fabric	3,910,776	0.016
655	Knitted etc. fabrics	32,628,432	0.130
656	Lace, ribbons, tulle etc.	11,784,772	0.047
657	Special textile fabrics, products	41,067,040	0.164
658	Textile articles n.e.s.	3,645,884,429	14.513
659	Floor coverings etc.	128,316,932	0.511
831	Travel goods, handbags	33,305,672	0.133
842	Men's outerwear, not knitted	1,056,655,507	4.206
843	Women's outerwear, not knitted	738,558,991	2.940

Commodity code/description		Trade value (US$)	Export share (%)
844	Undergarments, not knitted	26,477,645	0.105
845	Outerwear, knitted, nonelastic	803,725,950	3.199
846	Undergarments, knitted	878,298,401	3.496
847	Textile clothing accessories n.e.s.	456,530,433	1.817
848	Headgear, nontextile clothing	699,649,869	2.785
851	Footwear	107,829,218	0.429
LT2: other products			4.680
642	Paper etc., precut, articles thereof	24,766,515	0.099
665	Glassware	7,934,693	0.032
666	Pottery	1,111,751	0.004
673	Iron, steel: shapes etc.	2,672,061	0.011
674	Iron, steel: universals, plates, sheets	12,308,516	0.049
676	Railway rails etc.: iron, steel	18,043,744	0.072
677	Iron, steel wire (excl. w/ rod)	135,758	0.001
679	Iron, steel castings, unworked	749,242	0.003
691	Structures and parts n.e.s.	51,223,441	0.204
692	Metal tanks, boxes etc.	7,123,230	0.028
693	Wire products, nonelectric	666,806	0.003
694	Steel, copper: nails, nuts etc.	2,342,438	0.009
695	Tools	10,650,319	0.042
696	Cutlery	82,327,050	0.328
697	Base metal household equipment	45,473,707	0.181
699	Base metal manufactures n.e.s.	8,005,288	0.032
821	Furniture, parts thereof	100,832,479	0.401
893	Articles of plastic n.e.s.	94,108,318	0.375
894	Toys, sporting goods, etc.	221,215,945	0.881
895	Office supplies n.e.s.	6,318,000	0.025
897	Gold, silverware, jewelry	431,960,238	1.720
898	Musical instruments, parts	3,240,468	0.013
899	Other manufactured goods	42,451,838	0.169
Medium-technology manufactures			4.680
MT1: automotive			0.157
781	Passenger motor vehicles excl. buses	1,312,437	0.005
782	Lorries, special motor vehicles n.e.s.	5,202,243	0.021
783	Road motor vehicles n.e.s.	3,352,493	0.013
784	Motor vehicle parts, accessories n.e.s.	22,259,080	0.089
785	Cycles etc., motorized or not	7,342,382	0.029
MT2: process			5.915
266	Synthetic fibers to spin	950,319	0.004

Commodity code/description		Trade value (US$)	Export share (%)
267	Other manmade fibers	444,815	0.002
512	Alcohols, phenols etc.	356,735,398	1.420
513	Carboxylic acids etc.	23,422,118	0.093
533	Pigments, paints, etc.	37,288,659	0.148
553	Perfumery, cosmetics, etc.	19,294,789	0.077
554	Soap, cleansing etc. preparations	40,540,018	0.161
572	Explosives, pyrotechnic products	310,145	0.001
582	Products of condensation etc.	233,587,133	0.930
583	Polymerization etc. products	119,851,709	0.477
584	Cellulose derivatives etc.	133,232	0.001
585	Plastic material n.e.s.	120,057,787	0.478
591	Pesticides, disinfectants	6,480,134	0.026
598	Misc chemical products n.e.s.	13,656,540	0.054
653	Woven manmade fiber fabric	412,220,234	1.641
671	Pig iron etc.	2,786,205	0.011
672	Iron, steel: primary forms	9,662,030	0.039
678	Iron, steel: tubes, pipes etc.	87,572,244	0.349
786	Trailers, nonmotor vehicles n.e.s.	628,875	0.003
791	Railway vehicles	29,925	0.000
882	Photo, cinema supplies	336,075	0.001
MT3: engineering			2.253
711	Stream boilers and aux plants	1,404,494	0.006
713	Internal combustion piston engines	6,142,974	0.025
714	Engines and motors n.e.s.	2,122,269	0.008
721	Agricultural machinery excl. tractors	5,714,018	0.023
722	Tractors, nonroad	33,949,447	0.135
723	Civil engineering equipment etc.	9,910,121	0.039
724	Textile, leather machinery	13,957,565	0.056
725	Paper etc. mill machinery	655,256	0.003
726	Printing, bookbinding machinery, parts	872,612	0.004
727	Food machinery, nondomestic	8,118,421	0.032
728	Other machinery for special industries	9,164,996	0.037
736	Metal working machines, tools	3,885,149	0.016
737	Metal working machinery n.e.s.	536,292	0.002
741	Heating, cooling equipment	17,106,955	0.068
742	Pumps for liquids etc.	5,884,095	0.023
743	Pumps n.e.s., centrifuges etc.	10,065,458	0.040
744	Mechanical handling equipment	2,173,280	0.009
745	Nonelectric machinery, tools n.e.s.	5,756,833	0.023
749	Nonelectric machinery parts, accessories n.e.s.	2,533,596	0.010

Commodity code/description		Trade value (US$)	Export share (%)
763	Sound recorders, phonographs	164,316	0.001
772	Switchgear etc., parts n.e.s.	3,557,542	0.014
773	Electrical distributing equipment	8,124,323	0.032
775	Household-type equipment n.e.s.	70,996,357	0.283
793	Ships and boats etc.	12,670,738	0.050
812	Plumbing, heating, lighting equipment	7,466,942	0.030
872	Medical instruments n.e.s.	315,731,666	1.257
884	Optical goods n.e.s.	1,941,576	0.008
885	Watches and clocks	1,364,153	0.005
951	War firearms, ammunition	3,934,969	0.016
High-technology manufactures			1.221
HT1: electronic and electrical			0.416
716	Rotating electric plants	13,019,405	0.052
718	Other power generating machinery	1,781,606	0.007
751	Office machines	159,953	0.001
752	Automatic data processing equipment	1,389,723	0.006
759	Office, ADP machinery parts, accessories	2,366,468	0.009
761	Television receivers	22,161	0.000
764	Telecom equipment, parts, accessories n.e.s.	55,089,046	0.219
771	Electric power machinery n.e.s.	3,032,825	0.012
774	Electro-medical, x-ray equipment	2,124,771	0.009
776	Transistors, valves etc.	41,297	0.000
778	Electrical machinery n.e.s.	25,511,509	0.102
HT2: other			0.805
524	Radioactive etc. material	172,796	0.001
541	Medicinal, pharm products	169,570,093	0.675
712	Steam engines, turbines	186,610	0.001
792	Aircraft etc.	2,495,940	0.010
871	Optical instruments	55,432	0.000
874	Measuring, controlling instruments	29,744,476	0.118
881	Photo apparatus, equipment n.e.s.	8,058	0.000

Note: Based on SITC 3-digit, Revision 2 classification.
Source: Authors' calculations based on data from the United Nations Commodity Trade Statistics database (accessed 7 March 2016) and Lall's (2000) technological classification of exports.

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Innovation in the Textiles Sector: A Firm-Level Analysis of Technological and Nontechnological Innovation

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Abstract

In a knowledge-based economy, it has become increasingly important to better understand critical aspects of the innovation process such as innovation activities beyond R&D, the interaction among different actors in the market and the relevant knowledge flows. Using a sample of 431 textiles and apparel manufacturers, this paper explores the dynamics of firms' innovation activities by analyzing their innovation behavior, the extent and types of innovation, the resources devoted to innovation, sources of knowledge spillovers, the factors hampering technological innovation and the returns to innovation for three years, 2013–15. Our results show that 56 percent of the surveyed firms introduced technological and/or nontechnological innovations, while 38 percent introduced new products, these innovations were generally incremental as the majority of innovations were new only to the firm. Furthermore, the innovation rate increases with firm size; large firms have an innovation rate of 83 percent, followed by medium firms (68 percent) and small firms (39 percent). Technologically innovative firms spent, on average, 10 percent of their turnover on innovation expenditure in 2015. Acquisition of machinery and equipment is the main innovation activity, accounting for 56 percent of innovation expenditures. Large firms consider foreign market sources (clients and suppliers) and small firms consider local market sources their key source of information and cooperation. 63 percent of technological innovators cite improving the quality of goods as their most important objective. Lack of available funds within the enterprise is the single most important cost factor hampering innovation, followed by the high cost of innovation. Our results show that 67 percent of the turnover among product innovators in 2015 resulted from product innovations that were either new to the market or new to the firm.

Keywords: Innovation, textiles, technological, non-technological, Pakistan.

JEL classification: O14, O32.

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1. Introduction

Recent developments in the theory of economic growth and availability of data highlight the importance of innovation for the sustained growth of output and productivity. The process of innovation benefits the economy in several ways: by increasing productivity, reducing costs, creating more and better jobs, diversifying industrial composition, increasing incomes, better marketing techniques and managerial restructuring of businesses.

However, our understanding of innovations and their economic impact is still limited, especially in developing countries. In recent years, information technology has led to an extraordinary increase in access to information and new markets for firms in many developing countries. This, coupled with increased globalization, is constantly changing the landscape of innovation and firm competitiveness. It has also resulted in greater international competition and new organizational forms for the effective management of global supply chains. As a result, knowledge has taken a central place as the main driver of innovation and economic growth. In such a knowledge-based economy, it has become increasingly important to better understand critical aspects of the innovation process, such as innovation activities beyond research and development (R&D), the interaction among different actors in the market and the relevant knowledge flows.

Using a sample of 431 Pakistani textiles and apparel manufacturers, this study explores the dynamics of firms' innovation activities by analyzing their innovation behavior, the extent and types of innovation, the resources devoted to innovation, sources of knowledge spillovers, factors hampering technological innovation and the returns to innovation for three years, 2013–15. Textiles, like many other merchandise products, have experienced tremendous growth in recent years. World exports of textiles and clothing increased from $482 billion in 2005 to $797 billion in 2014. During the same period, Pakistani textile exports increased from $10.7 billion to $14 billion (US dollars). However, compared to the rest of the world, the textiles sector in Pakistan has been fairly stagnant and its share of world textile exports has been falling throughout the past decade.

As the major manufacturing sector of Pakistan, textiles contribute one fourth of industrial value-added and employ 40 percent of the industrial labor force. Most importantly, the sector accounts for, on average, 56 percent of national exports. Since it is competing in global markets, a continuous flow of innovation is required to at least maintain its share of world trade.

This competitive pressure requires the innovation of new products, new processes, new organizational structures and new marketing techniques to survive and strive in the global arena.

In Pakistan, two particular characteristics of textiles – scope and the production chain – posit both opportunities and challenges for becoming more innovative and competitive. First, even though textiles account for 56 percent of national exports, their share of world trade is less than 2 percent (1.8% in 2014). There is greater scope for increasing this world share through innovation and competitiveness. Particularly given the increasing trend in wages in China, the leading textiles exporter, coupled with the recent GSP plus status granted by Europe, openings are more likely for competitive textiles firms. Second, textiles have the longest production chain, with inherent potential for value addition at each stage of processing, from cotton to ginning, spinning, fabric, processing, made-ups and garments.

In this study, we take into account the fact that innovation is a dynamic and nonlinear system that is difficult to measure. Traditionally, two dominant ways of measuring innovation are R&D investment and patents. However, both these proxies are associated with inherent deficiencies. R&D investment is an input in the innovation process rather than an output. Thus, investing in R&D may or may not result in the introduction of new products or new processes in the market.

In the context of developing countries, firms generate technological advances outside formal R&D such as acquiring embedded technology through the purchase of machinery and hardware, licensing and the purchase of patents. In such cases, considering only formal R&D as an innovation effort might not capture the true extent of efforts to innovate. A patent on the other hand is an output, but poses two problems. First, not all innovations are patented. A firm's propensity to patent varies by location (developed vs. developing countries), the type of business and innovations. Second, not all patents have the same practical application to the production of goods and processes.

Our treatment of innovation is based on the Oslo Manual (OECD & Eurostat, 2005) and its recommendations for developing countries. It incorporates the idea of Schumpeterian "creative destruction" whereby innovation is a dynamic process in which new technologies replace the old. Schumpeter (1934) proposes five types of innovation: (i) introducing new products, (ii) introducing new methods of production, (iii) opening up new markets, (iv) developing new sources of supply for raw materials and inputs, and (v) creating new market structures in an industry. Similarly, it encompasses aspects of industrial organization (Tirole, 1995), uncertainties in innovation (Rosenberg, 1994), organizational structure (Lam, 2005), marketing mix models (Perreault & McCarthy, 2005) and the diffusion of technologies (Hall, 2005).[1]

The resulting framework highlights the driving forces behind innovation, the importance of technological aspects such as product and process, nontechnological aspects such as organizational and marketing practices, the role of cooperation and linkages and the view of innovation as a system. More recently, many countries, especially in Europe, are using the Oslo Manual framework to conduct innovation surveys. In Europe, community innovation surveys are designed based on this framework and are conducted at regular intervals.

Our survey results show that 56 percent of firms introduced technological or nontechnological innovations. While 38 percent of firms introduced new products, these innovations were generally incremental as the vast majority of innovations were new only to the firm. Six enterprises introduced products that were new to the world – all six are in Sialkot – and 30 enterprises introduced new products to their market. The innovation rate increases with firm size: large firms have an innovation rate of 83 percent, followed by medium firms (68 percent) and small firms (39 percent). Technologically innovative firms spent, on average, 10 percent of their turnover on innovation expenditure in 2015.

Acquiring newer vintages of capital with the aim of introducing new or improved products and processes is the dominant innovation activity. Acquisition of machinery and equipment is the main innovation activity, accounting for 56 percent of innovation expenditures. About 31 percent of innovation expenditure is on R&D (25 percent on in-house and 6 percent on external R&D). Overall, firms consider market sources their most important source of knowledge spillover. However, large firms consider foreign market sources (clients and suppliers) and small firms consider local market sources their key source of information and cooperation.

Firms appear to focus more on innovations that promote growth and product outcomes dominate their objectives: 63 percent of technological innovators cite improving the quality of goods as their most important objective. The lack of available funds within the enterprise is the single most important cost factor hampering innovation, followed by the high cost of

[1] See Chapter 2 of the Oslo Manual for a detailed description.

innovation. The economic importance of innovation seems very high, as measured by the percentage share due to innovative products. Our results show that 67 percent of the turnover among product-innovative firms in 2015 resulted from product innovations that were either new to the market or new to the firm.

The rest of the paper is structured as follows. Section 2 describes our methodology and data collection. Section 3 presents the descriptive statistics and results with a discussion. Section 4 concludes the study.

2. Survey and Data

The textiles sector is defined as all manufacturers classified under Sections 13 and 14 of the Pakistan Standard Industrial Classification (PSIC) 2010 (International Standard Industrial Classification 17 and 18). The total population of such firms is around 4,458. Table 1 gives a province-wise breakdown of these units.

Table 1: Provincial distribution of textiles and related product manufacturing firms

Province	Number of manufacturing firms	% of total population
Punjab	2,687	60.3
Sindh	1,592	35.7
KP	128	2.9
Balochistan	51	1.1
Total	4,458	100.0

Source: Authors' calculations.

Our study focuses only on Punjab and Sindh.[2] We have used the Directory of Industries[3] for both provinces as a basic data frame and then worked with the Bureau of Statistics in Punjab and in Sindh to update and clean the directory. We concentrate on major textile hubs in these provinces, drawing samples for only those districts or regions that represent at least 1.5 percent of the total population of textiles and related product manufacturers in Pakistan.[4]

[2] This decision was primarily driven by the lower concentration of manufacturing units in the other two provinces.

[3] The same is used for the Census of Manufacturing Industries and only firms with a minimum of ten workers are included.

[4] This was decided to avoid districts with a lower concentration of units, which could inflate the cost of the survey.

A total of six districts in Punjab (Faisalabad, Lahore, Gujranwala, Kasur, Sheikhupura and Sialkot) had concentrations equal to or greater than 1.5 percent. In Sindh, however, a priori it was difficult to determine the districts with accuracy and we relied more on the regions of Karachi and Hyderabad/Jamshoro.[5] We drew a stratified random sample representative first at the provincial level and then at the district/regional level. The total sample size was 15 percent of the population (3,946 firms) of the selected areas or 592 firms. However, given the significance of the Karachi region, which accounts for 33.9 percent of all textiles and related product manufacturers in Pakistan, coupled with an expected low response rate (given the less clean data frame and volatile security situation), we oversampled Karachi by 10 percent. As a result, our total sample after oversampling comprised 614 firms. The distribution of the population of interest across the two provinces, their weight and sample size are shown in Tables 2 to 4.

Table 2: Distribution, weight and sample size, by province

Province (population of selected regions only)	Number of firms	Weight	Sample size
Punjab	2,367	60.0%	355
Sindh [a]	1,579	40.0%	259
Total	3,946		614

Note: a = after adjusting for 10 percent oversampling for the Karachi region.
Source: Authors' calculations.

Table 3: Distribution, weight and sample size, by district (Punjab)

District	Number of firms	Weight	Sample size
Faisalabad	1,128	47.7%	169
Lahore	466	19.7%	70
Gujranwala	246	10.4%	37
Kasur	219	9.3%	33
Sheikhupura	167	7.1%	25
Sialkot	141	6.0%	21
Total	2,367		355

Source: Authors' calculations.

[5] Before 2004, Jamshoro was part of Dadu district.

Table 4: Distribution, weight and sample size, by district (Sindh)

District	Total number of firms	Weight	Sample size
Karachi (all districts)	1,511	95.7%	227
Karachi (all districts) – number of oversampled firms			22
Hyderabad and Jamshoro	68	4.3%	10
Total	1,579		259

Source: Authors' calculations.

Out of 614 firms drawn for the sample, 431 participated voluntarily in the survey, resulting in a response rate of 70.2 percent (Table 5).

Table 5: Survey response rate

Province	Sample size	Surveyed firms	Response rate	Closed/not found	%	Refusals	%
Punjab	355	307	86.5%	46	13.0	2	0.5
Sindh	259	124	47.9%	93	35.9	42	16.2
Overall	614	431	70.2%	139	22.6	44	7.2

Source: Authors' calculations.

3. Results

This section gives the results of the innovation and nontechnological innovation rates.

3.1 Innovation Rate

The innovation rate is defined as the implementation of a new or significantly improved product, process, marketing method or managerial method in business practices, workplace organization or external relations. The minimum requirement for innovation is that the product, process, organizational method or marketing method must be new to the firm, whether it was originally developed by that firm or adopted from other firms or organizations.

Overall, 56 percent of firms were involved in either technological or nontechnological innovation or had ongoing or abandoned innovation activities during the three-year period 2013–15. Sindh has a 75 percent innovation rate compared to 49 percent for Punjab (Table 6).

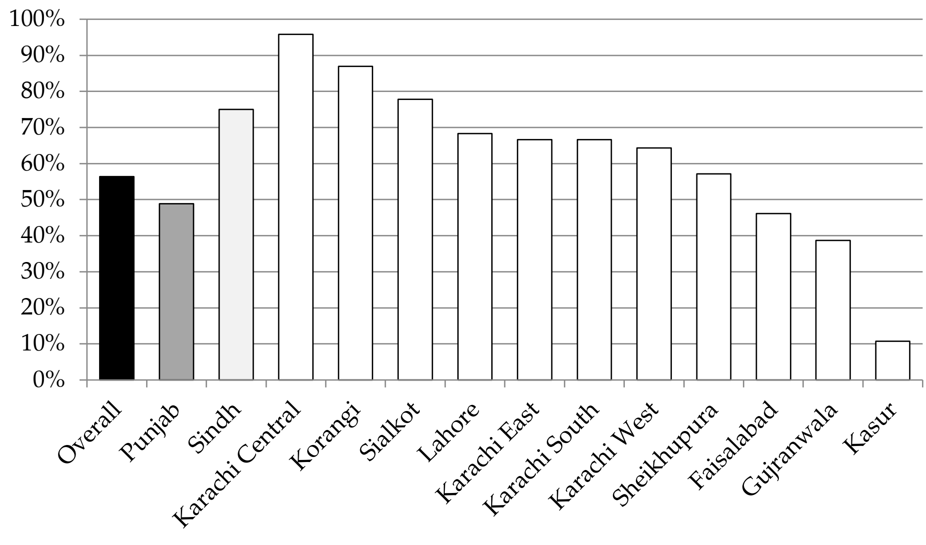
Table 6: Innovation rate, by province

Province	Innovation rate
Punjab	49%
Sindh	75%
Overall	56%

Source: Authors' calculations.

A geographical breakdown at the district level provides interesting insights into the concentration of innovative firms. Karachi Central is the most innovative district with an innovation rate of 96 percent. Kasur is the least innovative, with an innovation rate of only 11 percent (Figure 1).[6]

Figure 1: Innovation rate, by district



In Punjab, Sialkot is the most innovative district (78 percent) whereas Faisalabad, the district with the most textile units, has an innovation rate of 46 percent.

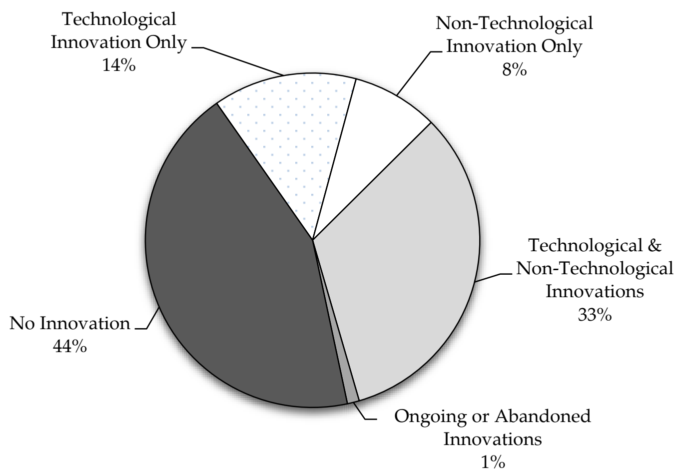
3.2 *Types of Innovation*

Technological innovation can be categorized into product and process innovations. Product innovation is the introduction of a good that is

[6] Jamshoro, Malir and Hyderabad are excluded due to limited observations (one and two each, respectively).

new or significantly improved with respect to its characteristics or intended use. Process innovation is the implementation of a new or significantly improved production or delivery method. Similarly, nontechnological innovation is categorized as managerial or marketing innovation. Managerial innovation is the introduction of a new organizational method in the firm's business practices, workplace organization or external relations. Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

Figure 2: Innovation rate, by type



Overall, 48 percent of the enterprises were involved in product or/and process innovations or reported ongoing or abandoned innovation activities during the sample period (Figure 2). This is striking since almost every second enterprise in the textiles sector has introduced a new product or/and a new process during these three years. While 14 percent of firms have either introduced a new product or a new process, 8 percent have introduced managerial or/and marketing innovations and 33 percent have introduced both technological and nontechnological innovations. Only 1 percent of enterprises are technologically active, i.e., they have ongoing innovations or have abandoned technological innovation activities during the sample period.

3.3 Innovation Rate by Firm Attributes

The literature on innovation suggests that firm-level attributes such as firm size, the main market in which firms sell their products and firm type affect innovation behavior.

3.3.1 Firm Size

Firms are classified as small, medium or large depending on the size of the workforce. Firms with 10–49 employees are classified as small, firms with 50–249 employees are classified as medium and firms with 250 or more employees are classified as large.

There are striking differences in the innovation rate across firms of different sizes. Large firms are more than twice as innovative as small firms. A similar trend emerges between technological innovation rates and firm size. Table 7 shows that, as firm size increases, the percentage of firms that introduced technological innovations alone or both technological and nontechnological innovations increases. While the percentage of firms that introduced only nontechnological innovations falls. This shows that bigger firms tend to introduce more technological innovations. Another trend (column 3) is that, as firm size increases, firms are more likely to introduce both technological and nontechnological innovations.

Table 7: Innovation rate, by type and firm size

Firm size	Technological	Nontech.	Tech. and nontechnological	Ongoing or abandoned	Overall rate
Small	11%	10%	17%	1%	39%
Medium	16%	8%	43%	2%	68%
Large	20%	5%	58%	0%	83%

Source: Authors' calculations.

3.3.2 Main Market

The main market of a given set of enterprises is their largest geographical market in terms of turnover during 2013–15. The questionnaire included nine different exhaustive geographical regions: local/regional (some provinces of Pakistan), national (across Pakistan), Europe, the US, the Middle East, China, Bangladesh, the rest of Asia and the rest of the world.

Firms with the Middle East as their main market are the most innovative (100 percent),[7] followed by the US (91 percent) and Europe (80 percent). Firms whose main market is the local market are the least innovative (41 percent). Table 8 presents a market-wise breakdown of innovative firms.[8] Overall, firms with international markets as their main market are more innovative than firms targeting local markets.

Table 8: Innovation rate, by market

	Local	Pakistan	Europe	US	Middle East
Innovation rate	41%	56%	80%	91%	100%

Source: Authors' calculations.

3.3.3 *Industrial Classification*

Innovation behavior also varies by type or the firm's main activity. We divide the sample into two broad categories: textiles and wearing apparel manufacturers (PSIC 13 and 14, respectively). Manufacturers of wearing apparel are more innovative (67 percent) than manufacturers of textiles (54 percent). They have a higher technological as well as nontechnological innovation rate. Since wearing apparel is generally at a higher stage in the textiles value chain, these firms are also perceived as being more innovative, which the data confirms (Table 9).

Table 9: Innovation rate, by industrial classification

Industrial classification	Overall	Technological	Nontechnological
Manufacturers of wearing apparel	67%	62%	56%
Manufacturers of textile	54%	45%	38%
Overall	56%	48%	41%

Source: Authors' calculations.

3.4 Technological Innovation Rate

The technological innovation rate is defined as the percentage of surveyed enterprises that reported any product or process innovations or both during 2013–15 as well as those firms that had ongoing or abandoned innovations during this time. Our results (shown in Table 10) show that 48

[7] We have eight observations for the Middle East.

[8] Since we have very few observations for Bangladesh, China, the rest of Asia and the rest of the world (2, 3, 1 and 1, respectively), these markets are excluded from the discussion. Furthermore, three firms did not mention their main market at all.

percent of enterprises were involved in either product or process innovation or both or had ongoing or abandoned innovation activities during the sample period. About 60 percent of firms in Sindh introduced technological innovations compared to 43 percent in Punjab.

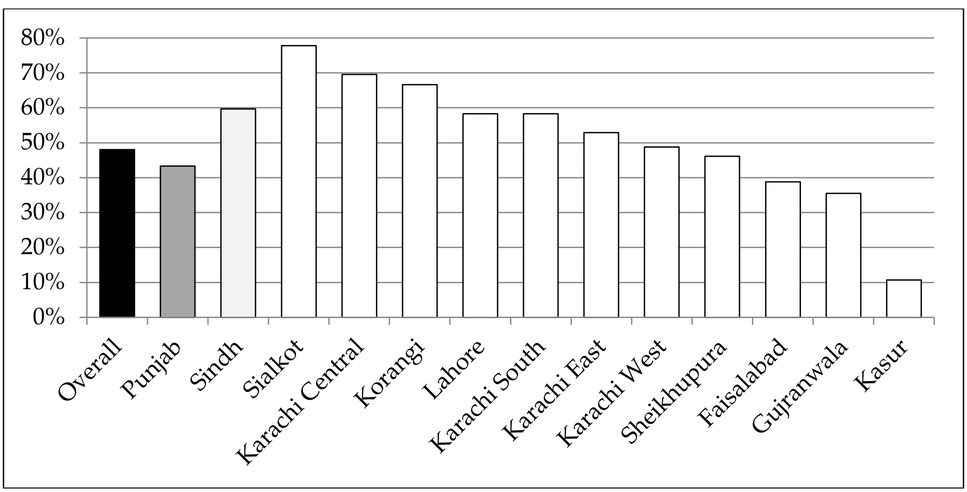
Table 10: Technological innovation rate, by province

Province	Technological innovation rate
Punjab	43%
Sindh	60%
Overall	48%

Source: Authors' calculations.

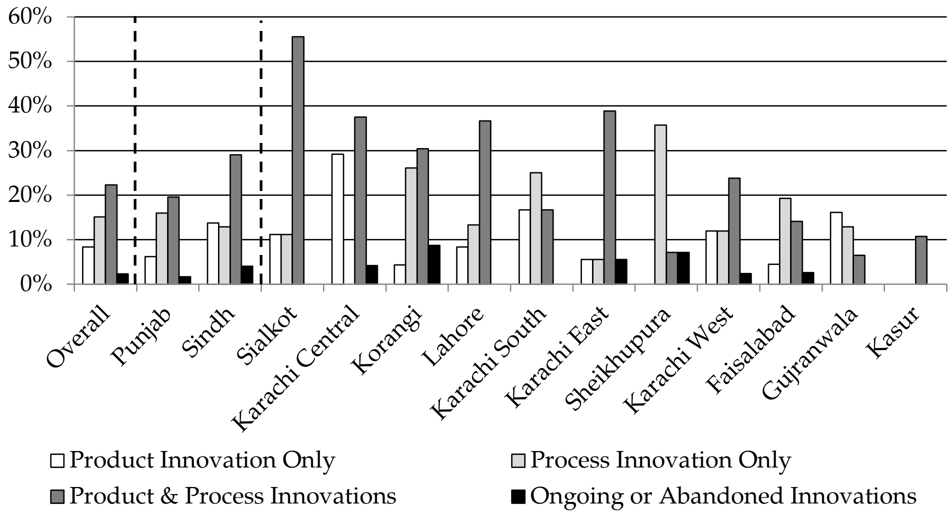
The breakdown of technological innovation at the district level (shown in Figure 3) reveals significant differences across districts. Sialkot is the most technologically innovative district in Pakistan with an innovation rate of 78 percent, followed by Karachi Central at 70 percent. Kasur is the least technologically innovative district in Pakistan with an innovation rate of 11 percent. Faisalabad, the textiles hub of Pakistan, has a technological innovation rate of 39 percent.

Figure 3: Technological innovation rate, by district



A detailed type-wise analysis of technological innovation reveals that almost half the technologically innovative firms have introduced both product and process innovation. Sialkot has the highest (56 percent) rate, whereas Gujranwala has the lowest rate (6 percent) for product as well as process innovation. Karachi Central has the highest rate (37 percent) for product-only innovation but 0 percent for process innovation. Sheikhupura and Kasur have a 0 percent product-only innovation rate (Figure 4).

Figure 4: Technological innovation, by type and district



Sheikhupura has the highest process-only (36 percent) innovation rate, followed by Korangi with 26 percent. Karachi Central and Kasur have a 0 percent process-only innovation rate. Sheikhupura and Faisalabad are the only two districts where the process-only innovation rate is highest.

3.5 Technological Innovation and Firm Size

There is considerable variation across firm sizes regarding the type of technological innovation introduced during 2013–15. Table 11 reveals that the percentage of firms introducing product-only innovation is higher for medium firms. Overall, a small fraction of large firms introduced product-only innovation and a bigger fraction introduced both product and process innovation. This shows a positive association between product and process innovations for large firms. However, there is not much variation in the type of innovation introduced by small firms.

Table 11: Technological innovation, by type and size

Firm size	Product	Process	Product and process	Ongoing or abandoned
Small	8%	10%	8%	3%
Medium	11%	13%	33%	3%
Large	5%	29%	42%	0%
Overall	8%	15%	22%	2%

Source: Authors' calculations.

3.6 Technological Innovation: Detailed Types

The previous section measured technological innovation as the introduction of new products and/or processes to the market. However, this does not completely measure the extent of innovation. The extent of innovation can be also measured by looking at the degree of novelty of product innovations. We provide a detailed analysis of product and process innovations by looking at the degree of novelty of product innovations and types of process innovations reported by firms. Further, we show how the degree of novelty and type of process innovation vary across locations and types of firms.

3.6.1 Product Innovation Type

Product innovations differ in their degree of novelty. We categorize these into three distinct types. A product innovation is considered new to the firm if it is being employed by the firm for the first time, even if it has already been introduced to the market by another firm. A new product innovation can also mean that one firm has introduced it to the market before its competitors, although the same innovation may already have been introduced to other markets. The market is defined as the firm and its competitors and can include a geographic region or product line. Finally, a world-first innovation is one that has been introduced by a firm to its market, but is also new to all markets.

Overall, 38 percent of enterprises introduced new products during 2013–15. A further breakdown (show in Table 12) reveals that the share of innovations that are new to the world is quite low (only around 1 percent). Out of 431 firms, six introduced product innovations new to the world and 30 introduced product innovations new to the market.

Table 12: Product innovation novelty, by province

Province	World first	%	New to market	%	New to firm	%
Punjab	6	2	22	7	76	25
Sindh	0	0	8	6	52	42
Overall	6	1	30	7	128	30

Source: Authors' calculations.

Overall, Sindh has a higher percentage of firms with product innovations, while Punjab has a higher percentage of product innovations that are new to the world and new to the market (Figure 5). All six product innovations new to the world originate from Sialkot, which is well-known for surgical goods and is also a leading manufacturer of sports goods. This result suggests that it is also the leading district in product innovations.

Figure 5: Product innovation novelty, by province

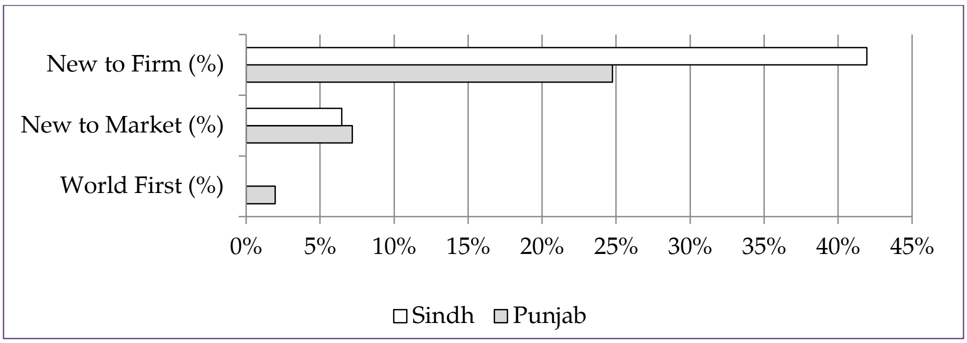
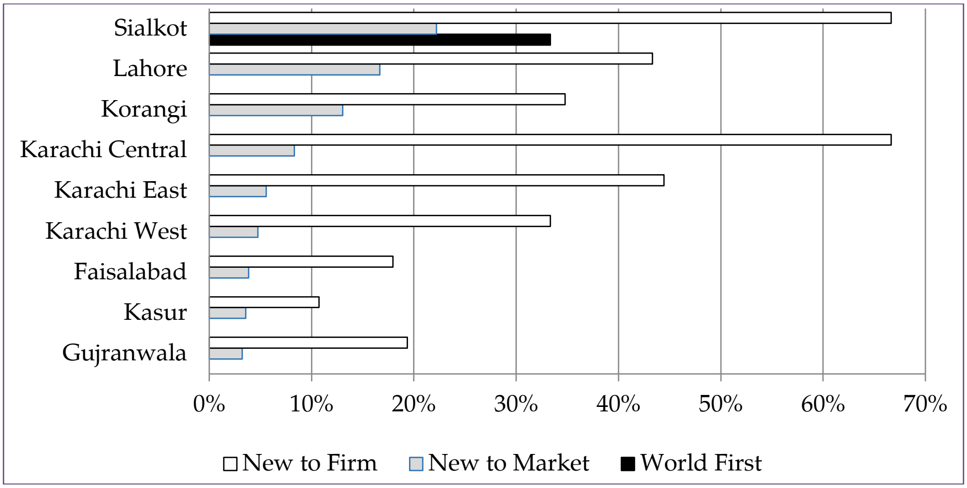


Figure 6 shows that Sialkot has the highest percentage (22 percent) of firms that introduced products new to the market, followed by Lahore (17 percent) and Korangi (13 percent). Sialkot and Karachi Central have the highest percentage (67 percent) of firms with product innovations new to the firm, followed by Karachi East (44 percent) and Lahore (43 percent). Faisalabad accounts for 4 percent of the firms with innovations new to the market and 18 percent of the firms with product innovations new to the firm.

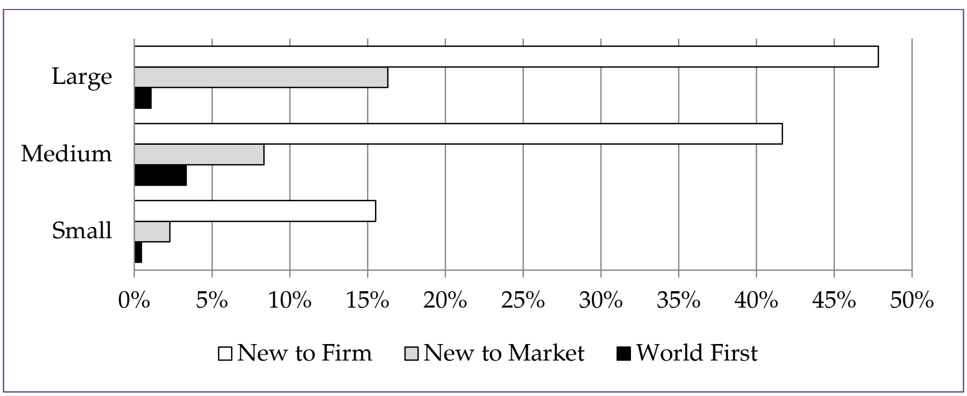
Figure 6: Product innovation novelty, by district



3.6.2 *Product Innovation Novelty and Firm Size*

Overall, 48 percent of large firms introduced products new to the firm, followed by medium firms (42 percent) and small firms (16 percent). Small firms have the lowest percentage of firms for all degrees of novelty in product innovation. Medium firms are the most innovative in terms of product innovations new to the world, whereas large firms are the most innovative with regard to product innovations new to the market (Figure 7).

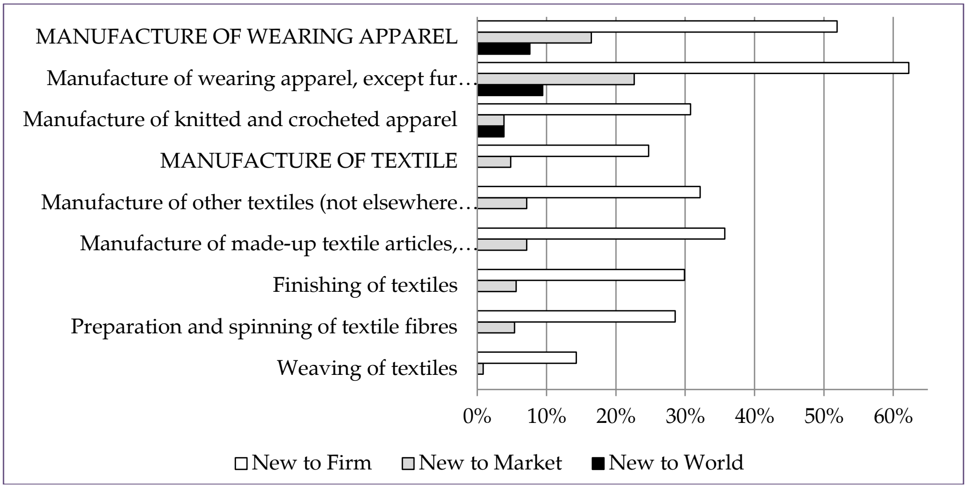
Figure 7: Product innovation novelty, by firm size



3.6.3 *Product Novelty by Industry*

Manufacturers of wearing apparel have the highest innovation rate for all three categories of novelty (Figure 8). They are three times as innovative (16 percent) as textiles in terms of products new to the market (5 percent) and twice as innovative in terms of product innovations new to the firm.

Figure 8: Product innovation novelty, by industrial classification

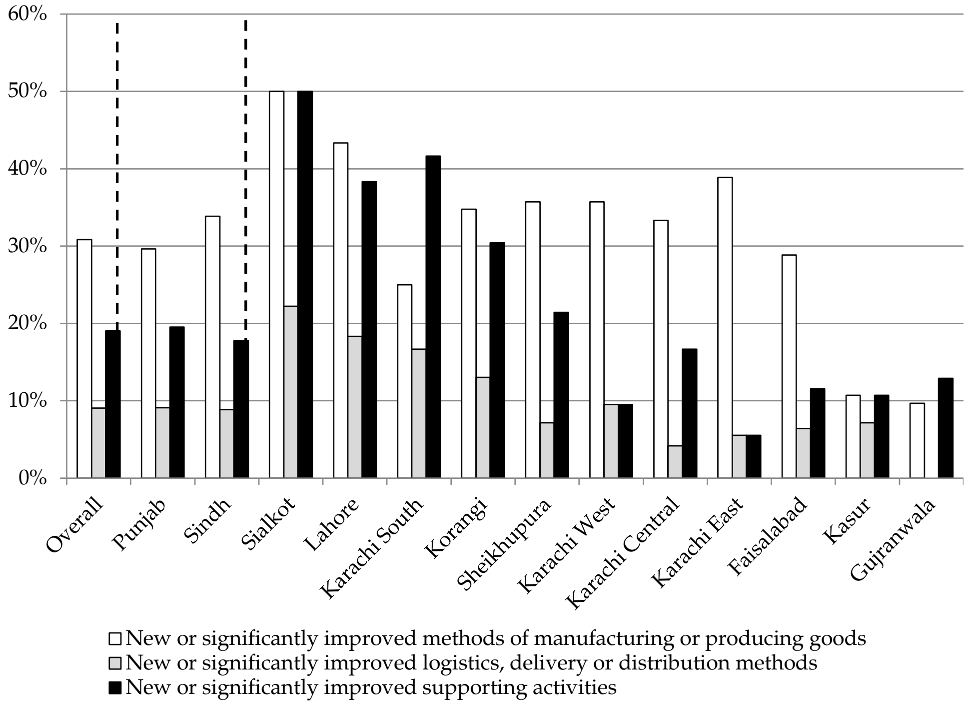


3.7 Process Innovation Types

In a similar fashion, technological innovations vary as to the type of process innovation introduced. Process innovation is subdivided into three categories: firms that developed (i) *new or significantly improved methods of manufacturing or production*, (ii) *new or significantly improved logistics, delivery or distribution methods and* (iii) *new or significantly improved supporting activities for processes*.

Again, Sialkot has the highest proportion of firms involved in process innovation in all three categories (Figure 9). Around half the firms are involved in developing new or improved methods of manufacturing or producing goods and other supporting activities. The results indicate that 31 percent of enterprises introduced new methods of manufacturing, followed by supporting activities (19 percent) and logistics, delivery or distribution (9 percent) methods.

Figure 9: Process innovation types, by district



3.8 *Nontechnological Innovation Rate*

The nontechnological innovation rate is the percentage of firms that reported any managerial innovations, marketing innovations or both during 2013–15. Overall, 41 percent of the enterprises were involved in either managerial or marketing innovations or both (Table 13). A province-wise breakdown of nontechnological innovation reveals a similar pattern to that found in the analysis of technological innovation. Sindh has a higher innovation rate than Punjab, with 60 percent of firms in Sindh having introduced nontechnological innovations. This is almost double the innovation rate for Punjab (34 percent).

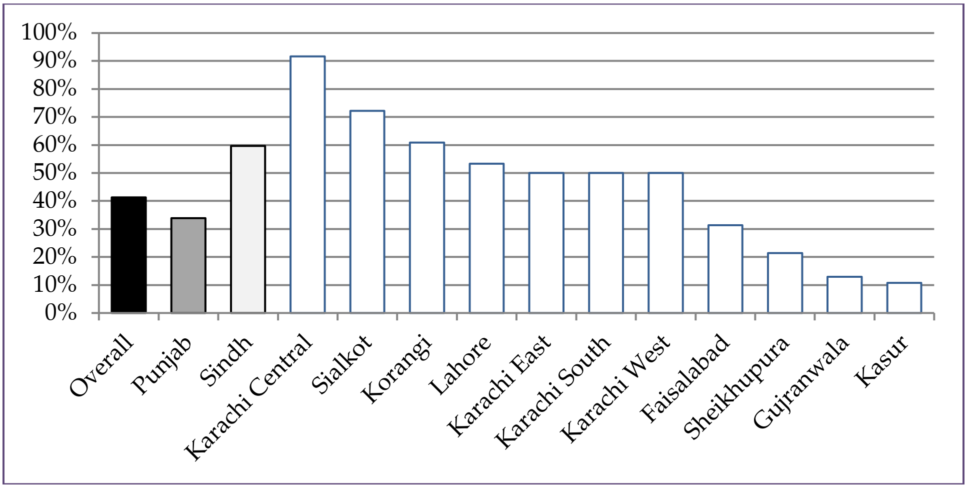
Table 13: Nontechnological innovation rate, by province

Province	Nontechnological innovation rate
Punjab	34%
Sindh	60%
Overall	41%

Source: Authors' calculations.

A stratification of the sample by nontechnological innovation rates by district shows that Karachi East is the most innovative district, with an innovation rate as high as 92 percent, followed by Sialkot (72 percent). Gujranwala has the lowest nontechnological innovation rate of just 13 percent. Again, Faisalabad has a modest rate of 31 percent (Figure 10).

Figure 10: Nontechnological innovation rate, by district

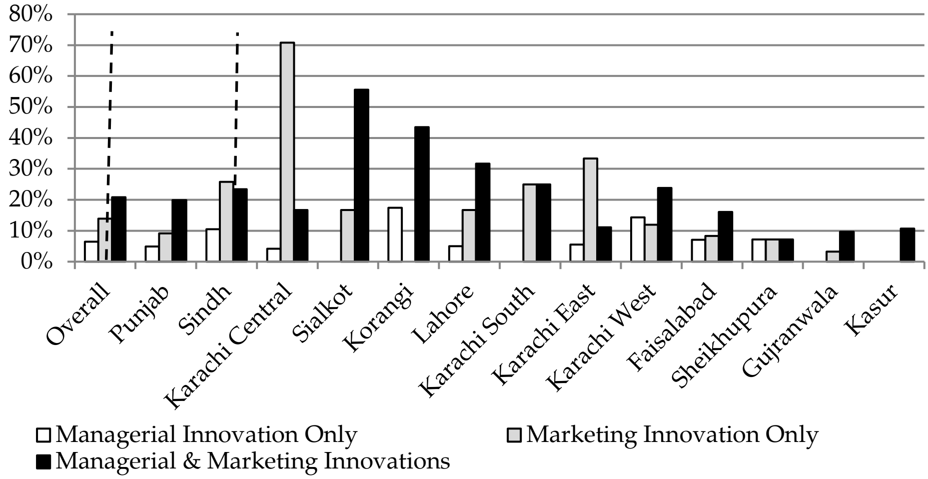


3.8.1 *Managerial and Marketing Innovations by District and Type*

A disaggregation of the data by type of nontechnological innovation reveals that, overall, 21 percent of firms introduced both managerial and marketing innovations, 14 percent introduced marketing-only innovations and 6 percent introduced managerial-only innovations. Nontechnological innovation behavior differs between the two provinces: firms in Sindh have the highest percentage of marketing-only innovations (24 percent) while those in Punjab have the highest managerial as well as marketing (23 percent) innovations.

Figure 11 shows that Sialkot has the highest managerial plus marketing innovation rate (56 percent), followed by Korangi (43 percent). Sheikhupura has the lowest rate (7 percent). Karachi Central has the highest marketing-only innovation rate (71 percent), followed by Karachi East (33 percent). Korangi and Kasur have a 0 percent marketing-only innovation rate. Korangi has the highest managerial-only innovation rate (17 percent), followed by Karachi West (14 percent). Sialkot, Gujranwala, Kasur and Karachi South have a 0 percent managerial-only innovation rate.

Figure 11: Type of nontechnological innovation, by district



3.8.2 *Types of Nontechnological Innovation by Firm Size*

Large firms have the highest nontechnological innovation rate (63 percent), followed by medium firms (51 percent). Small firms have the lowest rate (26 percent). Large firms are found to be the most active in all three categories: 10 percent for managerial-only innovation, 14 percent for marketing-only innovation and 39 percent for managerial and marketing innovation. Medium firms have relatively high rates of nontechnological innovation in all three categories.

Table 14: Types of nontechnological innovation, by firm size

Firm size	Managerial	Marketing	Managerial and marketing
Small	5%	16%	5%
Medium	7%	9%	35%
Large	10%	14%	39%
Overall	6%	14%	21%

Source: Authors' calculations based on data from the provincial bureaus of statistics.

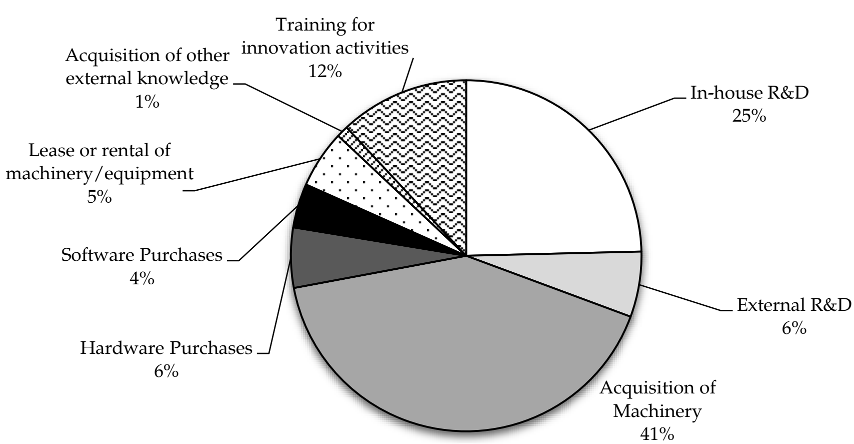
Table 14 shows that around 35 percent of medium firms are involved in both managerial and marketing innovations – the highest type among them. Both large and medium firms have the highest managerial and marketing innovation rate, followed by marketing-only and management-only innovation rates, respectively. However, small firms have the highest marketing-only innovation rate and an equal rate for managerial-only and managerial-plus-marketing innovations.

3.9 Expenditure on Technological Innovation

Traditionally, R&D expenditure measures the monetary resources devoted to innovation. However, in widely used indicators such as that proposed by the Frascati manual, many important inputs – such as the acquisition of machinery and training for innovative activities and expenditures related to the market introduction of innovations – are excluded. To overcome these deficiencies, the Oslo Manual proposes a broader input measure of innovation expenditure that takes into account most innovation-related expenditures. Innovation input is defined as the innovation cost or expenditure that includes innovation/investment in the following activities: in-house R&D, external R&D, the acquisition of machinery, equipment and software, other external knowledge, training for innovative activities, the market introduction of innovations and others (including design).

Firms were asked if they were active in any of the above categories over the three years 2013–15 and to estimate their innovation spending in each category for 2015 only. Overall, 9 percent of the turnover in 2015 (both innovative and noninnovative firms) was spent on innovation expenditure (Figure 12).[9] For those firms that were technologically innovative, the innovation expenditure stood at 10 percent of their turnover in 2015.

Figure 12: Innovation expenditure, by type



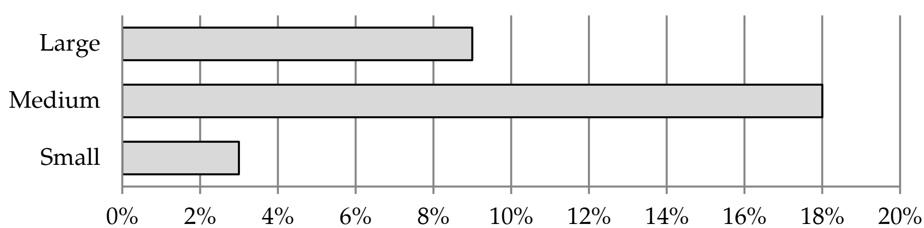
[9] Not all firms provided data on their turnover: of 431 firms that responded to the questionnaire, 377 provided data on turnover.

In aggregate terms, the technologically innovative firms in our sample spent around Rs25.4 billion on innovation in 2015. A segregation of innovation expenditures reveals that as much as 56 percent of their total expenditure was on the acquisition of machinery, equipment and software. A further subdivision shows that the highest percentage of expenditure was on the acquisition of machinery (41 percent), followed by in-house R&D (25 percent) and training for innovation activities (12 percent). About 6 percent was spent on external R&D and hardware purchases. The remaining 5 percent was spent on leasing/renting machinery, 4 percent on software purchases and 1 percent on the acquisition of other external knowledge.

3.9.1 Technological Innovation Expenditure by Firm Size

Innovation expenditure varies with the size of the firm. Different firms have different tendencies to innovate, different financial constraints and different innovative capacities. Figure 13 presents the results for technologically innovative firms.

Figure 13: Innovation expenditure by technology innovators, by firm size (% of 2015 turnover)

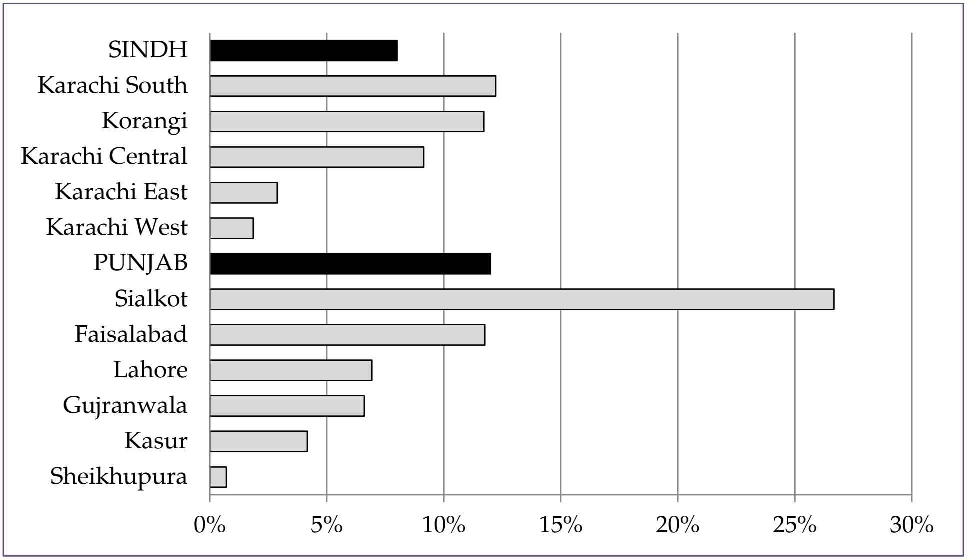


The results indicate that medium firms spent the highest proportion of their total turnover on innovation activities: on average, 18 percent in 2015. Large firms are second, investing 9 percent of the turnover on innovation expenditure. Small firms spent the lowest proportion (3 percent) of their turnover on innovation.

3.9.2 Technological Innovation Expenditure by District

Overall, firms in Punjab spent around 12 percent of their turnover on innovation expenditures compared to 8 percent by firms in Sindh (Figure 14). This difference is largely driven by the expenditure behavior of firms in Sialkot district. Firms in Sialkot spent more than a fourth of their turnover on innovation – more than twice as much as the average spent in the next district in line. Firms in Sialkot spent 27 percent of their turnover in 2015 on innovation-related expenditures, followed by Karachi South and Faisalabad (12 percent). Firms in Sheikhupura spent only 1 percent and firms in Karachi West spent 2 percent of their turnover.

Figure 14: Innovation expenditure by technology innovators, by district (% of 2015 turnover)

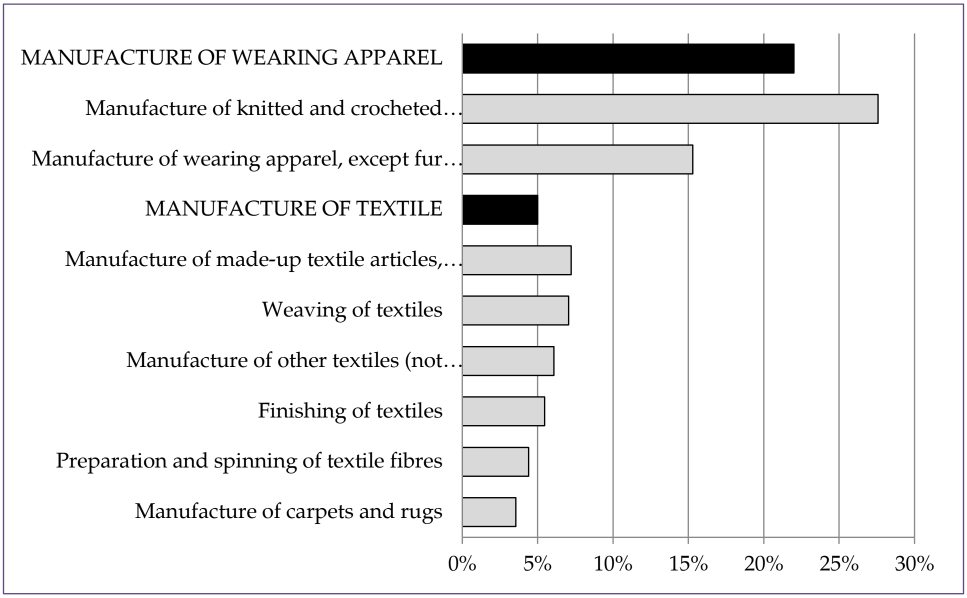


3.9.3 Innovation Expenditure by Industrial Classification

The wearing apparel industry invested over one fifth of its turnover in innovation inputs (22 percent). On the other hand, textiles firms only spent about 5 percent of their turnover on innovation activities (Figure 15).

A further analysis within each industry reveals noticeable differences in innovation expenditure among different types of firms. Overall, manufacturers of knitted and crocheted apparel invested the largest proportion in innovation. On average, firms in this subcategory spent 28 percent of their turnover in 2015 on innovation-related expenditures. Manufacturers of apparel were second, with 15 percent of their turnover spent on innovation.

Figure 15: Innovation expenditure by technology innovators, by PSIC code (% of 2015 turnover)



3.10 Product Innovation Turnover

Innovation inputs such as R&D expenditure culminate in benefits for the innovative firm in the form of increased turnover. This is also a useful indicator of the innovation intensity of product innovations. Firms were asked to estimate how much of their total turnover in 2015 was attributable to product innovations, separated into new-to-the-market innovations (a measure of novelty and creativity) and new-to-the-firm innovations (those adopted by the firm but invented elsewhere). The product innovations could have been introduced at any stage during the sample period.

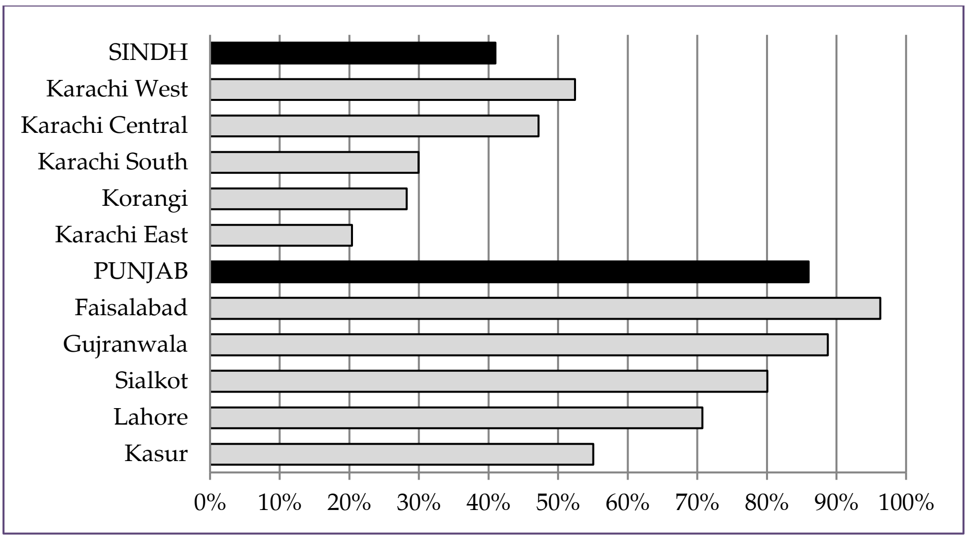
3.10.1 Innovation Turnover

The share of innovative activities in turnover quantifies the intensity of product innovations. Overall, the share of turnover in 2015 attributed to products that were new to the market and new to the firm for all product-innovative and noninnovative firms was 48 percent. A more accurate measure would be the share of innovative output for only those firms that introduced any product innovation during the three years 2013–15. Overall, 67 percent of the turnover of product-innovative firms in 2015 resulted from product innovations that were either new to the market or to the firm.

3.10.2 Share of Innovation Turnover by District

Overall, there is a noticeable difference between firms in the two provinces. Punjab has higher rates of turnover from product innovation than Sindh. Apart from Sheikhupura, the innovation output of all districts in Punjab is very high (Figure 16). Faisalabad has the highest ratio (96 percent), implying that product-innovative firms attributed almost all their turnover in 2015 to products that were either new to the firm or new to the market. Gujranwala has an innovation output of 86 percent, followed by Sialkot (80 percent). Sindh has a 41 percent innovation output: Karachi West has the highest ratio (52 percent), followed by Karachi Central (42 percent).

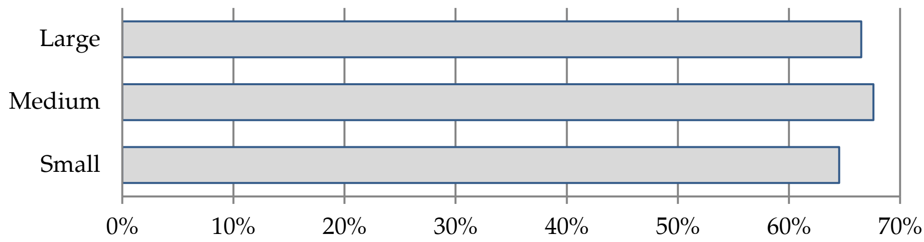
Figure 16: Turnover share of innovation output for product innovators, by district



3.10.3 Share of Innovation Turnover by Firm Size

There is little variation in innovation output across firms of different sizes (Figure 17). Medium firms have the highest innovation output ratio (68 percent), followed by large firms (67 percent) and small firms (65 percent).

Figure 17: Turnover share of innovation output for product innovators, by firm size



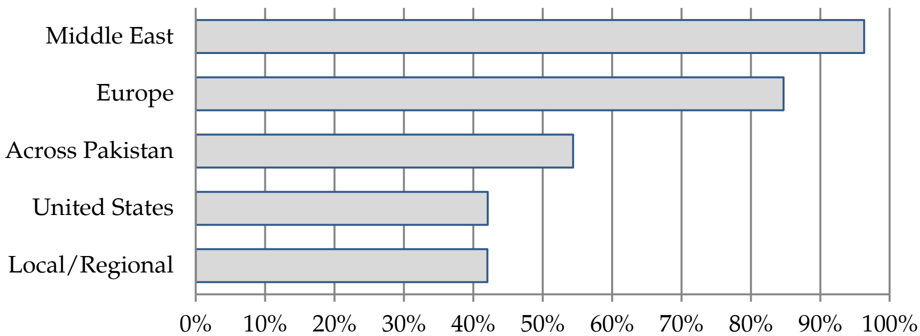
3.10.4 Share of Innovation Turnover by Industrial Classification

Disaggregating turnover with respect to industrial classification shows that there is no variation between manufacturers of textiles and wearing apparel. Both have innovation turnovers of 67 and 66 percent, respectively. However, a detailed analysis of subcategories reveals some heterogeneity. Firms engaged in spinning textile fibers have the highest innovation turnover ratio (80 percent), followed by manufacturers of wearing apparel (69 percent). Firms that fall under the category of textiles finishing have the lowest innovation turnover (40 percent).

3.10.5 Share of Innovation Turnover by Market

The classification of innovation turnover by the main market (shown in Figure 18) reveals striking differences. Product innovators with the Middle East as their main market have an innovation output of 96 percent of their total turnover in 2015. Interestingly, almost all sales to the Middle East by product innovators involve innovations that were either new to the market or at least new to the firm. This is followed by Europe, with an innovation output of 85 percent. The US and local markets have the lowest (42 percent) innovation outputs as a percentage of total turnover in 2015.

Figure 18: Turnover share of innovation output for product innovators, by main market



3.11 Technological Innovation Cooperation

Collaboration between firms and other entities is considered vital to the successful development and implementation of product and process innovations. Firms were asked about their sources of information and cooperation for innovation, the degree of importance and location. They were initially asked to identify sources that provided information on new innovation projects or contributed to the completion of existing innovation projects during 2013–15. Then, they were asked to rank each source according to its degree of importance: none, low, medium or high.

The sources were grouped into different categories: internal sources (within the enterprise or enterprise group), market sources (including suppliers of equipment, materials, components or software, separated into local and foreign), clients (separated into local and foreign), competitors and private R&D institutions (including consultants), institutional sources (including universities and public research institutions) and other sources (conferences, trade fairs, exhibitions, scientific journals and industry associations).

3.11.1 Type of Cooperation by Firm Size

This section analyzes innovation cooperation for innovative firms. We report the cooperation only if it was identified as highly important. Overall, firms consider market sources their most important source of information and cooperation for innovation: 49 percent of firms consider foreign clients their most important source and 38 percent consider local clients a very important source. However, the degree of importance varies with the size of the firm. As much as 72 percent of large firms consider foreign clients a very important source, followed by 53 percent of medium firms. However, only 19 percent of small firms consider foreign clients a very important source. On the other hand, 48 percent of small firms consider local clients a very important source, compared to 33 percent of medium firms and 32 percent of large firms.

After foreign clients, the second most important source is within the enterprise group: 43 percent of firms consider this a very important source of information and cooperation. About 31 percent of firms consider foreign suppliers a very important source and 29 percent see local suppliers as a very important source. Only 5 percent of firms see universities and public research institutions as a very important source of information and cooperation.

About 27 percent of firms consider competitors and conferences or exhibitions a very important source, with a visible difference between large and small firms. Different firm sizes cite different sources as being the most important. Large firms see foreign clients (72 percent) as their most important source, followed by firms within the enterprise group (56 percent), foreign suppliers (44 percent), competitors (39 percent) and conferences/exhibitions (34 percent). Small firms consider local clients (48 percent) their most important source, followed by local suppliers (42 percent), firms within the enterprise group (27 percent), foreign clients, competitors and conferences/exhibitions (19 percent each). Medium firms see foreign clients (53 percent) as their most important source, followed by firms within the enterprise group (44 percent), foreign suppliers (35 percent), local clients (33 percent), conferences/exhibitions (26 percent) and local suppliers (25 percent) (Table 15).

Table 15: Important sources of information for innovation, by firm size

	Internal	Market sources					Institutional sources			Other sources		
Firm size	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Small	27%	14%	42%	19%	48%	19%	3%	0%	2%	19%	2%	2%
Medium	44%	35%	25%	53%	33%	22%	4%	1%	0%	26%	15%	13%
Large	56%	44%	21%	72%	32%	39%	11%	7%	6%	34%	7%	7%
Overall	43%	31%	29%	49%	38%	27%	6%	3%	2%	27%	8%	7%

Note: 1 = within enterprise/group, 2 = foreign supplier, 3 = local supplier, 4 = foreign client, 5 = local client, 6 = competitors, 7 = consultants, 8 = universities, 9 = public research institutes, 10 = conferences, exhibitions, 11 = publications, 12 = associations.
Source: Authors' calculations.

3.11.2 Active Cooperation

Firms were also asked if, during the sample period, they had cooperated with other enterprises or institutions in any of their innovation activities (including other firms within their group). Innovation cooperation is defined as active participation with other enterprises or noncommercial institutions (including the firm's own group) in innovation activities. Both partners do not need to benefit commercially and we exclude work contracted out that involves no active cooperation. Overall, 24 percent of technologically innovative firms cooperated in innovation activities during 2013–15 (Table 16).

Table 16: Distribution of active innovation cooperators and noncooperators in the sample

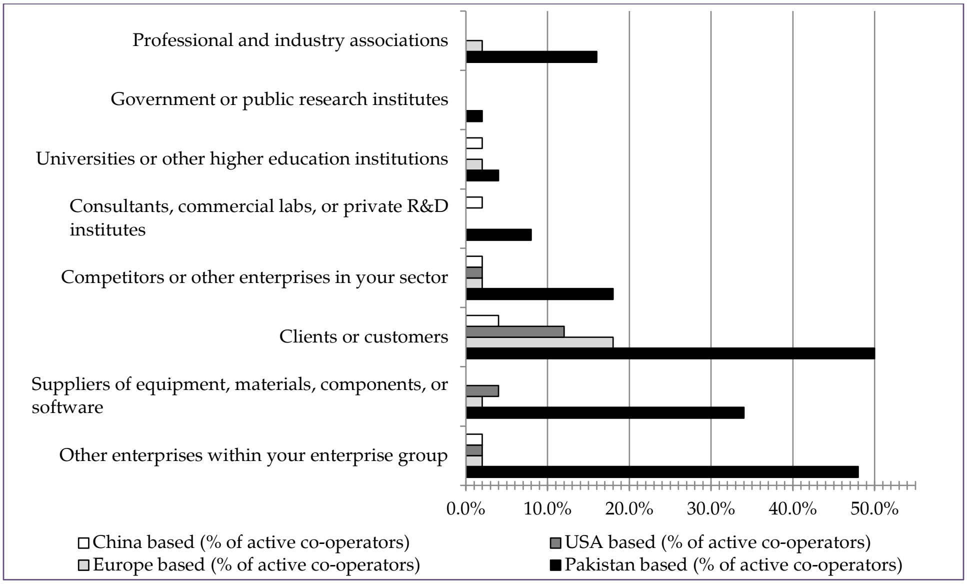
Cooperation status	Number of firms	% of tech. innovators
Active cooperators	50	24.2
Noncooperators	157	75.8

Source: Authors' calculations.

3.11.3 Innovation Cooperation by Location

In a follow-up question, innovative cooperating firms were asked to indicate their innovation cooperation partner by location (including the US, Pakistan, Europe, China, Bangladesh, Asia and all other countries). Overall, cooperating technological innovators considered clients and other enterprises within their group their most important partners, while Pakistan, Europe and the US were seen as the most important locations (Figure 19).

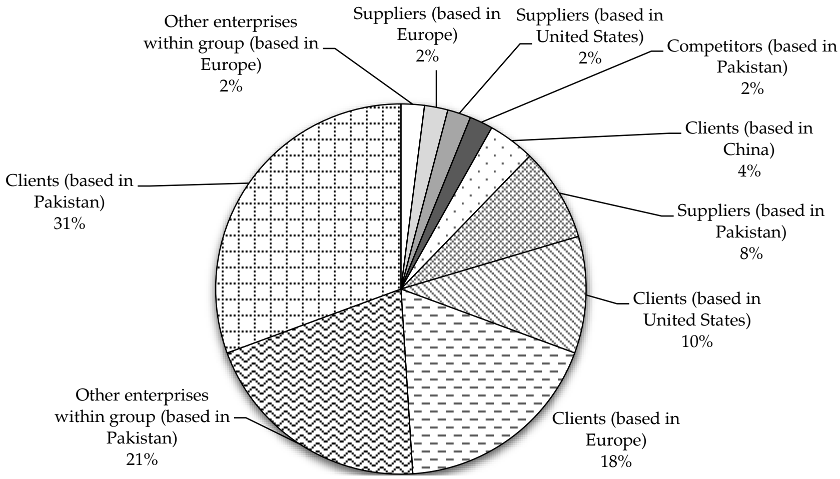
Figure 19: Cooperation partners, by type and location



3.11.4 Innovation Cooperation by Location and Importance

In a follow-up question, cooperating firms were asked to identify the type of cooperation partner they had found the most valuable to their innovation activities. Overall (Figure 20 shows), 31 percent of cooperating technological innovators consider clients based in Pakistan their most valuable partners in innovative activities, followed by other enterprises within the group located in Pakistan (21 percent), clients based in Europe (18 percent), clients in the US (10 percent) and suppliers based in Pakistan (8 percent). Among foreign partners, Europeans are considered the most valuable partners (20 percent), followed by Americans (12 percent). Conversely, every fifth technological innovator engaging in active cooperation sees European clients and suppliers as the most valuable cooperating partners.

Figure 20: Most valuable cooperation partners, by type and location



3.12 Factors Hampering Technological Innovation

Both innovative and noninnovative firms were asked to report factors that had prevented them from innovating or hampered innovative activities during 2013–15. Firms were also asked to rank each factor by importance on a scale of none (did not experience this constraint), low, medium and high. The questionnaire divided these factors into four mutually exclusive categories: cost, knowledge, market and other factors.

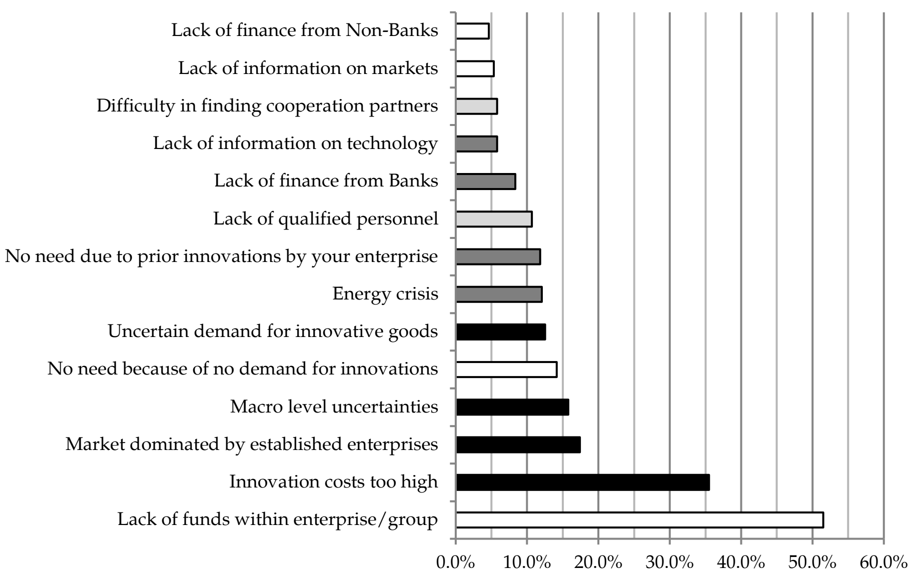
Cost factors include financial constraints and are divided into three different types: (i) lack of funds within the enterprise or its group, (ii) lack of external financing (banks and nonbanks) and (iii) innovation costs being too high. Knowledge factors include (i) the lack of qualified personnel, (ii) lack of information on technology, (iii) lack of information on markets and (iv) difficulty finding cooperating partners for innovation. Market factors include (i) the market being dominated by established enterprises and (ii) uncertain demand for innovative products. Other factors include (i) having no need to innovate due to prior innovations by the enterprise, (ii) having no need to innovate due to lack of demand for innovative products, (iii) macro-level uncertainties and (iv) any other reasons.

3.12.1 Constraints to Technological Innovation

Here, we report the constraints that firms ranked as being highly important. Overall, cost factors are seen as the most important constraint. Every second firm considers a lack of funds within the enterprise or its group the most important constraint to innovation. Lack of available funds within the enterprise is the single most important cost factor hindering innovation, cited by 52 percent of firms (Figure 21).

High innovation costs are the second most important cost factor preventing firms from innovating: 36 percent of firms report high innovation costs as a key constraint. Lack of financing from banks and other sources is not considered a major constraint. Only 13 percent of firms see this as a major impediment (8 percent cite the lack of bank financing and 5 percent cite the lack of nonbank sources).

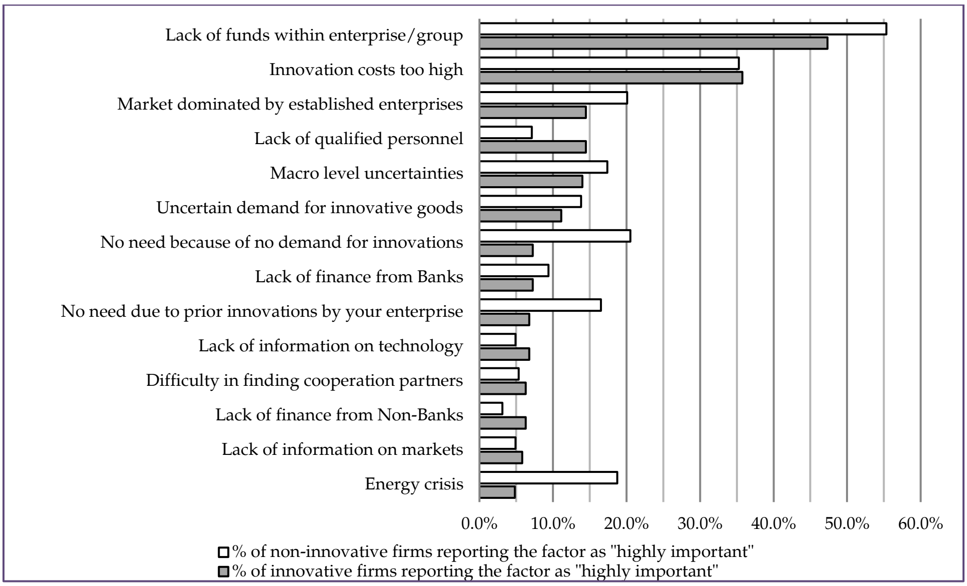
Figure 21: Constraints to innovation activities



Market factors are considered the second most binding constraint after cost: 17 percent of firms report that the market is dominated by established enterprises, which hampers innovation activities. About 16 percent see macro-level uncertainties as highly important, while 13 percent consider the uncertain demand for innovative products a highly important constraint. Surprisingly, not many firms consider knowledge factors to be binding constraints. Of these, the lack of qualified personnel is considered an important factor, with 11 percent of firms citing it as a highly important constraint to innovation.

Segregating firms into innovative and noninnovative firms yields no major difference between the two groups in terms of binding constraints to innovation (see Figure 22). The key difference lies in energy constraints: compared to 5 percent of innovative firms, as many as 19 percent of noninnovative firms cite this as a highly important constraint. There is also a difference in the perception that firms need not innovate due to prior innovations. As expected, a higher percentage of noninnovators consider this an important factor compared to innovators. Finally, compared to 7 percent of innovators, 21 percent of noninnovators see the lack of demand for innovative products as a highly important constraint to innovation.

Figure 22: Constraints to innovation activities, by innovative and noninnovative firms



3.12.2 Constraints to Innovation, by Firm Size

Firms of different sizes face different challenges and thus identify different factors as highly important constraints to innovation. Overall, 60 percent of small firms consider a lack of funds within the enterprise or its group to be a very important constraint. This is twice as high as among large firms (30 percent), while 52 percent of medium firms cite it as a key constraint (Table 17). Overall, medium firms cite the following constraints as being very important: lack of qualified personnel (15 percent), lack of information on technology (11 percent, compared to only 3 percent among small firms) and difficulty finding cooperative partners (11 percent, compared to only 2 percent among small firms).

Table 17: Factors hampering technological innovation, by firm size

Factor	Small	Medium	Large
Lack of funds within enterprise/group	60%	52%	30%
Innovation costs too high	33%	41%	34%
Market dominated by established enterprises	18%	19%	14%
Energy crisis	16%	8%	8%
No need because no demand for innovations	15%	17%	9%
Macro-level uncertainties	15%	17%	16%
Uncertain demand for innovative goods	11%	13%	15%
No need due to prior innovations by enterprise	9%	16%	14%
Lack of finance from banks	8%	11%	7%
Lack of qualified personnel	8%	15%	12%
Lack of information on markets	5%	8%	2%
Lack of finance from nonbanks	4%	7%	4%
Lack of information on technology	3%	11%	5%
Difficulty finding cooperation partners	2%	11%	8%

Source: Authors' calculations.

3.13 Innovation Objectives

A firm's innovation behavior, the type of innovation and its extent depend on the objectives of innovation. For example, firms may focus on improving efficiency, in which case their innovations will aim to reduce costs. Firms focusing on growth may innovate by introducing a new product range or capacity or by entering a new market. The surveyed firms were asked about their objectives and the significance of these in terms of both technological and nontechnological innovations.

3.13.1 Objectives of Technological Innovation

These objectives are divided into three categories: product outcomes, process outcomes and other outcomes. Each has multiple subcategories. Product outcomes include (i) increasing the range of goods, (ii) entering new markets or increasing market share and (iii) improving the quality of goods. Process outcomes include (i) improving flexibility in producing goods, (ii) increasing the capacity to produce goods, (iii) reducing the labor cost per unit of output and (iv) reducing material and energy costs per unit of output. Other outcomes include (i) reducing environmental impacts, (ii) improving worker health and safety, (iii) meeting government regulatory requirements and (iv) meeting international regulatory requirements. Firms were asked to rank these objectives as not relevant, low, medium or high with regard to their innovation objectives during 2013–15.

Overall, our results show that the textiles sector is more focused on innovation that promotes growth. Product outcomes dominate these firms' objectives: 63 percent of technological innovators report that improving the quality of goods is their most important objective, followed by entering new markets or increasing market share (43 percent), and increasing the range of goods (39 percent). Process outcomes vary less. Overall, every third firm reports improving flexibility in producing goods (29 percent), increasing the capacity to produce goods (35 percent), reducing the labor cost per unit of output (37 percent) and reducing material and energy costs per unit of output (34 percent) (Table 18).

Table 18: Key objectives of technological innovation

Objective	% reporting
Improve quality of goods	63%
Enter new markets or increase market share	43%
Increase range of goods	39%
Reduce labor cost per unit of output	37%
Increase capacity for producing goods	35%
Reduce material and energy costs per unit of output	34%
Improve health or safety of employees	32%
Meet international regulatory requirements	31%
Improve flexibility of producing goods	29%
Meet government regulatory requirements	27%
Reduce environmental impacts	21%

Source: Authors' calculations.

3.13.2 Objectives of Nontechnological Innovation

For nontechnological innovation, separate objectives were listed for managerial and marketing innovations.

3.13.3 Objectives of Managerial Innovation

Managerial innovation objectives include: (i) improving or maintaining market share, (ii) reducing the time taken to respond to customer or supplier needs, (iii) improving the quality of goods, (iv) reducing the cost per unit of output and (v) improving employee satisfaction and/or reducing employee turnover.

The objectives of technological and managerial innovation are more or less consistent (see Table 19). Improving the quality of goods ranks highest among managerial innovators. Around three quarters of the active managerial innovators surveyed report that improving the quality of goods is their most important objective when introducing new business practices. Reducing the time taken to respond to client and supplier needs is the second most important factor: 64 percent of active managerial innovators cite this as a highly important objective. Around half the firms report maintaining and improving their market share as a highly important objective. Around four in ten firms see reducing costs per unit of output and improving employee satisfaction as highly important objectives in managerial innovation.

Table 19: Key objectives of managerial innovation

Objective	% reporting
Improve quality of goods	70%
Reduce time taken to respond to customer or supplier needs	64%
Improve or maintain market share	52%
Improve employee satisfaction and/or reduce turnover rate	43%
Reduce cost per unit of output	42%

Source: Authors' calculations.

3.13.4 Objectives of Marketing Innovation

The objectives of marketing innovation are categorized as follows: (i) increasing or maintaining market share, (ii) introducing products to new customer groups and (iii) introducing products to new geographic markets. In this case, innovations among textile firms are more focused on growth. Firms introducing these innovations see increasing or maintaining their market share as the most important objective of marketing innovation. About 47 percent of firms report introducing products to new customer groups as a highly important objective, followed by introducing products to new geographic markets (32 percent) (Table 20).

Table 20: Key objectives of marketing innovation

Objective	% reporting
Increase or maintain market share	51%
Introduce products to new customer groups	47%
Introduce products to new geographic markets	32%

Source: Authors' calculations.

4. Conclusions

Using a sample of 431 Pakistani textiles and apparel manufacturers, we have analyzed their innovation behavior, the extent and types of innovation, the resources devoted to innovation, sources of knowledge spillovers, factors hampering technological innovation and the returns to innovation over a three-year period (2013–15). Our treatment of innovation is based on the Oslo Manual (2005) and its recommendation for developing countries. Our analysis looks at the importance of technological aspects such as product and process as well as nontechnological aspects such as organizational and marketing practices, the role of cooperation and linkages and the perception of innovation as a system.

Our results show that 56 percent of firms introduced technological or nontechnological innovations. While 38 percent of firms introduced new products, these innovations were generally incremental as the vast majority of innovations were new only to the firm. Six enterprises introduced products that were new to the world (all six are in Sialkot) and 30 enterprises introduced new products to their market.

The innovation rate increases with firm size. Technologically innovative firms spent on average 10 percent of their turnover in 2015 on innovation. Acquiring newer vintages of capital with the aim of introducing new or improved products and processes is the dominant innovation activity. Overall, firms consider market sources their most important source of knowledge spillovers, with large firms pointing to foreign markets (clients and suppliers) and small firms citing local markets as important sources of information and cooperation. Firms appear to be more focused on innovations that promote growth and product outcomes. The lack of available funds within the enterprise was the single most important cost factor hampering innovation, followed by the high cost of innovation.

The economic importance of innovation seems very high, as measured by the percentage share due to innovative products. Our results show that 67 percent of the turnover of product-innovative firms in 2015 resulted from product innovations that were either new to the market or new to the firm.

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Comparing Industrialization in Pakistan and the East Asian Economies

Rajah Rasiah* and Nazia Nazeer**

Abstract

Drawing on the successful industrialization and catch-up experience of the UK, the US, Germany, France, Italy, Sweden and Japan, and later South Korea and Taiwan, we argue that industrialization is a necessary phase for normal economies to stimulate rapid economic growth and structural change. This paper compares Pakistan's industrialization with that of selected economies in East Asia. The evidence shows that Pakistan not only has the lowest GDP per capita of this group, it has also industrialized the least. Pakistan enjoyed its highest manufacturing growth rates in the 1950s and 1960s. Thereafter, manufacturing grew slowly and unevenly until the 1990s and 2006, largely through clothing exports.

While Pakistan has faced deindustrialization since 2006, technology upgrading was never an integral part of its industrial policy. In contrast, the developmental role of the state, with a strong focus on technological catch-up and science-based education, is what propelled South Korea's leading firms to the world's technology frontier. Clientelist pressures compromised a similar role in Malaysia, the Philippines and Indonesia, although foreign-owned firms helped expand their manufactured exports. A structured technology upgrading framework was never part of policy planning in the Philippines, Indonesia and Thailand, while Malaysia's technology upgrading blueprint, launched in 1991, lacked sound execution. Export manufacturing in the Philippines, Indonesia, Thailand and Malaysia through imports of cheap foreign labor has benefited from low wages and foreign direct investment. The comparison offers Pakistan an opportunity to learn from both the more successful and less successful industrializers in East Asia, that it might create the conditions for rapid economic growth and structural change.

Keywords: Industrialization, deindustrialization, industrial policy, technological upgrading, Pakistan.

JEL classification: O14.

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1. Introduction

The East Asian countries' successful transformation from poor to rich and middle-income economies has always attracted policymakers' interest in the rest of Asia, Africa and Latin America (Rasiah, 1998). The successful development models of Singapore and Hong Kong are often removed from such policy lessons, given that they are city-states and inherited strong baseline conditions as entrepots under British colonialism and the gateway to trade with China and Southeast Asia. East Asia has produced the successful models of the Republic of Korea (henceforth referred to as Korea) and Taiwan, which became developed in one generation. Malaysia and Thailand had reached upper middle-income status by the 1990s, while China, Indonesia and the Philippines enjoy middle-income status despite their enormous populations.

Among the East Asian developing economies, China's GDP per capita grew fastest (by 31.9 times), followed by Korea (by 22.2 times) over the period 1960–2015. Thailand, Malaysia and Indonesia's GDP per capita grew by 9.9, 7.5 and 6.4 times, respectively, over the same period. In contrast, Pakistan's GDP per capita grew by only 3.7 times, exceeding that of the Philippines, which expanded by 2.4 times in 1960–2015.

While a wide range of reasons can be found to explain such contrasting growth outcomes, from political leadership to human capital development policy and trade strategies, the nature of structural transformation promoted through institutional change has increasingly gained currency as a key factor in explicating such unequal growth performance among these countries. That the Philippines' GDP per capita growth was smaller than that of Pakistan shows that geography (being located in East Asia) is not a decisive factor in determining why some countries develop faster than others. In searching for answers, it is also critical to assess the type of industrial policy implemented rather than referring to it as a 'black box' in explaining unequal outcomes.

Pakistan and the East Asian economies examined in this paper started to deindustrialize when their share of manufacturing in GDP began to fall. Korea began to deindustrialize after achieving developed status, but its manufacturing productivity continued to grow. China, Indonesia, Malaysia, the Philippines and Thailand began deindustrializing before they had achieved developed status. Since Pakistan has begun experiencing deindustrialization at such an early stage, when the economy is still poor, it is important to compare its industrialization experience with that of the East Asian economies.

This paper seeks to analyze the growth and competitiveness of manufacturing in Pakistan in comparison with selected East Asian economies. Owing to problems of data, we exclude Taiwan from the analysis, although its stellar experience is worth studying. We also exclude Singapore for the reasons cited earlier. Thus, we evaluate the economic growth experience of, and the significance of manufacturing for, Pakistan against that of China, Indonesia, Korea, Malaysia, the Philippines and Thailand.

Section 2 compares the GDP per capita growth rates of these economies, followed by a review of the theoretical considerations that underpin our analysis of their industrialization experience (Section 3). Section 4 analyzes changes in the composition, growth and competitiveness of manufacturing. Section 5 gives a critical account of the policies targeted at promoting industrialization and the technological performance of the high-tech industry of integrated circuits. Section 6 presents the study's conclusions and implications for industrial policy.

2. Growth in GDP per Capita Compared

Pakistan has the lowest GDP per capita of the countries compared at US$1,317 in current prices in 2014 (World Bank, 2015). Korea has the highest GDP per capita at US$27,970, followed by Malaysia in distant second place at US$11,300. The commensurate figures for China, Thailand, Indonesia and the Philippines are US$7,590, US$5,977, US$3,492 and US$2,813, respectively. Pakistan's real GDP per capita grew on average by 2.4 percent per annum over the period 1960–2014, exceeding the commensurate growth rate of 1.6 percent per annum for the Philippines (Table 1). However, the other East Asian economies grew faster than Pakistan. China grew fastest at 6.6 percent per annum on average, although it had the lowest starting base in 1960. Korea had the second highest average GDP per capita growth rate at 5.9 percent per annum. Thailand and Malaysia followed at 4.3 and 3.8 percent per annum, respectively.

Table 1: Annual average GDP/capita growth rates, selected Asian economies

Country	1960–70	1970–80	1980–90	1990–2000	2000–10	2010–14	1960–2014
China	1.8	4.3	7.7	9.3	9.9	7.5	6.6
Indonesia	1.3	5.2	4.2	2.6	3.8	4.3	3.5
Korea	5.9	7.2	8.4	5.6	3.9	2.5	5.9
Malaysia	3.4	5.3	3.1	4.4	2.7	3.8	3.8
Pakistan	4.5	1.6	2.9	1.4	2.1	1.7	2.4
Philippines	1.7	3.0	-1.0	0.5	2.9	4.2	1.6
Thailand	5.0	4.2	6.0	3.3	3.9	2.5	4.3

Source: Authors' calculations based on data from the World Bank (2015).

Yet Pakistan started off well, with an average annual growth rate of 4.5 percent per annum in 1960–70, which was exceeded only by Korea (5.9 percent). The commensurate growth rates of Indonesia, the Philippines and China all fell below 2.0 percent over the same period. Pakistan grew the slowest on average among these economies in 1970–80, 2000–10 and 2010–14 at 1.6, 2.1 and 1.7 percent, respectively, per annum. Its real GDP per capita on average grew faster only than that of the Philippines during 1980–90, 2000–10 and 2010–14.

Comparing Pakistan with the East Asian economies shows that it did better than the Philippines in terms of GDP per capita, but worse than China, Korea, Thailand, Malaysia and Indonesia over the period 1960–2014. Can their diverging GDP per capita growth rates be attributed to their experiences of industrialization? We turn to analyzing the key tenets of the argument that the manufacturing sector's differentiating and increasing returns give countries the potential to stimulate rapid economic growth and structural change (see Smith, 1776; Young, 1928; Kaldor, 1967).

3. Theoretical Considerations

Industrial policy has a long history: the first such policy is considered to have originated accidentally in Britain in the 15th century (Reinert, 2007). Early efforts to define industrial policy referred to it as a policy or set of policies targeted at expanding industry in general, and manufacturing in particular, with a focus on the shares of value-added and employment in the economy (Kaldor, 1967). Given the rapid expansion of automation in all manufacturing industries and its impact on reducing employment, we focus on the share of value-added rather than that of employment as a measure of industrialization and deindustrialization.

While structural economists such as Young (1928) and Kaldor (1967) focus on the differentiating characteristics of industrialization and its impact on the division of labor and economic expansion, they do not specifically analyze technological deepening. Chenery, Robinson and Syrquin (1986) attempt to do this, but confine their analysis to categorizations by capital goods, consumer durables, intermediate goods and raw materials. Lall, Weiss and Zhang (2006) subsequently use the classifications of high-tech, medium-tech and low-tech industries to address the sophistication of countries' economic structure. This became the basis of UNIDO's competitive industrial performance (CIP) index. However, these classifications do not address innovation and technology directly.

Past accounts show that a wide range of industrial policies, both explicit and implicit, were introduced to stimulate economic growth in the East Asian economies. China, Korea, Malaysia and the Philippines had explicit industrial policies targeted at stimulating particular manufacturing industries. Korea and Malaysia even targeted champions selected for state-led promotion, such as Samsung, Hyundai, Daewoo and POSCO in Korea (Amsden, 1989) and Proton and Perwaja in Malaysia (Jomo, 1990). The Philippines launched the 'People's car' in the 1960s (Ofreneo, 2016). Thailand and Indonesia had trade and investment policies targeted at stimulating manufacturing, but without any handpicked firms for specific support (Rasiah, 2009).

The differential outcomes of industrial policy among the East Asian economies suggest that specificities are important and particular strategies are key as to when industrial policy will work. This is all the more so when we consider that Pakistan has grown faster than the Philippines over the period 1960–2014. Thus, we examine the extant literature below to identify key signposts in analyzing industrial policy against its impact on economic and manufacturing growth.

The transformation of production into different stages and the evolution of embodied knowledge in which innovation depth transcends the nature and type of goods and services means that it no longer matters whether countries experience structural transformation by specializing in consumer, intermediate to capital goods. For example, Taiwan and Singapore show greater specialization in components and intermediate goods than Malaysia, but the former two are technologically superior to the latter, as reflected in their respective value-added activities. Hence, a successful industrial policy should be viewed as an exercise that stimulates sustainable economic transformation from low- to high-value-added activities in targeted as well as other industries in the economy. Technological change is the fuel that powers upgrading in value-added.

Marx (1957), Veblen (1915) and Schumpeter (1942, 1961) laid the foundation for a real assessment of technology by unbundling the 'black box' (Rosenberg, 1975, 1982). This led to a plethora of work defining technological capability (see, for instance, Dahlman, 1984; Pavitt, 1984; Lall, 1992). While technology and technological capabilities were the prime focus of these scholars, manufacturing became a key platform for stimulating productivity through learning and innovation in process, product and organizational technologies (Rasiah, 2002, 2004). The catch-up literature, which has its historical origins in Marx (1957) and Luxembourg's (1967) notion of capitalist integration and accumulation, was expanded by Veblen (1915), Gerschenkron (1962) and Abramowitz (1956). These works gave rise to the developmental function of the state, which goes beyond a regulatory role.

The empirical foundations of the developmental state, articulating the active role of the government in stimulating industrial structural change, can be found in works explaining industrial catch-up by Japan, Korea and Taiwan (see Johnson, 1982; Amsden, 1989; Wade, 1990). However, while Amsden (1989), Amsden and Chu (2003), Chang (1994) and Kim (1997) provide explicit accounts of catch-up in particular industries, Johnson (1982) and Wade (1990) give no empirical evidence on innovation and technology against the particular industrial policies pursued by Japan and Taiwan, respectively. Hence, there is a need to reinvestigate this topic. In doing so, we attempt to compare a range of countries, with Korea being clearly successful while Pakistan and the Philippines were the least successful.

4. Industrialization Experience: Pakistan and East Asia

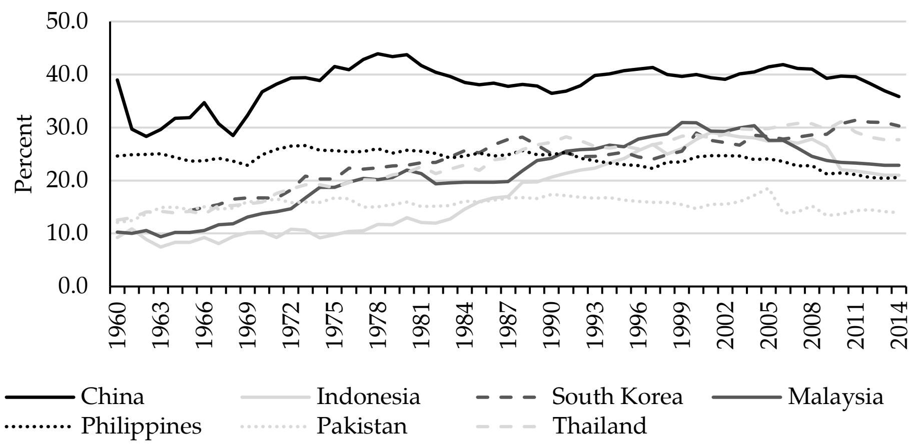
This section analyzes the importance of manufacturing in the economic growth of Pakistan and selected East Asian economies. We avoid using labor productivity and total productivity in this assessment because of measurement problems. The first can be biased by a productivity-less transition from labor- to capital-intensive technologies in production, while the second does not take account of learning and gestation periods and flows of disembodied systemic knowledge from abroad (Rasiah, 2015). Also, total factor productivity accounts poorly for technology embodied in machinery and equipment, humans and organizational structures. Thus, we use simpler measures such as the manufacturing share of GDP, growth in manufacturing value-added (MVA), manufactured export specialization, CIP and patents filed in the US in the high-tech integrated circuit (IC) industry.

4.1 Manufacturing Share of GDP

Since 1987, Pakistan has had the lowest share of manufacturing in GDP among the economies shown in Figure 1. Apart from a brief rise in 2004/05, the contribution of manufacturing to GDP has either declined or stagnated. Indeed, Pakistan's manufacturing sector had its highest share of GDP at 18.6 percent in 2005. Its share of GDP over long spells during 1960–2014 was, however, less than 10 percent.

Pakistan's industrial experience contrasts sharply with that of a number of East Asian economies. For example, manufacturing as a share of GDP in Korea peaked at 31.4 percent in 2011 before falling to 30.3 percent in 2014. The commensurate share of manufacturing in GDP for China peaked at 40.4 percent in 1978 – the year that economic reforms were introduced – before falling gradually to 30.1 percent in 2013. Thailand's manufacturing share of GDP rose to 30.7 percent in 2007/08 before falling to 27.7 percent in 2013/14. Malaysia's manufacturing share of GDP was highest in 1999/2000 at 30.9 percent before falling to 22.9 percent in 2014. For Indonesia, it peaked at 29.1 percent in 2001 before falling to 21.0 percent in 2014. Although the Philippines has performed more dismally than Pakistan, its manufacturing share of GDP was relatively high at 24.6 percent in 1960, peaking at 26.6 percent in 1973. Since then, it has fallen in trend terms to 20.6 percent in 2014.

Figure 1: Share of manufacturing in GDP, selected Asian economies



Source: Authors' calculations based on data from the World Bank (2015).

4.2 Manufacturing Growth

Pakistan's manufacturing sector recorded a real average growth rate of 6.6 percent per annum over the period 1960–2014 (Table 2), which is higher than the commensurate growth rate achieved by the Philippines (4.1 percent).

Table 2: Annual average % growth in MVA, selected Asian economies

Country	1960–70	1970–80	1980–90	1990–2000	2000–14	1960–2014*
China	–	–	9.6	13.9	10.5	11.2
Indonesia	4.6	14.0	12.2	6.6	4.7	8.1
Korea	23.2	16.2	11.9	8.1	5.8	12.1
Malaysia	–	11.6	9.8	9.9	4.0	5.7
Pakistan	9.9	5.4	8.2	3.8	5.9	6.6
Philippines	5.8	6.1	0.9	2.6	4.7	4.1
Thailand	11.6	10.1	9.9	6.8	4.1	8.1

Note: * 1980–2014 for China, 1970–2014 for Malaysia.
Source: Authors' calculations based on data from the World Bank (2015).

Malaysia experienced real annual average manufacturing growth of 5.7 percent over the period 1970–2014. Korea (12.1 percent) had the highest growth rate, followed by China (11.2 percent over the period 1980–2014), Thailand (8.1 percent) and Indonesia (8.1 percent). Only during 1960–70 (under the Ayub Khan government, which promoted the growth of industrial capitalists) did Pakistan's manufacturing growth reach almost 10 percent per annum on average, exceeding the growth rates of Indonesia and the Philippines.

4.3 Composition of Manufacturing

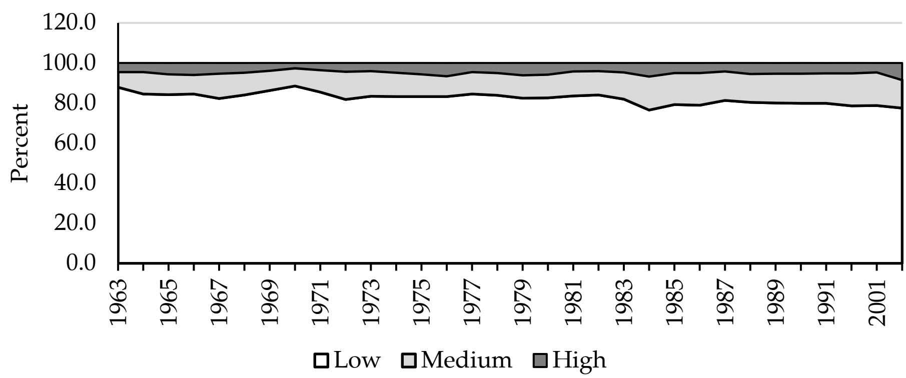
Changes in the composition of manufacturing by industrial sophistication of exports is another measure of industrial performance (see Lall, 1992). While the concept of industrial sophistication advanced by Lall has its flaws (the 4-digit standard classification does not differentiate products by value-added segments), we use it with some modifications in this exercise. We include 'other manufacturing', which consists of a small share of professional goods in the low-tech category, and transport equipment in the high tech category, owing to the increased sophistication of the industry. We do not expect the adjustment to change the results much as professional goods account for less than 5 percent of the 'other manufacturing' category, while the assembly of transport equipment is more sophisticated than the assembly of printed circuit boards in the electronics industry (which Lall classifies as a high-tech industry).

Figures 2–8 illustrate the degree of MVA specialization in Pakistan and selected East Asian economies. Indonesia shows the strongest specialization in low-tech industries in 1970, accounting for 92.6 percent of MVA compared to 88.7 percent for Pakistan. The other economies are not significantly different: low-tech industries dominate MVA in Korea (82.4 percent), Malaysia (85.9 percent), the Philippines (82.9 percent) and Thailand (72.0 percent) in 1970. Low-technology industries also dominate China's MVA in 1980 at 71.8 percent.

Pakistan's MVA composition has changed very little over the period 1963–2006 (Figure 2). The low-technology industries of textiles and clothing; foods, beverages and tobacco; and wood, paper, furniture and nonmetal products still accounted for 77.5 percent of MVA in 2006. Indeed, cotton-based textiles and clothing dominate Pakistan's exports (Rasiah & Nazeer, 2015). The shares of medium-tech and high-tech industries reach only 14.0 and 8.5 percent, respectively, of MVA.

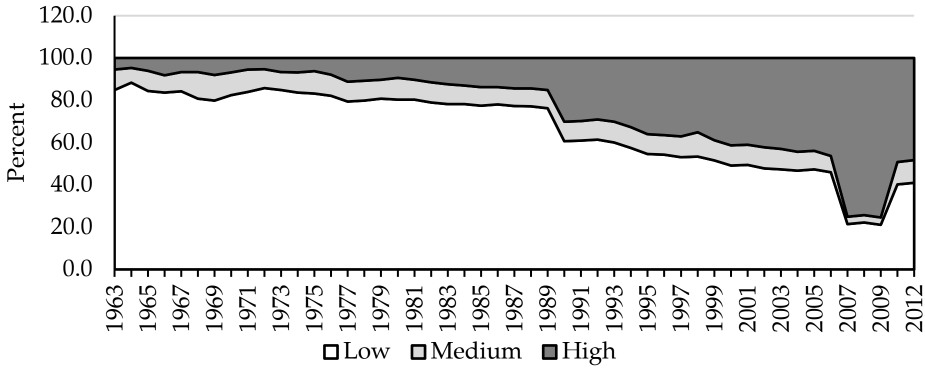
In contrast, high-technology industries grew rapidly to become the leading contributor to Korea's MVA, peaking at 75.4 percent in 2009 before falling to 48.3 percent in 2012 (Figure 3). China (62.1 percent in 2009), Indonesia (66.0 percent in 2011), Malaysia (60.2 percent in 2012), the Philippines (62.1 percent in 2010) and Thailand (63.8 percent in 2011) were also doing better than Pakistan by the turn of the millennium, their specialization in low-technology industries having fallen faster than that of Pakistan (Figures 4–8).

Figure 2: Composition of MVA, Pakistan, 1963–2006



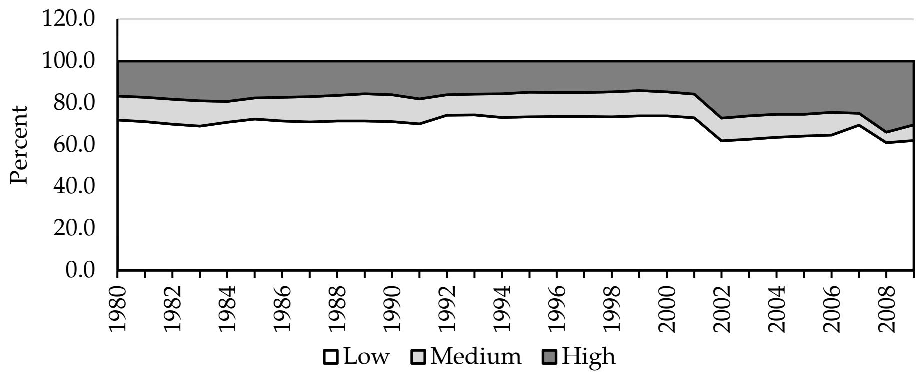
Source: Authors' calculations based on data from the World Bank (2015).

Figure 3: Composition of MVA, Korea, 1963–2012



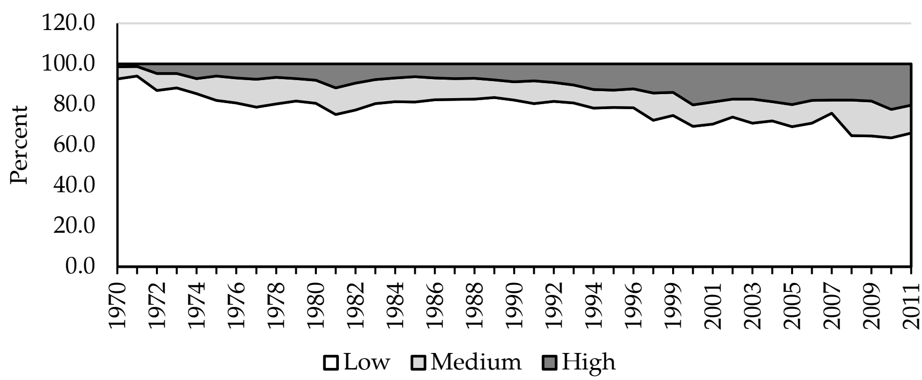
Source: Authors' calculations based on data from the World Bank (2015).

Figure 4: Composition of MVA, China, 1980–2009



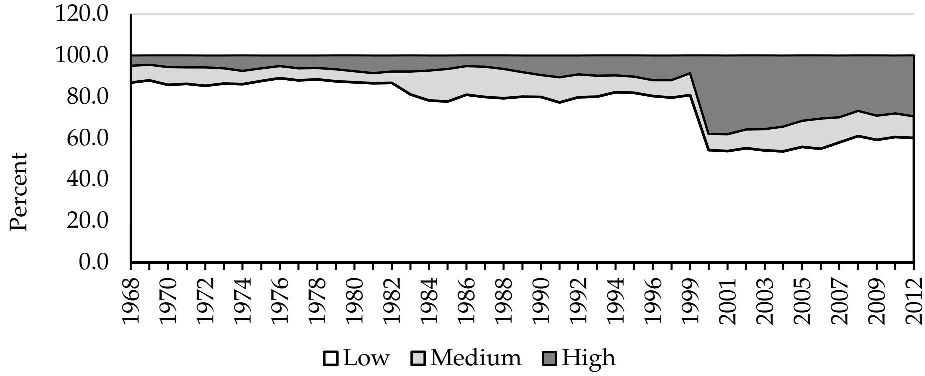
Source: Authors' calculations based on data from the World Bank (2015).

Figure 5: Composition of MVA, Indonesia, 1963–2011



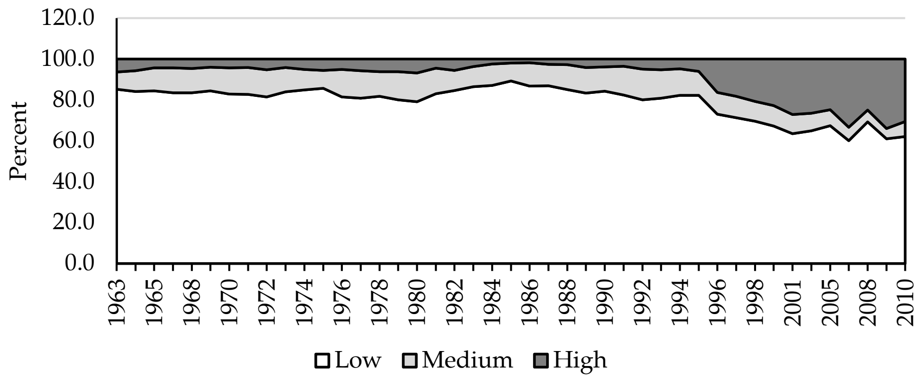
Source: Authors' calculations based on data from the World Bank (2015).

Figure 6: Composition of MVA, Malaysia, 1963–2012



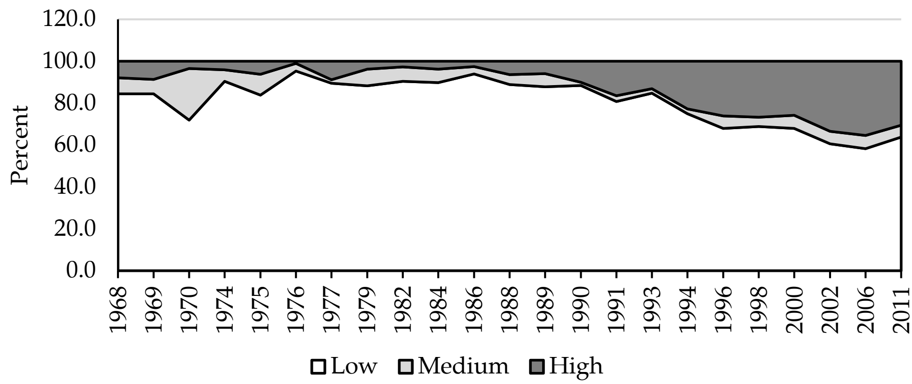
Source: Authors' calculations based on data from the World Bank (2015).

Figure 7: Composition of MVA, the Philippines, 1963–2010



Source: Authors' calculations based on data from the World Bank (2015).

Figure 8: Composition of MVA, Thailand, 1963–2011



Source: Authors' calculations based on data from the World Bank (2015).

In addition, Pakistan had the smallest share of high-tech industries in 2006, accounting for only 8.5 percent of MVA. In contrast, high-tech industries had a far higher share of MVA in China (30.5 percent in 2009), Indonesia (20.4 percent in 2011), Korea (48.3 percent in 2012), Malaysia (29.4 percent in 2012), the Philippines (30.5 percent in 2010) and Thailand (30.5 percent in 2011). Korea has the most sophisticated high-tech industry by far, with extensive research and development (R&D) operations and specialization in high-value-added segments of the industry (Rasiah, Yap & Yap, 2015).

Not only is Korea powered strongly by high-technology industries, its national firms also lead several of the world's high-tech industries, e.g., Samsung in electronics, POSCO in steel manufacturing and Daewoo in shipbuilding (Chang, 1994). With the exception of Korea, MVA in the remaining countries examined is dominated by low-tech industries. In contrast, Pakistan's manufacturing shows the highest concentration of low-technology industries. Its chief exports, cotton fiber, textiles and clothing, are still exported largely to higher-value-added downstream producers abroad or using foreign brand names (Rasiah & Nazeer, 2015).

4.4 Competitiveness of Manufacturing

We use UNIDO's CIP index to analyze the competitiveness of manufactured exports in Pakistan and the selected East Asian countries. This measure was first used by UNIDO to benchmark and rank countries' industrial competitiveness in 2003. It has since evolved, with eight indicators grouped through three subcategories (UNIDO, 2013, p. xv). The first subcategory assesses a country's capacity to produce and export manufactures and is measured by MVA per capita and manufactured exports per capita. The second subcategory indicates levels of technological deepening and upgrading and is measured by industrialization intensity and export quality. The third subcategory assesses a country's impact on world manufacturing and is measured using proxies for its share of MVA in world MVA and of manufacturing trade in world manufacturing trade.

Table 3 gives the CIP index, MVA per capita and manufactured exports per capita (MX/capita) for the sample. With a CIP score of 0.032, Pakistan was ranked at 74 in the world in 2010, far below all the East Asian economies examined in this paper. Korea was ranked fourth, with a CIP score of 0.404. Taiwan and Singapore were ranked just below Korea in fifth and sixth place, respectively, followed by China in seventh place. Malaysia, Thailand, Indonesia and the Philippines were ranked at 21, 23, 38 and 44, respectively.

Table 3: CIP of selected Asian countries, 2010

Country	CIP	MVA/capita	MX/capita
China	0.3293 (7)	820.0	1,123.6
Indonesia	0.0823 (38)	302.3	395.7
Korea	0.4044 (4)	4,782.7	9,280.3
Malaysia	0.1834 (21)	1,426.9	5,930.9
Pakistan	0.0315 (74)	116.9	99.8
Philippines	0.0726 (44)	296.0	516.6
Singapore	0.3456 (6)	8,198.3	35,709.1
Thailand	0.1712 (23)	1,053.7	2,517.2
Taiwan	0.3649 (5)	6,153.1	10,825.2

Source: UNIDO (2013).

Pakistan also shows the least industrialization intensity among the countries compared: its per capita MVA and manufacturing exports were only US$117 and US$100, respectively, in 2010. With its small population, Singapore had the highest figures (US$8,198 and US$35,709, respectively), followed by Taiwan (US$6,153 and US$10,825, respectively). Korea had the next highest, at US$4,783 and 9,280, respectively, followed by Malaysia with US$1,427 and 5,931, respectively.

4.5 Technological Upgrading in IC Manufacturing

We focus on the state of technology in East Asia's leading high-tech manufactured export, ICs, to augment our analysis. Pakistan does not export ICs, which are a key component of all electronics (and many other) goods. China, Indonesia, Korea, Malaysia, the Philippines and Thailand accounted for 17.2, 0.1, 10.5, 7.2, 2.8 and 1.6 percent of world exports of ICs in 2014 (World Trade Organization, 2015). Taken together, these six countries contributed 39.2 percent of world IC exports in 2014.

Using the number of patents filed in the US as a proxy for the state of technological upgrading in the industry over the period 1981–2011, we can see that the contrast in technological depth among these countries is sharper than that of export shares. As shown in Table 4, Korea dominates the filing of patents, followed by Taiwan, Singapore, China and Malaysia. The presence of foreign firms makes the Philippines the next highest patent taker. No patents were filed from Indonesia, while the number filed from Thailand is very small, which shows that firms in these countries participate little in R&D operations (see also Rasiah et al., 2015).

Table 4: Patents filed in the US, selected Asian economies

	1981–85		1986–90		1991–95		1996–2000		2001–05		2006–11	
Country	**N**	**F**	**N**	**F**	**N**	**F**	**N**	**F**	**N**	**F**	**N**	**F**
China	0	0	0	0	0	3	0	27	11	52	177	436
Indonesia	0	0	0	0	0	0	0	0	0	0	0	0
Malaysia	0	0	0	0	0	1	0	5	4	39	3	270
Philippines	0	0	0	0	0	0	0	5	0	40	0	70
Singapore	0	0	0	1	0	14	0	36	4	216	290	545
Korea	1	0	103	2	1,526	1	5,095	11	8,049	139	25,014	409
Taiwan	0	0	2	0	278	5	3,063	124	4,826	43	5,223	107
Thailand	0	0	0	0	0	0	0	3	0	4*	0	3

Source: Available from http://www.gartner.com/technology/home.jsp

Although their performance is markedly unequal, the evidence generally shows that the industrial experience of Korea, China, Malaysia, Thailand, Indonesia and the Philippines was superior to that of Pakistan. Their performance record was strongly influenced by their specialization in export manufacturing as well as the shift from low- to high-tech industries. However, the differential outcomes for these countries also show that their industrialization experience was different: Korea experienced the strongest transition from specializing in low- to high-tech industries while Pakistan and the Philippines were the least successful. It is thus important that the institutional frameworks shaping industrialization in each country are examined in detail to explain these differences (Section 5).

5. Implications for Industrial Policy

In this section, we discuss the particular policies introduced, or the absence thereof, by Pakistan and the selected East Asian governments to promote industrialization against the nature of deindustrialization that has, in each case, set in. Korea, the Philippines and Malaysia introduced explicit industrial policies, while Pakistan, Thailand and Indonesia introduced specific measures from time to time to stimulate investment in manufacturing.

5.1 Pakistan

Burki (2008, p. 28) traces five industrial policies implemented through five-year development plans in Pakistan. The Ayub Khan government played something of a developmental role till the late 1960s, offering liberal imports of raw material and intermediate products as well as protection for agriculture and industry (Haque, 2015, p. 95). Indeed, as shown in Tables 1 and 2, Pakistan's highest growth in GDP per capita and manufacturing was in the 1960s. As Naseemullah and Arnold (2015, p. 10) note, an industrial class was also created during this period. Subsequent efforts to dismantle economic concentration since the late 1970s, followed by the deregulation of the economy in the 1980s, have undermined Pakistan's capacity to promote industrial widening and deepening.

Premature deindustrialization became inevitable once liberalization began to dominate economic policy in Pakistan in the 1980s (Hamid, Nabi & Zafar, 2014; Hamid & Khan, 2015). However, the industrial policy that emerged in the 1950s and 1960s, and subsequent efforts to nationalize industry under the Bhutto government, did not demonstrate the use of technological catch-up policies. Industrial focus was largely on import substitution. Export manufacturing a la Southeast Asia – by stimulating the relocation of giant foreign multinationals (Rasiah, 2009) or supporting national firms through technology acquisition from abroad and learning and domestic R&D as in Korea and Taiwan (Amsden, 1989; Wade, 1990; Kim, 1997) – did not take off.

Not only did Pakistan become politically vulnerable when Zia-ul-Haq's military government took power in 1978, the country also lacked any system of incentives to attract foreign firms or to promote national firms. Liberalization fueled massive imports and the high exchange rate of the Pakistani rupee brought in the effects of 'Dutch disease', squeezing the manufacturing sector further (Corden & Neary, 1982). Hence, despite being endowed with some of the best raw materials in cotton and a highly educated diaspora, the lack of a technology policy left Pakistan primarily an exporter of cotton and low-value-added clothing and textiles, and an importer of high-value-added, finished clothing.

5.2 Korea

Korea has had an active industrial policy since the late 1960s when Park Chung Hee took power. Going against the grain of comparative advantage, the government launched heavy and technology-intensive industries in the late 1960s. Family firms were merged to create chaebols that sought to produce a wide range of goods as conglomerates (Jones & SaKong, 1980). While export-processing zones were also created (e.g., Masan and Inchon), government policy was targeted at spawning national firms (Amsden, 1989).

Fashioning this promotion after Japanese history, Park's government offered subsidized credit and protection in the domestic market to national firms such as Samsung, Hyundai, Daewoo and the originally state-owned Posco in a range of industries (electronics, iron and steel, automobiles, ships) (Chang, 1994). While these rents were given to targeted firms, the government also imposed performance standards in the form of export quotas, with severe penalties for abusers (Amsden, 1989). Nonperformers were quickly removed from the subsidies. While trade and financial coordination were important (implemented through quotas and tariffs, and subsidized interest rates for targeted firms), technological catch-up became the vehicle for upgrading and expanding the manufacturing sector in Korea (Kim, 1997). The won was fixed against the US dollar and banks were government-owned till 1985.

Human capital development became a major thrust of technological catch-up. On the one hand, the government invested heavily to widen and deepen the supply of science and technology-based human capital (Vogel, 1991). On the other hand, large outflows of students seeking science-based education in the West generated experiential knowledge gained from studying at the best research universities and working at frontier firms. They either returned in large numbers or participated in knowledge flows to stimulate technological-catch up (Saxenian, 2006). The government also supported initiatives by Korean firms to acquire technologically superior firms in order to move up the value chain. For example, Samsung purchased Schlumberger, Zilog and Micron Technology to accelerate its catch-up in memories (Edquist & Jacobsson, 1987).

Starting from the Park dictatorship, the Korean state has enjoyed autonomous power and been able to stave off any attempt to capture it. This autonomy allowed the government to play a developmental role (see Jessop, 1989; Skocpol, 1994, 1995). The stiff application of what Chakravarty (1987) and Sen (1983) call the 'carrots-and-sticks approach' spearheaded technological catch-up by Korean firms. Hence, national firms such as Samsung, Hyundai, Posco and Daewoo have evolved either as leaders in shaping the world technology frontier or been solely responsible for doing so in their respective industries (Mathews & Cho, 2000). This exercise has not only resulted in Korea's manufacturing sector being dominated by high-tech industries, but it has also driven rapid upgrading from low- to high-value-added activities. This is the primary reason that Korea was able to move from being a poor country in the 1960s to a developed country by the late 1980s.

5.3 Malaysia and the Philippines

The Philippines and Malaysia launched industrial policies in the 1950s through import substitution, but without any focus on stimulating technological upgrading. Both countries had enjoyed free trade practices under the American and British spheres of influence prior to the introduction of import-substitution industrialization.

Following the Bell Trade Act of 1946, American goods entered the Philippines without any trade restrictions until 1954 (Hutchcroft, 1989, p. 42). British goods could also enter colonial Malaya and, since 1957, independent Malaysia without trade restrictions until the enactment of the Pioneer Industry Ordinance (PIO) in 1958 (Rasiah, 1993). Industrial policy emerged in the Philippines in the mid-1950s to check the balance-of-payments crisis arising from massive imports from the US. Similarly, in Malaysia, the PIO came into effect because of very large imports of manufactured goods against volatile price fluctuations in rubber and tin exports (Edwards & Jomo, 1993).

While sugar processing, clothes manufacturing and car assembly were protected to control the domestic markets, the national oligarchies that owned these enterprises exerted strong clientelist power over the state in the Philippines. It was from this policy regime that the government launched the 'People's car' (Ofreneo, 2016). Foreign ventures that had previously imported consumer goods relocated their final assembly and processing to circumvent tariffs in Malaysia. However, until 1971, apart from imposing tariffs and quotas on final goods, the governments in both countries offered manufacturing firms liberal import policies on raw materials and intermediate goods.

The Philippines and Malaysia introduced export-processing zones in the early 1970s by attracting giant multinationals to manufacture for export, using imported inputs. However, both import substitution and export orientation coexisted in these countries. Apart from the Marcos regime of the 1970s and early 1980s, when the Communist rebellion threatened to undermine foreign manufacturing activities in the Philippines, foreign multinationals dominated manufactured exports in both countries.

While both countries introduced a range of incentives and offered excellent basic infrastructure (at least in the export-processing zones) to attract foreign direct investment, they had no strategy in place to stimulate technological upgrading for several decades. Malaysia attempted to do so in

1991, but lacked a policy framework to promote technological catch-up. Strategic industries were identified and lubricated with financial incentives and grants, but no roadmap taking account of appraisal was implemented. Hence, manufactured exports in these countries have remained primarily in low-value-added assembly and processing segments.

As Rasiah (2011, 2012) argues, clientelist pressures[1] have denied the state an effective developmental role in both countries. Malaysia has done better than the Philippines only because of attempts in 1991 to stimulate upgrading and resource endowments that have generated foreign exchange from oil and gas exports and oil palm processing. The institutions introduced and organizations set up from then on,[2] the corporatization of the Malaysian Institute of Microelectronics Systems, the creation of science and technology parks and the provision of R&D grants have all lacked effective selection, monitoring and appraisal of state-promoted industrial enterprises (Rasiah, 1999). Following the acceptance of structural adjustment packages by the Philippines since the mid-1980s, no active industrial policy has re-emerged in the country (Ofreneo, 2016).

5.4 Thailand and Indonesia

Thailand and Indonesia introduced import substitution policies in the 1950s, 1960s and 1970s, and continued these even when export-oriented manufacturing was promoted strongly in the 1980s and 1990s, respectively. Localization policies, especially in automobile assembly (based on components sourced domestically), and joint ventures were the norm in Indonesia until 2000.

Batam has enjoyed exemption from national ownership conditions since the 1990s when Indonesia joined Singapore and Malaysia to form the Singapore, Johore and Rhiau (SIJORI) growth triangle, which was announced in 1989 but formalized in 1994 (Rasiah, 2007). The Batam export-processing zone was even leased to Temasik Holdings of Singapore to handle its development and coordination of investment and manufacturing. However, Thailand abandoned its localization policies in the late 1980s to attract foreign automobile assemblers, while Indonesia was forced to abandon its protectionist policies following the collapse of the Suharto government in 1999 in the wake of the Asian financial crisis.

[1] In Malaysia, from the politically powerful component party, the United Malays National Organization of the National Front ruling coalition; in the Philippines, from its powerful landlords.

[2] Including the Human Resource Development Council, the Malaysian Technology Development Corporation, the Multimedia Super Corridor, the Malaysian–Industry Government High Technology Group and the Multimedia Development Corporation.

Low-end clothing, electronics, wood processing and automotive components dominate manufactured exports in these countries. Foreign ownership dominates electronics exports and automotive component exports in both countries. Thailand has also become Southeast Asia's primary export base for automobiles. National supplier firms, including the joint ventures that originally emerged under the localization policies, have managed to sustain component sales to foreign multinationals.

However, industrial specialization in both countries has been confined to low-value-added activities. Initiatives by firms – both national suppliers and foreign lead firms – to forge innovation ties with universities and organizations engaged in training and R&D have emerged in Thailand and Indonesia since 2000 (Intarakumnerd & Chaoroenporn, 2013; Intarakumnerd, Chairatana & Chaiyanajit, 2016; Rasiah, Shahrivar & Amin, 2016). Unless both governments introduce a focused policy to stimulate upgrading, using an effective selection, monitoring and appraisal strategy, such pockets of innovation and dynamism are unlikely to translate into upgrading on a national scale.

It is clear that the developmental role played by the Korean government was instrumental in turning a poor country into a developed one by focusing on technological catch-up in manufacturing activities. Its scarce resources and heavy emphasis on science-based education propelled the country's leading firms to the world's technology frontier. On the other hand, clientelist pressures have compromised such a role in Malaysia and the Philippines.

A clearly structured technology upgrading framework was never part of government planning in the Philippines, Indonesia and Thailand. While Malaysia launched a framework to stimulate upgrading in 1991, its execution fell short as the developmental role required to implement the policy was compromised by political interests. Pakistan's industrial policy of the 1960s was very similar to what the Philippines and Malaysia had in place in the 1950s, which focused on protection without an emphasis on technological upgrading. Subsequently, industrial policy was abandoned altogether in the 1980s, which explains the industrial stagnation that set in.

6. Conclusion

Of the countries examined, the evidence shows that Pakistan not only has the lowest per capita GDP income, but it has also industrialized the least. Pakistan enjoyed its highest manufacturing growth in the 1950s and

1960s, but this was not driven by instruments to promote technological upgrading. Thereafter, manufacturing gradually stagnated, with its share of GDP increasingly slightly in the 1990s until 2006; this is accounted for largely by clothes manufacturing.

The developmental role played by the state to varying degrees was instrumental in stimulating economic growth in South Korea, Malaysia, Thailand, the Philippines and Indonesia. South Korea, in particular, became developed in one generation through successful technological catch-up. Its scarce resources and strong emphasis on science-based education propelled the country's leading firms to the world's technology frontier.

Clientelist pressures compromised such a forceful role in Malaysia, the Philippines, Indonesia and Thailand, although foreign-owned firms helped expand their manufactured exports. A clear technology upgrading policy was never part of government planning in Indonesia, the Philippines and Thailand, although all three countries made an effort to stimulate heavy industry. While Malaysia launched a blueprint to stimulate upgrading in 1991, its execution fell short as the developmental role required to implement the policy was compromised by political interests. Export manufacturing in the Philippines, Indonesia, Thailand and Malaysia, through imports of cheap foreign labor, has benefited from low wages and foreign direct investment.

For Pakistan, the lesson to draw from East Asia is not to imitate the successful model of South Korea or the less successful examples of Indonesia, Malaysia, the Philippines and Thailand. Instead, Pakistan's industrialization will have to focus on technological catch-up in industries that have already evolved, but also in industries that complement existing economic activities, such as machinery and equipment, information and communication technology and biotechnology. Learning from both the more successful and less successful examples could help Pakistan adapt and adopt frontier technologies to fuel its industrialization. Government focus should be on institutional change so that there is vetting, monitoring and appraisal of the incentives system that has evolved to stimulate industrialization and technological catch-up in the country.

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Correlates of Entrepreneurship in Pakistan: The Regional Dimension

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Abstract

This study analyzes entrepreneurial ability in Pakistan through a cross-sectional comparison of provinces and districts based on data from the Global Entrepreneurship Monitor for 2010–12. The aim is twofold: to (i) identify individual and country-level factors that affect nascent and potential entrepreneurs and (ii) see how regional income levels and the degree of development affect entrepreneurship (of both the opportunity and necessity varieties), eventually contributing to innovation and economic growth. We investigate the effect of total early-stage entrepreneurial activity on entrepreneurial framework conditions at the regional level and then evaluate the impact of education, age, gender and entrepreneurial ability on potential entrepreneurs, nascent entrepreneurs and baby business owners to examine the entrepreneurial startup process.

Keywords: Entrepreneurship, income, development, regional, Pakistan.

JEL classification: L26, O10.

1. Introduction

According to the Solow model (and many others), a country's economic growth depends on its technology and investment in innovation. This requires investing regularly in research and development (R&D), with individuals who are willing to take on the associated risk of business ventures that may or may not succeed. Young entrepreneurs play an important role in this context because they are thought more likely to invest time and capital in business ventures that evolve around new technology.

According to the World Bank (2016, p. 225), Pakistan's ranking in terms of the capacity for starting new businesses has fallen from 114 in 2015 to 122 as of 2016. This may be due to the poor credit environment, political instability or lack of initiative. Aldrich and Martínez (2001) explain that, while anyone can start a business, not everyone can make a success of

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it. The empirical literature identifies two types of entrepreneurs: necessity and opportunity entrepreneurs. Opportunity entrepreneurs tend to be hardworking, growth-oriented and more successful with regard to survival and profitability. Opportunity entrepreneurs are ambitious and focus on innovation and creativity.[1]

While there is a vast body of empirical research on entrepreneurial activity and empirical support for the entrepreneurial startup process in developed countries, few studies have looked at Pakistan in this context. This paper uses data from the Global Entrepreneurship Monitor (GEM) for 2010–12 to establish relationships between total early-stage entrepreneurial activity (TEEA) and economic framework conditions (EFCs) as well as between cultural and individual factors and the birth ratio and conception ratio with regard to entrepreneurial activity.

Section 2 provides a brief introduction to the GEM data. Section 3 introduces the key concepts and empirical research in this field. Section 4 presents the data for analysis. The results are discussed in Section 5. Section 6 compares the TEEA rate and EFCs for 2010, 2011 and 2012 based on the GEM data. Section 7 concludes the paper with a set of recommendations.

2. Global Entrepreneurship Monitor Data

Over the past decade, there has been a marked shift from managerial to entrepreneurial capitalism. Various studies underscore the positive effects of entrepreneurship on economic growth. To support entrepreneurial capitalism, many countries have adapted their public policies to incorporate easier business formation, access to finance, protection of intellectual property rights and fair tax policies (Acs & Szerb, 2007). However, according to the GEM data, there is a U-shaped relationship between entrepreneurship and the level of development. In addition, for high-income countries, entrepreneurship has a positive impact on growth, while the opposite is true for low-income countries (Sternberg and Wennekers, 2005).

Sternberg and Wennekers (2005) discuss the findings of the GEM conference and conclude that the impact of entrepreneurship differs along the stages of development. Despite the U-shaped relationship between entrepreneurship and economic development, low-income countries can still benefit from the prevalence of multinationals and

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[1] See, for instance, Giacomin et al. (2011); Verheul et al. (2010); Block and Sandner (2009); Hechavarria and Reynolds (2009); McMullen, Bagby and Palich (2008); Hessels, van Gelderen and Thurik (2008); Morris et al. (2006).

foreign direct investment through positive spillover effects, while high-income countries should opt for policies that encourage small business startups as high-growth startups and opportunity entrepreneurship lead to knowledge spillovers. However, in devising policies to encourage startup firms and businesses, policymakers should consider the regional framework conditions.

There are three stages of economic development: the factor-driven stage, the efficiency-driven stage and the innovation-driven stage. The GEM studies reveal that countries at the innovation-driven stage can enhance entrepreneurship by focusing on entrepreneurship education and training, while those at the factor-driven stage should work on moving to the efficiency-driven stage by focusing on their institutions and increasing entrepreneurial capacity (Acs, Desai & Hessels, 2008).

Wong, Ho and Autio (2005) show that entrepreneurship is not just driven by new firms, but also by innovative and imitative entry of existing firms into new markets. This is based on the Schumpeterian principle of the 'entrepreneur as innovator'. Entrepreneurship on its own does not affect economic growth as much as the prevalence of fast-growing, innovative new firms. Higher levels of technological innovation lead to higher growth rates, but the GEM studies reveal that this is true only for a few countries. At the national level, innovation and new business creation can be treated as two separate phenomena.

3. Literature Review

The concept of nascent entrepreneurs has garnered increasing interest as researchers try to establish its relationship with education, age, entrepreneurial ability and economic conditions. According to Davidsson (2006), "nascent entrepreneurs" and "nascent ventures" are associated terms. There is also increasing focus on the relationship between entrepreneurship and the startup and gestation processes. Giacomin et al. (2011) show that the two types of entrepreneurs (necessity and opportunity entrepreneurs) differ in their progression from idea conception to business creation and growth.

The empirical literature on entrepreneurship focuses on the factors behind starting a new business, which influence entrepreneurial activity and economic development. Reynolds et al. (2000, 2001, 2002, 2004) state that these factors or EFCs drive TEEA, although other noneconomic conditions – government policy, education and experience, cultural and social factors and age – may also play a role. Business survival and growth is closely related to the gestation process.[2] The motivation resulting from both positive and negative circumstances can lead to different gestation processes, which act as a catalyst for necessity and opportunity entrepreneurs (Bhola et al., 2006; Shapero & Sokol, 1982). This stimulus comes from the underlying cultural and social characteristics.

There is strong evidence that deep-rooted cultural factors affect the conception of new businesses (Hayton, George & Zahra, 2002; Inglehart & Baker, 2000). Job dissatisfaction and the employment uncertainty related to political and social change are associated with higher self-employment (Noorderhaven et al., 2004). Materialism also acts as a catalyst for business startups. According to Uhlaner and Thurik (2007), societies with lower materialistic values tend to have lower levels of entrepreneurial activity.

Age and education are also key drivers of entrepreneurial activity. One strand of the literature states that, as individuals grow older, they are less likely to start a new business because they have become more risk-averse with age and prefer stability (Henley, 2007; Grilo & Irigoyen, 2006). The other strand of the literature argues that older individuals have more professional experience, networks and accumulated financial capital, which encourages self-employment. Age may be associated with a better working knowledge of the industry and better business sense (Cowling & Taylor, 2001; Coate & Tennyson, 1992). An analysis of the GEM data also shows that self-reported confidence in one's ability to start and run a business leads to higher entrepreneurial activity (Arenius & Minniti, 2005; Reynolds et al., 2001; Wagner, 2004).

Although GEM studies find that education has a positive impact on entrepreneurial activity, empirical studies suggest that education alone is not responsible for self-employment (Henley, 2007; Grilo & Irigoyen, 2006; Davidsson & Honig, 2003). Higher levels of education act as a safety net in case the new business venture fails. Better educated individuals are able to survive changing business environments and identify new trends faster (Davidsson & Honig, 2003).

The relevance of age and education to entrepreneurial activity also holds for Pakistan. GEM reports on Pakistan cite entrepreneurial education as a significant EFC along with factors such as government programs and

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2 See, for instance, Carter, Gartner and Reynolds (1996); Burke, Fraser and Greene (2010); Delmar and Shane (2003).

policies, cultural and social norms, market openness, infrastructure, R&D transfer, financial environment and internal market dynamics.

4. Data and Methodology

We use data from the GEM reports for Pakistan for 2010, 2011 and 2012, which also classifies other countries as factor-driven, efficiency-driven or innovation-driven economies. The TEEA rates have already been calculated for these three years. TEEA is defined as having "conducted specific activities to start a business in the past year," being "an owner or part owner (51 percent) of the business" and having "paid salaries for more than three months" (Frederick & Monsen, 2011). The TEEA rate is used to establish the level of entrepreneurial activity. For this purpose, we further classify the TEEA rate as per Frederick and Monsen (2011):

TEEA = nascent entrepreneurs (< 3 months) + new entrepreneurs (3–42 months)

To measure the level of economic development, we take the GDP per capita (GDPPC), adjusted for purchasing power parity (PPP) (in US$), for all countries for 2010–12. Our model establishes a relationship between TEEA, GDPPC and GDPPC-squared as specified below:

$$TEEA^{*} = \alpha_0 + \alpha_1 GDPPC + \alpha_2 GDPPC^2 + \varepsilon \tag{1}$$

This estimation is used to establish the quadratic relationship between GDPPC and TEEA.

We determine the prevalence rate for all countries for 2012 by calculating the conception ratio and birth ratio. The conception ratio measures the number of individuals who have the required skills and perceive an entrepreneurial opportunity to start a business. This is done by taking the ratio of the prevalence rates for nascent entrepreneurship to potential entrepreneurship. Here, nascent entrepreneurs are defined as "individuals who are actively involved in setting up a business they will own or co-own; this business has not paid salaries, wages or any other payments to the owners for more than three months" (Qureshi & Mian, 2012). Potential entrepreneurship is calculated as the weighted index of the response to two questions as reported in the GEM 2012 report for Pakistan: "there will be good startup opportunities where I live in the next six months" and "I have the knowledge, skill and experience required to start a new business."

The birth ratio indicates how many individuals will succeed over time and comprises the prevalence rate of baby business owners and of nascent entrepreneurs. Baby business owners are defined as those individuals "who are currently an owner-manager of a new business… owning and managing a running business that has paid salaries, wages or any other payments to the owners for more than three months, but not more than 42 months" (Qureshi & Mian, 2012). After calculating these ratios for each country in the 2012 GEM report, independent t-tests are executed for factor-driven, innovation-driven and efficiency-driven economies to compare the significance, scope and success of entrepreneurship across different economies.1

5. Results

This section presents the regression results and ratio analysis.

5.1 Regression Analysis

Table 1 gives the regression results for specification (1). The sample comprises of all the countries that have been part of GEM studies since its inception (classified as: factor-driven, efficiency-driven and innovation-driven economies in GEM reports). The findings reveal that economic development measured by GDPPC (US$) has an impact on TEEA. GDPPC starts rising the TEEA rate of an economy will start to fall, once it reaches its minimum it will start rising as GDPPC keeps on increasing. In the earlier phase of economic growth once the formation of business is done the business environment becomes less conducive for further entrepreneurship resulting in higher investment costs and lower returns for all. These low returns coupled with limited resources and small consumer base restrain the number of entrepreneurs from investing their time and effort in new venture. TEEA would fall. After the threshold level of GDPPC is reached, the TEEA rate begins to rise when the entrepreneurs find that the market has increased and the returns for investing in new business venture are far greater than the risk and opportunity cost involved. This finding is in accordance with Frederick and Monsen (2011), who also establish this U-shaped relationship between GDPPC and TEEA rate.

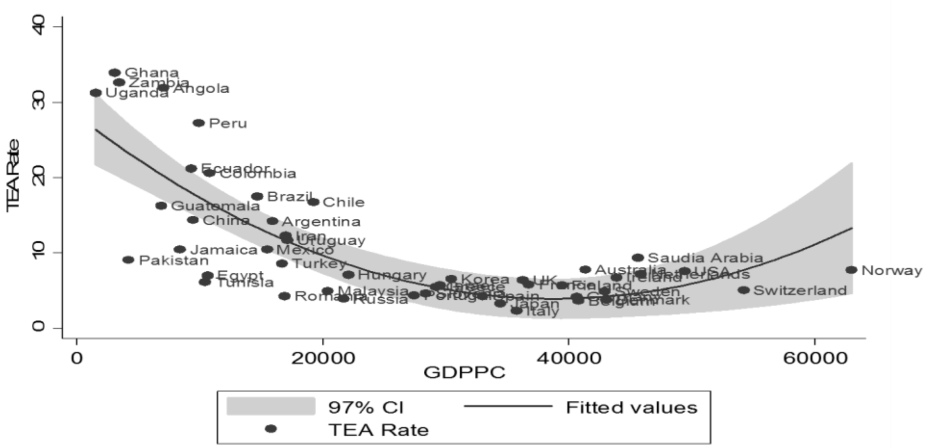
Table 1: TEEA and GDPPC in GEM countries, 2010–12

	2010	2011	2012
GDPPC	-0.00125***	-0.000557***	-0.00107***
	(0.000191)	(0.000154)	(0.000163)
GDPPC-squared	1.61e-08***	5.19e-09**	1.22e-08***
	(3.31e-09)	(2.17e-09)	(2.52e-09)
Constant	28.26***	20.90***	28.26***
	(2.315)	(2.357)	(2.178)
Observations	46	43	64
R-squared	0.625	0.412	0.498

Note: GDPPC is adjusted for PPP (US$). Robust standard errors are given in parentheses and are significantly different from 0 at *** p < 0.01, ** p < 0.05 and * p < 0.1.
Source: GEM Pakistan reports for 2010–12 and Trading Economics database.

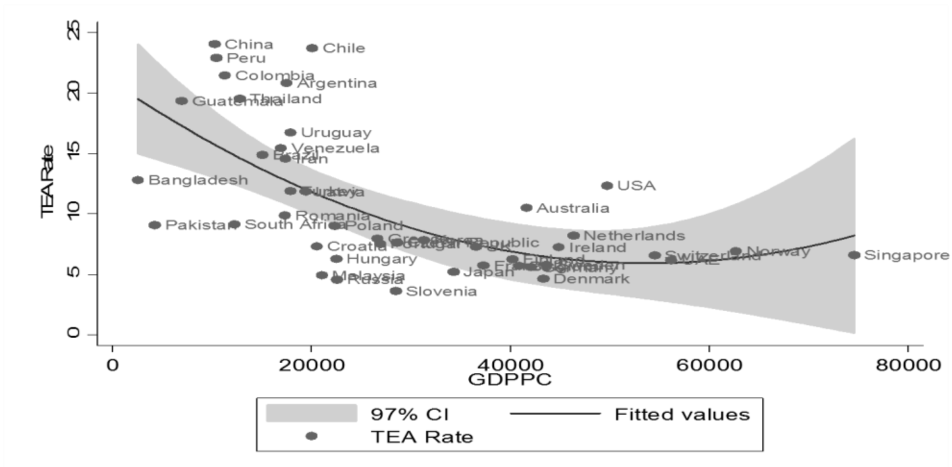
Using specification (1), we obtain the predicted values for TEEA and establish a relationship between TEEA* and GDPPC for each year. This data (comprising of all countries included in GEM reports) also reveals a quadratic relationship between TEEA* and GDPPC (Figures 1 to 3).Pakistan has a low GDP but in comparison to other countries it has an even lower TEEA rate.

Figure 1: Fitted quadratic curve for TEEA and GDPPC, 2010



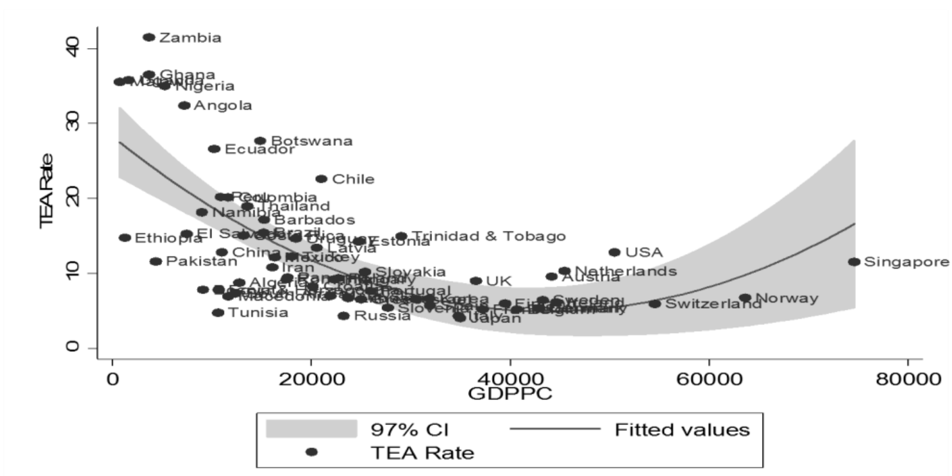
Note: GDPPC is adjusted for PPP (US$). The sample comprises 46 GEM countries.
Source: GEM Pakistan report for 2010 and Trading Economics database.

Figure 2: Fitted quadratic curve for TEEA and GDPPC, 2011



Note: GDPPC is adjusted for PPP (US$). The sample comprises 43 GEM countries.
Source: GEM Pakistan report for 2011 and Trading Economics database.

Figure 3: Fitted quadratic curve for TEEA and GDPPC, 2012



Note: GDPPC is adjusted for PPP (US$). The sample comprises 64 GEM countries.
Source: GEM Pakistan report for 2012 and Trading Economics database.

Low GDPPC and TEEA* for Pakistan can be attributed to policy related EFCs as figures (5-7) taken from GEM reports 2012 indicate. Among the factor-driven, efficiency-driven and innovation-driven economies, Pakistan scores lower on government programs and policies. In comparison to innovation-driven economies, Pakistan also lags behind in entrepreneurial education. The literature links TEEA rate with government policies as they provide an incentive for an entrepreneur to establish a new business. If infrastructure and government policies are not conducive to new entrepreneurial activities, individuals may not invest their time and effort along with financial resources in a new business. This is also reflected in the analysis about Pakistan in GEM reports, a large portion of individuals do not find the environment conducive to starting a new business. Intuitively, factor driven economies TEEA* is low for lower levels of GDPPC, it implies that for Pakistan TEEA* in comparison to such economies is even lower.

5.2 Ratio Analysis

The country data is classified as factor-driven, efficiency-driven and innovation-driven economies as per the GEM reports. Tables 2 and 3 give the descriptive statistics for the conception ratio and the birth ratio respectively. The conception ratio shows how quickly new ideas are implemented while the birth ratio shows the sustainability of a business in a given sector once it is established. The literature (Arenius and Ehrstedt, 2008) indicates that birth ratio would be significant for factor-driven economies and conception ratio would be significant for innovation-driven economies. Efficiency-driven economies have an ambiguous relationship with birth and conception ratios. By GEM classification, efficiency-driven economies include those that have moderate EFCs implying that such countries have the ability to start a new business by innovation (conception ratio) and are also persistent in using the same business technology (birth ratio). We conducted t-tests in order to see the significance of the two respective ratios according to the economic classification done in GEM report 2012 (factor-driven, efficiency-driven and innovation-driven economies). These independent t-test results reveal that the success of the entrepreneurial startup process varies across economies.

Table 2 gives the descriptive statistics for the conception ratio of the three types of economies where the conception ratio indicates the rate at which new ideas are conceived and implemented. The t-test results showed that the only significant difference lies between the conception ratio of innovation-driven and efficiency-driven economies.

Table 2: Descriptive statistics for conception ratio: GEM countries, 2012

Country grouping	N	Mean	SD	T	Significance
Innovation-driven economies	24	0.127	0.061	2.2523	0.000**
Efficiency-driven economies	30	0.163	0.054	-0.1320	Not significant
Factor-driven economies	13	0.166	0.091	1.5247	Not significant

Note: The t-statistics are calculated at a 95 percent confidence interval and are significantly different from 0 at *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.
Source: Authors' calculations based on GEM data for 2012.

Table 3 gives the descriptive statistics for the birth ratio which measures the steadfastness of entrepreneurs in continuing to run their business such that they can earn profits for longer periods. Our t-test results for birth ratio reveal factor-driven economies to be significantly different from innovation-driven economies. This shows that factor-driven economies are less likely to innovate.

Table 3: Descriptive statistics for birth ratio: GEM countries, 2012

Country grouping	N	Mean	SD	T	Significance
Innovation-driven economies	24	0.785	0.310	0.1722	Not significant
Efficiency-driven economies	30	0.803	0.437	-2.7143	0.000***
Factor-driven economies	13	1.444	1.125	2.7143	0.000**

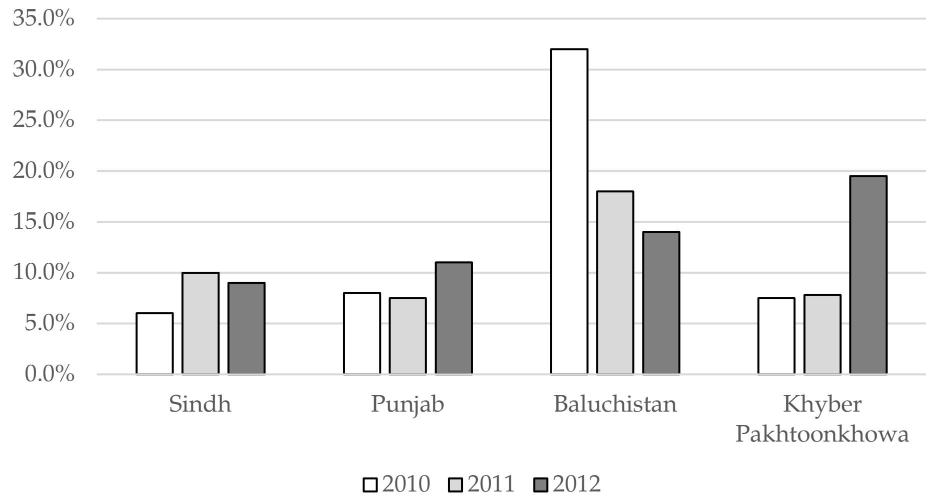
Note: The t-statistics are calculated at a 95 percent confidence interval and are significantly different from 0 at *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.
Source: Authors' calculations based on GEM data for 2012.

As a factor-driven economy for which the birth ratio is significant in comparison with innovation driven economies, Pakistan may not be developing new technology but it does have a significant number of large established businesses. This is supported by the regression analysis, which shows that Pakistan has a lower TEEA* rate than other countries, where the TEEA rate measures new business ventures.

6. TEEA in Pakistan at a Glance, 2010–12

Figure 4 (taken from GEM report, (Quershi and Mian, 2012)) shows the TEEA rate for the four provinces of Pakistan over 2010–12. In Sindh, the TEEA rate increases in 2011 from 2010 and then falls in 2012. In Punjab, the TEEA rate falls slightly in 2011 and then rises in 2012. The most prominent changes can be seen in KP and Balochistan. In Balochistan, the TEEA rate falls over all three years while in KP, it increases, with a very high margin in 2012. The fall in Balochistan can be attributed to its poor infrastructure and political instability, while the rise in KP may have stemmed from its better financial environment.

Figure 4: TEEA rates in Pakistan, 2010–12

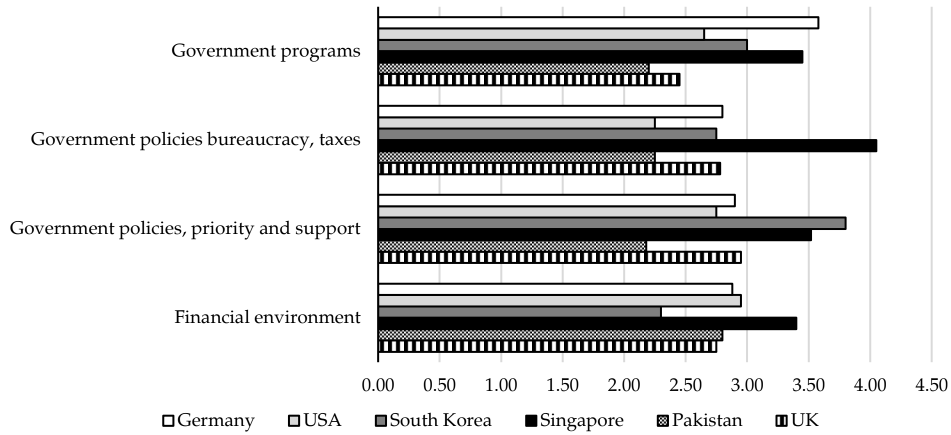


Source: GEM Pakistan reports for 2010–12.

The following Figures 5 – 7 are also taken from GEM reports for the year 2012 (Qureshi and Mian, 2012). On the basis of the scores generated in this report we compare the economic framework conditions (EFCs) of Pakistan to a group of other economies that are either innovation-driven, efficiency driven, or factor-driven to evaluate where Pakistan stands amongst such countries.

Figure 5 compares Pakistan with the sample of innovation-driven economies on the basis of policy and environment factors. With regard to government programs, Pakistan has the lowest average while Germany has the highest. This means that government programs in Germany are designed to facilitate new business startups. On government policy (bureaucratic red tape and priority), Pakistan has the lowest rating while Singapore has the highest, followed by South Korea. On financial environment, Pakistan ranks third while Singapore scores the highest. Looking at the data, we can say that, in comparison to innovation-driven countries, Pakistan ranks low in terms of starting a new business.

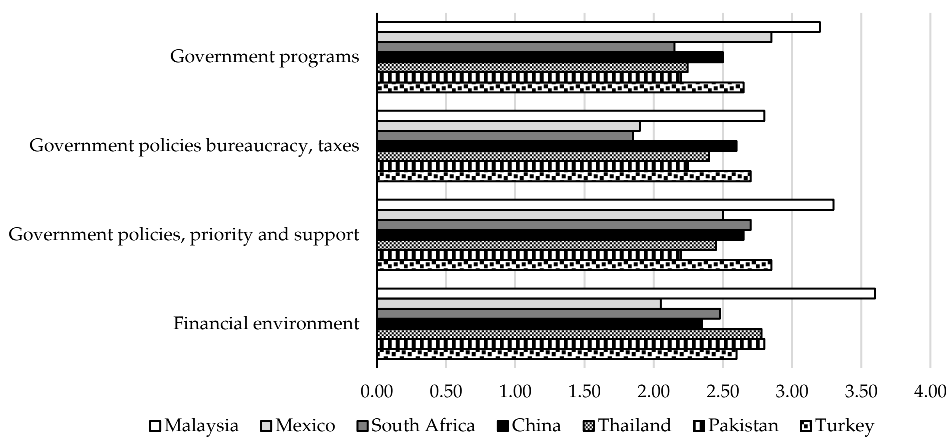
Figure 5: Mean EFC scores for Pakistan relative to innovation-driven economies (policy and environment factors)



Source: GEM Pakistan report for 2012.

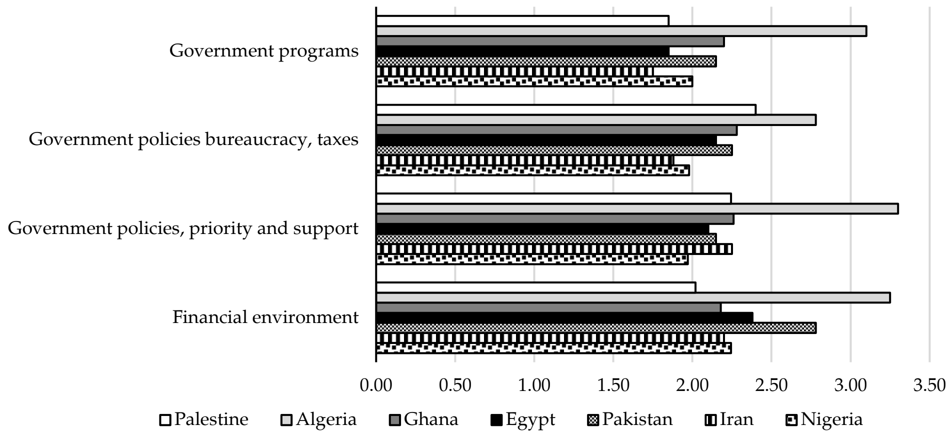
Figure 6 compares Pakistan's government policies and programs and its financial conditions with efficiency-driven economies. Of the seven countries under consideration, Pakistan ranks sixth on government programs, fifth on bureaucratic red tape and seventh on government priority and support. In the latter case, even Mexico and South Africa have a better mean average. In the financial environment category, Pakistan is second with mean average above that of China and Thailand.

Figure 6: Mean EFC scores for Pakistan relative to efficiency-driven economies (policy and environment factors)



Source: GEM Pakistan report for 2012.

Figure 7: Mean EFC scores for Pakistan relative to factor-driven economies (policy and environment factors)



Source: GEM Pakistan report for 2012.

Figure 7 compares Pakistan with other factor-driven economies (Palestine, Iran Nigeria, Egypt and Ghana). In comparison to these countries, Pakistan ranks third on government programs, fourth on bureaucracy and taxes and fifth on policy support and priority. The financial environment in Pakistan is the second most conducive after Algeria.

Overall, relative to these factor-driven, efficiency-driven and innovation-driven economies, Pakistan ranks low in government programs and policies that facilitate entrepreneurship which could be the reason for its deviation from the quadratic trend curve for GDPPC and TEEA* (Figures 1-3). Despite having a financial environment that is conducive to entrepreneurship, the country's GDPPC (US$) remains low. To improve its TEEA, Pakistan should adopt more favorable government programs and policies that facilitate investment and attract nascent entrepreneurs.

7. Conclusion

This paper examines GEM data in terms of economic development (measured by GDPPC) and TEEA, which tend to have a significant relationship with each other. Their quadratic relationship shows that at higher levels of GDPPC, TEEA rises. Pakistan is an outlier and lies below the trend curve, due to its low TEEA rate which shows that the government needs to introduce better policies and programs to foster entrepreneurship.

The ratio analysis shows that, for conception ratio, innovation-driven economies are significantly different from efficiency-driven economies owing to their quick adoption of new technology and ideas while for birth ratio, factor-driven economies are significantly different from innovation-driven economies. Since Pakistan is a factor-driven economy so this means that persistence of businesses here could generate higher growth over time. But to sustain businesses the government needs to provide the right set of policies that facilitate entrepreneurs and attract new investors. If such a mechanism is in place then Pakistan's TEEA rate could rise with its GDPPC.

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Same Jeans, Same Stitch? A Comparison of Denim Production Across Three Factories in Punjab, Pakistan

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Abstract

In this paper, we look at denim production in three different factories in Punjab, Pakistan. We map the manufacturing process for a standard pair of denim jeans produced for an international retailer. We asked three factories of different scales and proximities to the technological frontier to stitch, finish and wash an identical pair of jeans. These firms included a large-scale exporter with established links to a major multinational brand, a medium exporter with links to regional European labels and a small producer selling primarily to the domestic market. Timing the operations ourselves, we find that the stitching time of the large-scale exporter is about one-third less than that of the medium exporter and about half the stitching time of the small firm. Of the three firms, only the large exporter pays wages based strictly on standard minute value – the time expected to complete an operation. The two smaller firms pay piece rates that reflect the market rates paid for individual operations by firms throughout the sector. Even without increases in stitching efficiency, the two smaller firms could reduce their stitching costs by 30–50 percent if they were able to switch to paying wages based on stitching times. We also calculate the labor cost savings that the two smaller firms could accrue by adopting some of the more advanced equipment used by the large exporter, along with lower piece rates. Of these, the most reasonable investment would be in better loop-making machines; the cost of equipment could be recuperated by producing 325,000–500,000 garments, which for the medium firm is four to eight months' production at current levels. However, piece rates are entrenched and, if sticky, could reduce the incentives for firms to adopt labor-saving technologies.

Keywords: readymade garments, manufacturing, Pakistan, piece rates, SMV, choice of technology.

JEL classification: O14.

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* Professor, Department of Economics, Lahore School of Economics. I would like to thank the firms who participated in our stitching experiment for their openness and cooperation. I would also like to thank Rashid Amjad, Rajah Rasiah, and Irfan ul Haque for their valuable comments at the conference.
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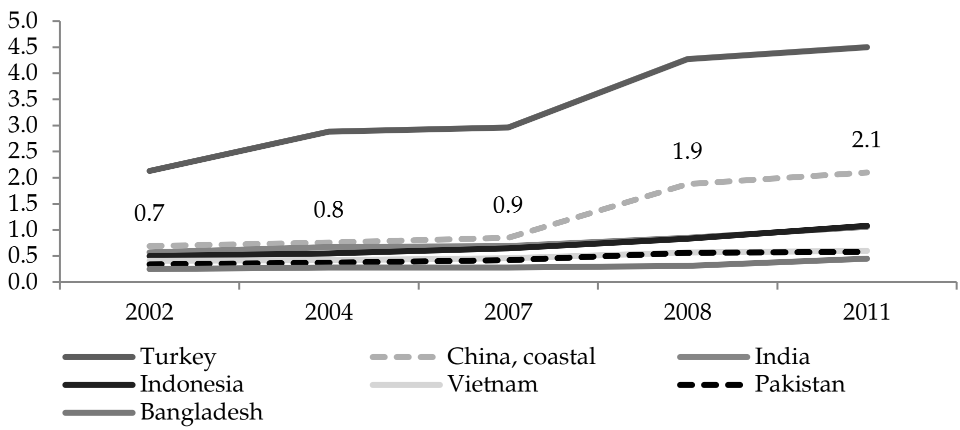
1. Introduction

Textiles account for over half of Pakistan's exports, with readymade garments (RMGs) and textile made-ups comprising more than half of textile exports in 2011/12 (Hamid, Nabi & Zafar, 2014).[1] Pakistan produces both woven fabrics and knitwear, in about equal amounts. Due to restrictions on the import of synthetic fabrics, Pakistan's garment producers are concentrated in home textiles (towels and bed linen), menswear (socks and polo shirts) and denim. Pakistan's homegrown cotton is well suited to woven denim production, the product category that we focus on in this study.

When the European Union granted preferential GSP+ status to Pakistan in December 2013, garment manufacturers were palpably excited about the prospects of increased export opportunities to Europe.[2] They also hoped to capitalize on the trend of rising wages in China as international brands sought cheaper sourcing options (Figure 1).

Figure 1: Labor cost (USD/hour) in the textiles industry



Source: Technopak and Werner International, Textile Intelligence.

To these ends, the current government announced the development of a 1,500-acre industrial estate for garments – the proposed Quaid-e-Azam Apparel Park outside Lahore, near Sheikhupura.[3] However, Pakistan faces

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[1] As of 2014, Pakistan was the sixth largest exporter of textiles and eighth largest exporter of clothing outside Europe and the US (http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx?Language=E, accessed 31 January 2016).

[2] Indeed, exports of apparel rose in the first six months of 2015 (compared to the previous year) even though overall exports to Europe fell in the same period (McGregor, 2015).

[3] As of June 2016, a masterplan has been approved.

a number of competitors for the business expected to move out of China, including Bangladesh, Cambodia, India, Indonesia and Vietnam. From Figure 1, we can see that, as of 2011, Pakistan and India's labor costs per hour were comparable, but that of Bangladesh was even lower.

As we know, however, it does not make sense to look at wages alone when there are significant differences in labor productivity. The New Delhi-based consulting firm Technopak estimates that, while wages are higher in Bangladesh, workers are less efficient and the level of technology is lower (Table 1). Similarly, our pilot project to benchmark physical output productivity – rather than the standard revenue productivity – using high-frequency worker and line-level data finds a 16 percent productivity advantage when comparing a Pakistani knitwear manufacturer to the most efficient units in a sample of Bangladeshi firms producing very similar products (Chaudhry, Macchiavello, Chaudhry & Woodruff, 2016).

Table 1: Worker efficiency, wages and technology in selected Asian countries

Countries	Average payout (US$ p.m.)	Key product category	Country av. operational efficiency	Technological advancement	Raw material availability
China	220-270	All products	55-57%	High	All
Indonesia	170	Woven synthetic	44-46%	Medium	Synthetic fiber
Vietnam	120	All products	40-42%	Medium	None
Pakistan	116	Denim	42-44%	Medium	Cotton
Cambodia	88	Denim, woven	42-44%	Medium	None
Bangladesh	83	Knitwear, woven bottoms	38-40%	Low	None
India	130	All products	44-46%	Medium	Cotton

Source: Presentation by Technopak, 9 December 2013, International Textile and Clothing Conference, Lahore.

In addition, Pakistan has the advantage of homegrown cotton, reducing material costs over competitors such as Bangladesh, Vietnam and Cambodia. On the other hand, its manufacturers tend to face higher energy costs and greater political instability in comparison to the same. When looking at overall costs (labor, materials, overheads, shipping, tariffs, etc.), Nathan Associates (2009) find that Pakistan compares favorably to Bangladesh in the production of t-shirts and chinos.

Along with researchers at the University of Warwick, we recently carried out a pilot project to compare the sewing efficiencies of Bangladeshi factories to those in Pakistan (Chaudhry et al., 2016). We intended to make these comparisons using measures of the time allocated to each sewing operation carried out along the line, known in the RMG sector as the standard minute value (SMV) or standard allowed minute (SAM). Although international databases of SMVs exist, many factories develop their own standards, usually based on their time and motion studies. Since similar stitching operations are performed for a variety of garments, we hypothesized that SMV/SAM could be used to compare factories' efficiency levels even though different styles of garments were being manufactured. As long as there is consistency within the factory in how the local SMV is calculated, relative efficiencies between firms can be compared based on the SMVs for identical processes.[4]

It is much easier to match processes across factories to compare SMVs when they produce the same category of apparel, for example, t-shirts or trousers. However, the data our co-researchers had collected in Bangladesh was mainly for knitwear (t-shirts), while the data we collected in Pakistan was principally for denim (jeans). This variety in the garments being produced made it difficult to compare SMVs. Another constraint was that only the large firms had industrial engineers to calculate SMVs, and so we were unable to compare the larger, more organized firms with smaller units. In our work on the RMG sector, we have noted significant variation in the scale of production, the technologies utilized and the ways that factories collect data and plan production, despite producing similar products and exporting to some of the same markets.

Given the issues encountered in the pilot benchmarking project in matching processes across factories producing different garments, and the fact that smaller factories lack data on SMVs, this case study is an attempt to compare efficiencies between factories of different levels of sophistication by timing their stitching of an identical denim garment. We then compare these firms based on stitching times, stitching cost and quality of the finished garment.

The remaining paper proceeds as follows. In Section 2, we describe the three firms, the stitching experiment and the results. In Section 3, we discuss the benefits and drawbacks (for the smaller firms) of adopting

[4] The benchmarking exercise requires making adjustments for 'helpers' who assist sewing operators and can be made more precise if there is data on the types of sewing machines used (for example, auto-trimmers).

some of the advanced technology used by the large exporter. Section 4 concludes the study.

2. The Experiment

Starting with the already woven fabric, the production of denim jeans is broken down into several stages, roughly, fabric cutting, sewing, dry and wet processes (the application of chemicals, lasers, sandpaper and washes for a fashionable 'worn' look) and packing/shipping. Details of these processes and the different technologies used by denim producers in Pakistan are given in Appendix 1.

For this case study, we engaged three firms at different scales of production in an experiment – where each produced a batch of identical jeans – in order to better understand the differences between firms, particularly in the efficiency of sewing operators. To a lesser extent, we attempt to compare some of the other processes, including cutting, washing and finishing. Only the large-scale firm in our sample regularly produces the garment chosen for the experiment. The other two firms do not produce this exact style, but produce very similar products so that the experimental garment was easily within their skill set.

We start by describing the three firms that agreed to participate in the experiment. Then, we describe the stitching experiment carried out and discuss the results. The results include comparisons of the stitching times, stitching costs and garment quality.

2.1 The Three Experimental Firms: Characteristics and Technology

We engaged three firms for the experiment: a large exporter (Firm A), a small to medium exporter (Firm B) and a small producer for the domestic market (Firm C). We summarize the basic characteristics of the firms in Table 2 and the technologies they use in Table 3.

Firm A is a large-scale vertically integrated firm, operating two shifts a day on seven assembly lines. It uses some of the most technologically advanced equipment such as laser machines that add elaborate designs to the jeans. Some lines are dedicated to basic garments; others specialize in higher-fashion garments (such as denim products with embroidery or special accessories). Firm A employs around 1,500 sewing operators. The minimum order it accepts from any buyer is not less than a few thousand garments. The firm is well organized, employs industrial engineers and professional management and has fairly sophisticated methods of collecting and organizing high-quality production data at the line and worker level, which can be used to analyze and improve efficiency.

Firm B can be called small- to medium-scale (as it buys fabric from the market but has all other facilities installed) and operates one assembly line for a single eight-hour shift per day. It prefers large orders but is willing to accept some smaller orders (a few hundred garments) from buyers it has worked with if that buyer previously gave a larger order. The firm has three sections (front, back and assembly), employing 100 to 150 sewing operators. The CEO has an engineering background, but the firm does not have a separate industrial engineering department nor does it use SAM/SMV in costing orders. Firm B collects some data, but little of it is computerized, making it more difficult to track firm and worker performance over time.

Firm C is a very small firm with 15 to 20 operators. It is essentially a small stitching unit, as it outsources washing and dry processes. The system of production is less organized compared to the other two firms and it produces primarily for the local market, only occasionally receiving small export orders. The machines at Firm C appeared much older and less well-maintained than the machines at the other firms. The management confirmed that it procures used sewing machines.

Table 2: Characteristics of experimental firms

Characteristic	Firm A	Firm B	Firm C
Number of sewing operators	1,500	100–150	15–20
Main market	Europe and US	Europe	Pakistan
Segment	Major international brands	Regional European brands	Motorcycling pants, mainly domestic
Output per month (average)	700,000	50,000–150,000	100–1,000
Number of lines	7	1	1

Note: Firm A = large exporter, high-tech, Firm B = medium exporter, medium-tech, Firm C = small domestic producer, low-tech.
Source: Authors' survey.

The three firms also differ in the technologies utilized, as summarized in Table 3. The largest firm, Firm A, is more capital-intensive.

Its processes are generally more automated and it has access to expensive high-tech machinery, including machines to spread the fabric for cutting, robotic arms that cut the fabric, specialized machines for making and attaching loops and back pockets, and lasers to add elaborate designs to the fabric. Stitching operations are semi-automated. On the other extreme, Firm C uses very basic sewing machines for all operations; little is automated and some processes – such as pattern design and dry/wet finishes – are outsourced. The medium exporter, Firm B, like Firm A and unlike Firm C, carries out all processes in-house, but uses more labor-intensive techniques than Firm A.

Firm B is closer to Firm A than it is to Firm C in the way production is organized. This is representative of other firms in the sector we visited: there are a handful of large exporters using advanced technology, medium firms using an intermediate level of technology and small firms using very basic technology. This wide range of firm sizes (a few large exporters and a large periphery of small to medium firms) with accompanying variations in technologies employed across firms in the RMG sector is a pattern we have observed in other manufacturing sectors in Pakistan, including electric fans, surgical goods, sports gloves and soccer balls.

Table 3: Technology in the different stages of production

Technology	Firm A	Firm B	Firm C
Pattern design	CAD software	CAD software	No in-house CAD
Fabric spreading	Automated	Manual	Manual
Fabric cutting	Automated	Manual	Manual
Small parts (belt loops, etc.)	Specialized machines	Specialized machines	Standard sewing machines
Stitching	Automated sewing machines	Semi-automated sewing machines	Basic sewing machines
Dry processes (sandpaper, resin, etc.)	Semi-automated	Manual	Outsourced
Wet processes (stone washing, etc.)	Italian washing machines	Turkish and Chinese washing machines	Outsourced

Note: Firm A = large exporter, high-tech, Firm B = medium exporter, medium-tech, Firm C = small domestic producer, low-tech.
Source: Authors' survey.

2.2 The Stitching Experiment

Typically, for each style of garment a firm manufactures, factories first design an operational breakdown, laying out the individual steps in the stitching process. In factories employing industrial engineers, the time allocated for each operation by machine operators and helpers, known as the SMV or SAM, is quantified as well. The total amount of time estimated for the garment to be stitched is then determined as the sum of SMVs for all operations.

For this case study, we have collected data on the SMV/SAM from the three firms that produced an identical pair of denim jeans. The data for Firm A, the most technologically advanced firm, was already available for the garment – a standard five-pocket pair of denim jeans that the factory regularly produces. For Firms B and C, however, we had to conduct our own time and motion studies to measure their SMVs since they do not produce exactly the same garment nor do they employ industrial engineers who calculate the SMVs.

First, we asked Firm B and Firm C to develop their own operational breakdowns based on the sample garment we provided; this was not a difficult task as it was very similar to styles they already produce. As mentioned earlier, Firm A regularly produces this exact garment so that its operational breakdown was already available. Next, we conducted time and motion studies to calculate the SMV/SAM for Firms B and C. The cycle time – the total time needed to complete each operation – was calculated using a stopwatch, as the average of five consecutive timed motions. To obtain the SMV/SAM, we added a 10 percent bundle allowance and 20 percent personal and machine allowances to the cycle times, according to common practice in the industry.

The total SMV (in minutes) to stitch a garment is given in the first row of Table 4. The results are striking: the total stitching time for Firm B is 50 percent higher and for Firm C is double that of the SMV provided by Firm A. To be fair, the SMVs of Firms B and C could fall with more experience; for our experiment, just two-and-a-half dozen garments were produced. Nonetheless, we expect that, even with practice, substantial differences in stitching efficiency would remain. We should note here that we are unable to decompose the differences in stitching efficiency to differences in technology as opposed to other factors that differ between the firms, such as worker characteristics and management – all of these are likely to play a part and to differ across firms.

Table 4: Total SMV and stitching cost per garment for producing identical denim jeans

SMV/cost	Firm A	Firm B	Firm C
Total SMV (minutes)	15.14	22.07	32.55
Stitching cost based on own/actual piece rates paid per operation (PRs)	13.61	27.39	70.75
Stitching cost based on own SMV and Firm A's piece rate factor (PRs)	13.61	19.90	29.36
Stitching cost based on own SMV and a nonexperiment firm's range of piece rate factors (PRs)		17.65–24.27 Mean = 20.96	26.04–35.81 Mean = 30.92

Note: Firm A = large scale, high-tech, Firm B = small to medium scale, medium-tech, Firm C = very small scale, low-tech.
Source: Authors' calculations based on SMVs and piece rates provided by Firm A, piece rates provided by Firms B and C, and timed operations to measure SMV for Firms B and C. An industry standard 10 percent bundle allowance and 20 percent personal and machine allowances were added to the times collected for Firms B and C.

We compare the stitching cost per garment based on the firms' own piece rates paid per operation in the second row of Table 4. The three firms provided this data themselves. For Firms B and C, the piece rates are standard across styles for a particular operation, i.e., it is a fixed payment in PRs, determined operation by operation but without the use of time-and-motion studies since these firms do not use SMV. As noted earlier, the piece rates for Firms B and C reflect a market rate for the operation. On the other hand, Firm A's piece rates are calculated as the SMV multiplied by a fixed factor; in other words, Firm A's piece rates are linear in the SMV.

What we found was quite surprising: Firm B's cost of stitching the garment using its own piece rates is twice the cost of Firm A. For Firm C, the stitching cost is an incredible five times that of Firm A. The cost differences greatly exceed the differences in stitching times, suggesting that Firms B and C are significantly overpaying workers for many operations.[5] Similar to our findings, Technopak (2007) calculates for a number of garments that the cost of stitching using market piece rates (as Firms B and C do) is higher than under a salary-based system. The problem is that, when piece rates for a particular operation are based on a market rate, the

[5] In addition to the piece rates, the firms also pay a small fixed wage to workers that varies by firm. We are not accounting for those differences here.

wage bill is dissociated from the work content as measured by SMV. What is interesting here is that, while Firm A also uses piece rates, these are directly related to SMV, helping to bridge the disconnect between pay and work content.

In the third row of Table 4, we calculate the cost of stitching the garment for Firms B and C, using the SMVs we timed for them along with Firm A's (fixed) piece-rate factor. This brings the differences in stitching cost back in line with the inter-firm differences in stitching time, since Firm A pays piece rates that are linear in SMV times. When we compare the figures for Firms B and C in rows 2 and 3 of Table 4, we see that both are significantly overpaying their workers per garment. In other words, the two smaller firms could save significantly on labor costs if they paid piece rates based on SMV as is done by Firm A.

In earlier discussions with the firms, the management had indicated that the negotiated piece rates were probably higher than those determined by SMV. However, the magnitude of our findings is unexpected: using its current technology and workers, Firm B could reduce its marginal labor cost by at least 37 percent and Firm C could cut its marginal labor cost by half, using SMV-based piece rates. To the extent that the SMVs of both firms could come down with more experience of producing the experimental garment, the cost saving could be even greater.

Finally, in row 4 of Table 4, we use the firms' own SMVs with an outside (nonexperimental) firm's range of piece-rate conversion factors to give an alternative range of stitching costs. While Firm A pays piece rates that are a constant multiplied by the SMV, this nonexperimental firm pays piece rates that are a nonconstant factor multiplied by the SMV. Its piece factor varies according to the operation: some are slightly less than Firm A, others slightly more. Both firms also give workers a fixed payment in addition to their wages, which vary by firm. The mean stitching cost using the outside firm's piece rates yields a similar cost saving to that obtained using Firm A's piece-rate calculations.

Next, we look at the efficiency differences between the firms and the extent of overpayment at the level of individual operations for those processes that could be matched across all three factories (Appendix 2). We were able to visually match the majority of operations performed across the three factories for each operation performed to produce the experimental garment, even though the operational breakdown differed slightly from firm to firm. For the operations we were able to match across all three factories, we can compare the individual SMVs (see Table A1 in Appendix 2). Firm A's stitching is more efficient than that of Firm B for 19 operations and less efficient for 11 operations. Firm A is more efficient in stitching than Firm C in 27 operations and less efficient in four operations. Firm B is more efficient than Firm C in 25 operations and less efficient in six operations.

Table A2 in the Appendix compares the piece rates paid by Firms B and C to the piece rates implied by their SMVs, using Firm A's piece-rate conversion factor. Compared to what it would pay workers using an SMV-based piece rate, Firm B's actual piece rates lead to overpayment for 24 operations, underpayment for three operations, and accurate payments for three operations. Firm C's actual piece rates overcompensate for 27 operations and accurately compensate for three operations.

2.3 *Quality of Experimental Garments*

We asked an industrial engineer from a local firm with experience in the denim sector to examine a sample of the jeans stitched for the experiment (Table 5). The consultant viewed the jeans produced by Firms B and C mostly favorably. Overall, the jeans produced by Firm B more closely resembled the sample provided by Firm A.

We did not have a full batch from Firm A for examination, but we did have some information gathered from factory visits and discussions with management. Sewing defects found at inspection tables along the line are around 10–12 percent. However, this rises significantly when one adds the defects that emerge after the dry and wet processes (sandpaper, chemicals, lasers, stone washing) – up to 30 or 40 percent. These processes add considerable value, but by intentionally damaging the fabric for a fashionable effect, unintended damage to the stitching also occurs frequently. Fortunately, rework brings the ultimate rejection rate down to around 4 percent (although there is a fair amount of month-to-month variation), of which about a quarter is due to faults in the fabric itself. While the quality data was collected in real time (shared on the company portal), there are no tools to analyze the data continuously. The upper-level manager in charge of quality checks the data at least twice a day and brings it along for discussions on the floor.

Table 5: Quality comparison of jeans stitched by Firms B and C to sample from Firm A

	Firm A	Firm B	Firm C
Estimated price for foreign buyer	– US$8	– US$6 – Some sewing repairs needed – Finishing (clipping loose threads)	– US$3–4 – Some sewing repairs needed – Finishing (clipping loose threads) – Cheap accessories (main reason for discount compared to B)
General impression	–	– Closely resembles sample piece – Solid sewing – Same silicone washing, same heat applied as sample piece – Issues with finishing (extra threads not cut)	– Solid sewing, though not quite as close to sample as firm B – Issues with finishing (extra threads not cut) – Good wash, though different fabric used, so more shrinkage observed
Errors common throughout batch	–	– Different thread used from sample (so more stitches per inch observed – Incorrect stitch on bottom hem (single instead of chain) – Waist band narrower than sample (by two points or 1/8 in.), either because cut too small or because operator folded too much before stitching – Incomplete finishing (extra threads not trimmed)	– Incorrect stitch on bottom hem (single instead of chain) – Loose buttons (machine error) – Back-pocket stitching defect (decorative "v" in the middle of pocket loose), machine or fabric issue – Incomplete finishing (extra threads not trimmed)
Other defects observed in individual pieces	–	– High/low defect in back pockets (unequal distance from top of jeans, uneven), operator fault – Broken stitch on a belt (machine fault) – Dry process fault (too aggressive rubbing of sandpaper on one leg)	– Bartack on back pocket uneven in one pair – Bartack slip on one back loop – Inner pocket not pressed before stitched inside (so pocket lumpy inside) – Back pocket upper seam had skip stitch

Note: Firm A = large exporter, high-tech, Firm B = medium exporter, medium-tech, Firm C = small domestic producer, low-tech.
Source: Authors' survey.

3. Choice of Technology

Table 6 provides the cost of machinery used by the three firms for some of the specialized stitching processes. As we can see, Firm A's investments in capital technology greatly exceed the other two firms, in most cases by orders of magnitude.

Table 6: Cost of (new) machines used by each firm (in PRs)

Operation	Firm A	Firm B	Firm C
Attach loops	2,100,000	375,000	225,000
Attach back pocket	8,000,000	50,000	33,000
Bottom hem	650,000	50,000	33,000
Loop making	450,000	25,000	175,000
Cutting machine	20,000,000	156,000	36,000
Spreader	8,000,000	Not used	Not used

Source: Authors' survey.

According to Firm A, adopting more automated technology makes sense, given its scale of production, because it increases the consistency of garment quality and, by saving on labor and therefore wages, allows the firm to remain internationally competitive. Given its scale of production, Firm A finds the payback period for new labor-saving technologies to be very short.

Some of the technologies, especially the spreader and automatic cutting machines used by Firm A, would be difficult for the smaller firms to finance. In addition, the capacity utilization of the small firms would be low unless they were to significantly expand the scale of their operations. On the other hand, the equipment used by Firm A for the bottom hem and loop making are not prohibitively expensive: combined, their cost is less than US$11,000 at current exchange rates. In Table 7, we estimate that the labor cost saving of adopting Firm A's loop-making machine (along with piece rates that adjust with SMV) to Firms B and C is substantial, and the smaller firms could recuperate the capital cost by producing 325,000–500,000 garments.

These calculations assume that Firms B and C could lower their SMVs (and piece rates) for these operations to those of Firm A, and so the cost saving could be exaggerated if Firm A's management and worker quality also contribute to its lower SMV for these operations. It is crucial that piece rates also adjust along with SMV; the labor cost saving will not materialize at all if the firms stay with the market-determined piece rates.

Table 7: Labor cost savings of adopting the technology of the most advanced firms

	Firm B		Firm C	
Operation	Piece rate saving per garment (PRs)	No. garments to recover capital cost	Piece rate saving per garment (PRs)	No. garments to recover capital cost
Bartack loops	0.72	2,916,667	2.14	981,308
Attach back pocket and second seam back pocket	0.13	61,538,462	5.38	1,486,989
Make and fuse loops	1.41	319,149	0.91	494,505
Bottom hem	0.39	1,666,667	2.64	246,212

Source: Authors' calculations based on cost of equipment and differences in piece rates based on timed performance of operations. Data on energy and maintenance costs were not available.

Note that we do not have data on the electricity or maintenance costs and so, the total cost savings may be greater (lower) than the figures in Table 7, depending on whether the energy use and maintenance requirements of Firm A's machines are less (more) than the current capital of Firms B and C. On the other hand, the calculations may underestimate the value of investing in the same equipment used by Firm A if the quality also improves, reducing defects (and, therefore, rework) and raising the price received from buyers.

4. Conclusion

Across the garments sector, firms vary widely in their level of sophistication in producing technically the same product (jeans). This pattern, however, is not unique. We have observed the same across manufacturing sectors in Pakistan – a small number of larger exporters using technologies close to the frontier, a somewhat larger cohort of medium firms using some older and some newer technology and a large periphery of small players using second-hand machinery, outdated technologies and often reverse-engineered equipment.

How do they coexist? Smaller, less formal, firms are significantly less productive, but also have lower overheads and other costs. In addition, these three types of firms are not necessarily competing head-to-head; rather, they are operating in different segments of the market. Firm A is one of many suppliers competing globally for the business of a major international brand. Firm B also faces international competition, but is operating in a lower segment of the denim market, producing for smaller regional European brands. Firm C fills some minor export orders, but focuses primarily on domestic sales.

Previous studies have highlighted some reasons for the slow adoption of technology in the manufacturing sector. Some literature points to the role of labor in opposing new technologies. Lazonick (1979) and Mokyr (1990) explain how trade unions slowed down the process of technology adoption during the industrial revolution. The practice of paying piece rates, extremely common in Pakistan, may also induce workers not to accurately report the benefits of new technologies (Holmstrom & Milgrom, 1991). Milgrom and Roberts (1995) and Atkin et al. (2015) suggest that misaligned incentives between workers and owners within firms is an important barrier to the adoption of technology and workers may perform better while learning new technologies if piece rates are combined with incentives to use the technology.

On the other hand, firm owners themselves may also be responsible for the lag in adoption. Bloom and Van Reenen (2007, 2010) and Bloom, Schankerman and Van Reenen (2013) suggest that firms may fail to adopt innovative management practices in the absence of product market competition. The process of adopting new technologies may also require changes in complementary technologies, which takes time to implement (Rosenberg, 1982; David, 1990; Bresnahan & Trajtenberg, 1995).

In our view, small and even medium firms in Pakistan likely lack the ability to finance as well as the operational scale to make use of many state-of-the-art technologies. We have not even considered the role of human capital in adopting new technologies here; large exporters likely attract a better pool of workers who will have less difficulty operating more complex machinery. Another consideration is that it is often more appropriate to pay fixed wages rather than piece rates if the newer technology is more automated, as often it is. Even if firms can increase their scale, if they are confined to paying piece rates that are unrelated to the SMV, investment in time-saving equipment will be hard to justify because the labor cost saving will be negligible.

What role, then, can the government play to encourage greater innovation and vibrancy in the sector? Let us start with the first issues mentioned: scale, skills and finance. Many technologies are realistic only for export firms operating on a fairly large scale. Reducing the impediments to exporting (including easier imports of high quality intermediate inputs) could allow firms to grow to a scale of operations that would support investments in state-of-the-art technology. Training workers would give them the skills to operate more advanced equipment, but would be costly and help only if firms decide to invest in it. Policies to increase access to finance capital investment may help some, but is not likely the full answer. Even if we limit our discussion to those technologies that may be appropriate for a smaller scale, we have noticed in our discussions with firms that many prefer the self-financing model. For those firms that shy away from banks for religious reasons, wider access to Islamic finance may encourage them to borrow. The availability of Islamic banking products has grown rapidly in the last several years in Pakistan. Its role in encouraging firm-level capital investment should be an area of future research.

As mentioned earlier, adopting more advanced and automated technologies may not be profitable for firms if they cannot then lower their labor costs due to sticky piece rates that are disconnected from the work content. The benefits of a fixed wage system go deeper. On top of the cost savings that Technopak (2007) estimates, it suggests that, if factories were to shift to salaries from piece rates, the salary system would be more conducive to producing quality output. Fixed wages require firms to be better managed, but also encourage innovation and the adoption of modern management techniques such as 6-sigma, lean manufacturing and total quality management (Technopak, 2007). In its experience, the most efficient garment firms internationally work on salaries.

Manufacturing workers in Pakistan work mainly on piece rates in a variety of sectors. In garments, firms feel they have to pay the market rate for an operation or else their best stitchers will move to another firm (Chaudhry & Faran, 2015). Fixed wages makes firms' wage bills less responsive to demand, which may be difficult for smaller firms facing greater variability in orders. Even if firms wish to shift to fixed salaries, they would need to place more emphasis on actively managing those workers, on top of the fact that workers may resist the change and prefer the flexibility of piece-rate work (see Chaudhry & Faran, 2015, for an example from the fan sector).

The piece rate is an entrenched system in Pakistan and there would almost certainly be resistance to change. How do we deal with this impasse? One way to move firms toward salaries from piece rates is by external pressure: according to Verhoogen (2016), one of the largest soccer-ball firms in Sialkot (Pakistan) moved to fixed wages under pressure from a foreign buyer. An unintended bonus of the shift was that the new salary system facilitated the adoption of a cost-saving technology. Other soccer-ball producers paying piece rates were much slower to adopt the technology, if at all.

In our sample, Firm A has found a partial solution by tying its piece rates directly to the SMV, so that cost matches work content. As we have calculated here, Firms B and C might be able to reduce their wage bills significantly by using SMV to compute piece rates, but only if they are able to keep their workers from leaving for other firms. This could prove difficult if other firms in the sector continue to pay the 'market rate'. Being a large exporter, Firm A is probably an attractive employer and faces less difficulty in retaining workers.[6] Firms could benefit from industrial engineering services to calculate SMVs, which might help them align their piece rates with their stitching times. Along these lines, a recent project funded by UNDP, Promoting Employment and Productivity in the Garment Industry, builds on an earlier project, Gender Promotion in the Garment and Clothing Industry through Skills Development (GENPROM), which provided master trainers – intended to help recruit and train women stitchers – and consulting services for quality, cutting and industrial engineering.[7]

This paper offers only a snapshot of the distribution of technologies and efficiency levels of firms. But are firms innovating over time? Other articles in this special edition provide some answers. These include Wadho and Chaudhry's piece on the textiles sector more broadly defined, Firdousi on sports gloves, and Raza on the soccer-ball sector.

[6] It also differs from many RMG producers in Pakistan in that it employs a relatively large number of women stitchers.

[7] According to our sources, mainly large firms (exporters) availed of these services in the earlier GENPROM project.

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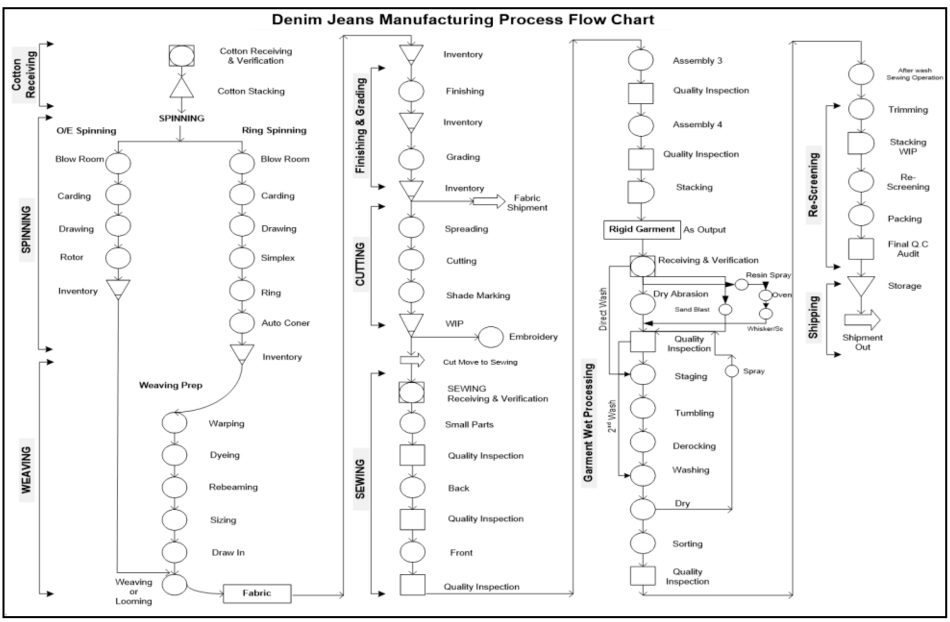
Appendix 1

Mapping the Manufacturing Process and Technologies

Starting with the already woven fabric, the production of denim jeans is broken down into several stages. These are roughly: cutting, sewing, dry and wet processes, and packing/shipping (Figure A1). Within each stage are a large number of individual processes. Please note that the following discussion of the processes involved and different technologies employed in manufacturing a pair of denim jeans is not intended to be exhaustive, particularly with regard to international practices. Rather, it is indicative of the range of processes currently in use in Pakistani factories.

Figure A1: Denim jeans manufacturing process



Source: Large-scale denim producer in Punjab.

4.1.1 Pattern Design, Fabric Spreading and Cutting

The fabric, once received from the supplier (which may be a sister concern or the firm itself in the largest, vertically integrated units), is inspected and inventoried. Firm A estimates that it is able to use 85–90 percent of the fabric. Its cut-to-ship ratio is usually 103–105 percent, but occasionally rises to 107 percent, depending on the customer. Typically, Firm A rejects 1.3 percent of the cut fabric. It produces its own denim material, but also procures specialized fabrics, such as stretch fabrics incorporating Lycra, from outside firms when needed. Fabric producers typically give concessions or discounts to make up for wastage due to fabric defects.

Before the pieces for a pair of denim jeans are cut, a pattern is designed, usually with the aid of computer programs. Variations in the shade (color) of fabric from roll to roll – particularly after it is subjected to chemicals and washed for special finishes – necessitate that factories cut all the different pieces for an individual pair of jeans from the same roll of fabric. We do not know if this is a common practice internationally. Computer-aided design (CAD) software takes the information on the size and shape of the fabric pieces needed for the jeans and fits them into a pattern intended to minimize the amount of fabric wasted. In many cases, the software lays out the pieces without enough space between them to be cut. Often, workers in the CAD section will at least partially rearrange the pattern to make it more amenable to cutting.

The pattern is then printed and laid over the spread fabric for cutting. Before the fabric is cut, it is spread on long tables, dozens of layers thick, so that stacks of pieces are cut simultaneously. As the fabric is spread, it is checked for defects. Spreading can be done manually or through an automated process whereby a large machine mechanically spreads the fabric many layers thick.

Cutting can also be done either manually or by an automated process. In manual cutting, workers use long mechanical saws to cut through the layers of fabric, using the pattern laid on top. Automated cutting involves a robotic arm cutting the fabric with a mechanical saw. The most advanced technology (not used in any firm we visited) is laser cutting. Complementarities may exist between the more advanced technologies. For example, automated cutting may be better able to handle the tight patterns generated by the auto-CAD software programs, reducing fabric wastage. Even though fabric is the costliest portion of a garment (verbal estimates are given at 50–70 percent), most firms have paid little attention to increasing efficiency here.

4.1.2 Sewing

Stitching is where the most workers are employed in manufacturing a garment. Garments are stitched on a line (consisting of ?? machines and workers). In denim jeans production, there are typically four sections for sewing: small parts (such as pockets, waist belts, belt loops), fronts, backs and assembly. Garments move along the assembly line in bundles of 20–30 garments. Each operation on the garment takes a different length of time to complete; some sewing operations can be done very quickly while others take longer. Therefore, production supervisors (sometimes with the assistance of an industrial engineer) organize production to 'balance the line', in other words, to minimize the time that operators and machines are idle on the line, waiting for work.

One or more sewers may be assigned to an operation, depending on how long it takes in relation to other operations. Operations completed quickly may be assigned to one operator, whereas a complex operation taking longer to complete may have two or three operators assigned to it. Helpers are sometimes assigned to assist sewing operators by preparing a garment for stitching, for example, aligning pieces or cutting threads. Additionally, more or less experienced operators may be strategically placed in order to minimize downtime.

Different technologies can be employed in the sewing section, in particular, the sewing machines themselves and the equipment used to move garments along the line. In the least technologically advanced factories, garments are transported by hand or cart and basic or standard sewing machines are used for all processes. More advanced technologies include auto-trimming sewing machines, set to make only a certain length of stitch after which the thread is automatically cut; specialized machines for stitching certain small parts such as belt loops; and specialized machines for performing particular operations such as attaching a back pocket to each pair of jeans. At the most sophisticated level, there are also fully automated solutions for transporting in-process garments from one sewing operator to the next, such as Eton. Factories may also employ an intermediate system where garments are clipped on and manually pulled along a track.

4.1.3 Dry and Wet Processes

Dry and wet processes add a great deal of value to denim garments. These include the application of chemicals, sandpaper, rubbing, and stone washing, which intentionally damage the denim for the purpose of making the garment more fashionable. Pakistani factories have been able to incorporate these techniques into their production process and the quality of these value-added finishes is internationally accepted.

We observed a number of differences among denim factories in how the same dry and wet processes were carried out. In firms using less technology, the dry processes were mostly done manually. For example, a process known as 'scraping' was carried out using emery paper (sandpaper). Manual scraping was done on plain wooden boards, with operators applying hand pressure to give the garment the desired 'worn' look. In the more technologically advanced firms, scraping was done while the garment was stretched over inflated balloons. Another process involved adding the effect of 'whiskers' to create lines at the hips and thighs similar to those made after the garment has been worn. This can be done manually on jeans using wooden boards and the sharp edge of emery paper or with a machine that presses the lines into the jeans. Chemicals such as potassium permanganate and resin were also applied. In the less technical firms, jeans were simply hung out for the application while placing them on inflated balloons was used in the more mechanized firms.

Following the dry processes are the wet processes (including stone washing) in massive washing machines. The best machines are Italian, followed by Turkish and then Chinese machines. Firms sometimes bring in specialized washing consultants from Italy or Turkey. The jeans are then dried and repairs made (as the dry and wet processes may damage the stitching). Accessories such as buttons and rivets are attached, the jeans are pressed and retail tags added and the garments are then packed for shipment.

Appendix 2

SMVs, Actual Piece Rates and SMV-Based Piece Rates at the Operation Level

Table A1: Comparison of SMVs per garment (of matched processes only)

	Operation description	Firm A	Firm B	Firm C
1.	Hem watch pocket	0.15	0.12	0.17
2.	Serge facing	0.24	0.08	0.04
3.	Attach facing to pocket bag	0.42	0.26	0.59
4.	Att. watch pocket (mittered) with show seam toward WB CF side	0.40	0.49	1.11
5.	Serge left fly from side and bottom	0.12	0.07	0.05
6.	Attach zip to left fly	0.07	0.11	0.92
7.	Edge-stitch left fly	0.21	0.35	
8.	Fold and attach zip to right fly	0.22	0.25	1.33
9.	Serge right pnl with fly	0.20	1.34	
10.	Top-stitch right fly and hem crotch	0.28		
11.	Join crotch	0.28		
12.	Hem back pocket (dnls)	0.35	0.54	0.24
13.	Mock-stitch back pocket	0.20	1.62	1.07
14.	Make and fuse loops = 5	0.10	0.35	1.64
15.	Attach back pocket auto	1.00	1.49	2.30
16.	Second seam back pocket	0.80		
17.	Attach yokes	0.29	0.29	0.46
18.	Seat seam	0.35	0.34	0.73
19.	Bartack back pocket	0.35	0.24	0.43
20.	Set front pocket	0.45	0.15	0.54
21.	Turn and top-stitch front pocket	0.47	0.41	0.68
22.	Close pocket bag	0.70	0.22	1.11
23.	J-stitch	0.17	0.17	0.37
24.	Close out-seam busted	0.70	0.57	0.66
25.	Press busted seam	0.35	1.30	1.52
26.	Top-stitch sides 7″	0.30	0.46	0.91
27.	Fell inseam	0.64	0.87	1.48
28.	Attach waist band (auto)	0.80	0.44	0.92
29.	Close band ends	0.15	0.73	1.65
30.	Buttonhole	0.08	0.16	0.48
31.	Attach stud	0.13	0.15	0.39

	Operation description	Firm A	Firm B	Firm C
32.	Rivets = 6	0.30	0.73	1.30
33.	Bartack loops = 5	0.40	0.69	0.89
34.	Hem bottom snls	0.40	0.50	1.28
35.	Attach leather patch	0.20	0.29	1.06
36.	Thread trimming final	1.13	2.93	5.20
	Total	13.38	15.79	31.52

Source: Firm A's SMVs provided by Firm A and timed by authors for Firms B and C.

Table A2: Comparison of actual piece rate and piece rate implied by timed SMVs, using Firm A's pay scale (for matched processes only) per garment (in PRs)

		Firm A	Firm B		Firm C	
	Operation description	Piece rate (actual = implied)	Actual piece rate	Piece rate implied by timed SMV	Actual piece rate	Piece rate implied by timed SMV
1.	Hem watch pocket	0.14	0.15	0.11	0.50	0.15
2.	Serge facing	0.22	0.25	0.07	0.50	0.04
3.	Att. facing to pocket bag	0.38	0.25	0.24	1.00	0.53
4.	Att. watch pocket (mittered) with show seam toward WB CF side	0.36	0.50	0.44	1.00	1.00
5.	Serge left fly from side and bottom	0.10	0.10	0.06	0.50	0.05
6.	Attach zip to left fly	0.06		0.10	1.50	0.83
7.	Edge-stitch left fly	0.19		0.32		
8.	Fold and attach zip to right fly	0.20	0.30	0.23	4.00	1.20
9.	Serge right pnl with fly	0.18	1.10	1.21		
10.	Top-stitch right fly and hem crotch	0.25				
11.	Join crotch	0.25				
12.	Hem back pocket (dnls)	0.32	0.30	0.49	1.00	0.21
13.	Mock-stitch back pocket	0.18	1.50	1.46	1.00	0.97
14.	Make and fuse loops = 5	0.09	1.50	0.32		1.48
15.	Attach back pocket auto	0.90	1.75	1.34	7.00	2.07
16.	Second seam back pocket	0.72				0.00
17.	Attach yokes	0.26	0.40	0.27	3.00	0.41
18.	Seat seam	0.32	0.50	0.30	3.00	0.66
19.	Bartack back pocket	0.32	0.36	0.21	1.00	0.39
20.	Set front pocket	0.41	0.25	0.14	1.00	0.49

		Firm A	Firm B		Firm C	
	Operation description	**Piece rate (actual = implied)**	**Actual piece rate**	**Piece rate implied by timed SMV**	**Actual piece rate**	**Piece rate implied by timed SMV**
21.	Turn and top-stitch front pocket	0.42	0.60	0.37	2.00	0.62
22.	Close pocket bag	0.63	0.60	0.20	1.00	1.00
23.	J-stitch	0.15	0.35	0.15	2.00	0.33
24.	Close out-seam busted	0.63	1.00	0.51	3.00	0.60
25.	Press busted seam	0.32	1.15	1.17	3.50	1.37
26.	Top-stitch sides 7″	0.27	0.50	0.41	2.00	0.82
27.	Fell inseam	0.58	1.20	0.79	4.00	1.34
28.	Attach waist band (auto)	0.72	0.70	0.40	3.00	0.83
29.	Close band ends	0.14	0.65	0.66	3.00	1.49
30.	Buttonhole	0.07	0.20	0.14	1.00	0.43
31.	Attach stud	0.12	0.20	0.14	1.00	0.35
32.	Rivets = 6	0.27	0.75	0.66	2.00	1.17
33.	Bartack loops = 5	0.36	1.08	0.62	2.50	0.80
34.	Hem bottom snls	0.36	0.75	0.45	3.00	1.15
35.	Attach leather patch	0.18	0.60	0.26	1.50	0.96
36.	Thread trimming final	0.64	1.50	1.64	4.00	2.92
	Total	11.68	21.04	15.89	64.50	26.67

Source: Piece rates provided by Firm A, piece rates provided by Firms B and C, and timed operations for Firms B and C. Added were an industry standard 10 percent bundle allowance and 20 percent personal and machine allowances.

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Measuring Technology Differences Across Football Manufacturers in Sialkot

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Abstract

A fascinating example of the fluctuating fortunes of Pakistani exports is that of the footballs produced by a cluster of manufacturers in Sialkot. Dominated by Pakistani firms, the sector is now under heavy threat from cheaper balls produced in East Asia (particularly China). What is striking is that the technology used by most firms has not progressed significantly in the last 30 years. This raises the question of whether Pakistan is falling behind the technology frontier. Using data from a sample of firms, we map the football production process and focus on different cutting technologies to compare productivity across firms and measure the benefits of upgrading this technology across firms of different sizes. Our results show that technology upgrading comes at a cost, but is worthwhile for firms that need to produce a large volume of balls. However, the falling demand for Pakistani balls may not justify this for most small and medium firms in the sector, which make up the vast majority of firms in the cluster.

Keywords: Technology, manufacturers, footballs, Sialkot, Pakistan.

JEL classification: O33.

1. Introduction

The city of Sialkot is the center of football manufacturing in Pakistan. The origins of this industry, which is currently home to a large number of football firms, dates back to British colonial rule in the Subcontinent. Over the years, the football industry of this region, which now constitutes both large and small production units, has experienced considerable growth. However, in the last 15 years, Pakistan has lost a significant portion of the world's market share to China, which to date continues to pose a threat to the domestic industry (see Atkin et al., 2015b, figure A.1).

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This paper maps the football manufacturing process and looks at the technology used at each stage of production. It then focuses on the technologies used to cut the pieces used to make footballs, which we find to be the main bottleneck in the production process if the firm is operating near full capacity. Comparing technologies, we find that, while the higher cutting technology is indeed more productive in terms of labor output, the scale of production in most firms does not justify the investment. We also present some theories as to why firms that should upgrade their technology, do not.

2. The Handstitched Football Production Process

The production of footballs in the Sialkot area dates back to the late 18th century when two Sikh brothers began producing footballs. The original football manufacturers were leather makers who took the skills they had gained from producing for the Mughals and then the British to start stitching footballs. Most of these footballs were made for British troops in India, the UK and British territories (see Atkin et al., in press).

While the original football manufacturing process used leather, the current production process relies on faux leather or rexine. The steps followed by the present manufacturers mirror the production process from more than a century ago (see Atkin et al., 2015a):

- Cutting out rectangular rexine sheets from long rolls of rexine.
- Gluing layers of cloth to the back of the rexine sheets, using an imported rubber-based glue. This adds bounciness to the balls and the cloth adds weight and durability (multiple layers, usually cotton or polyester or a combination of both, can be added, depending on the quality of the ball).
- Cutting out the pieces of rexine that go into the production of the ball. The majority of balls produced are ‘buckyballs’, which require 20 hexagonal pieces and 12 pentagonal pieces.
- Printing designs and logos onto the hexagons and pentagons, based on customer preferences and using durable ink or paint.
- Stitching these pieces together to make the ball (a rubber bladder is glued onto one piece and this piece is stitched to the other pieces).
- Checking the balls for quality and durability; cleaning and packing the balls for shipping.

Each production step requires different labor skills and, in some cases, different technologies. Almost all firms cut and layer the rexine with cloth manually, though one of the largest firms in the industry uses an automatic machine for lamination. The cutting process involves either cutting dies (which are rather like cookie cutters) combined with manual presses or a large hydraulic press that cuts out half or a full sheet of pieces automatically.

Similarly, while most firms in Sialkot employ labor to hand-stitch the balls, a growing number of firms have begun using stitching machines (similar to sewing machines). The higher-quality balls are hand-stitched; the lower-quality balls (called 'promotional balls') are machine-stitched. A few firms use a more advanced technique known as 'thermo-layering', in which the pieces are molded onto bladders using heat-based technology. The majority of firms print designs and logos on the balls manually and the same applies to the final quality checks, cleaning and packing.

By our definition, an operational football firm must have an in-house cutting facility, otherwise it serves more as a trader than a producer. Each step employs people who are usually hired on contract (a common practice) and are typically paid per piece (piece rates). The football panels are then sent elsewhere to be stitched – usually to stitching centers situated in villages on the outskirts of Sialkot.

3. Reasons for Focusing on Cutting Technologies

Our research team observed the machines used to cut the primary raw material (laminated synthetic leather sheets) into panels. The findings allowed us to determine the parameters needed to compute the output capacity of each machine. As mentioned earlier, football manufacturing has four key production steps: lamination, cutting, printing and stitching.

One of the largest firms in the industry, which uses an automatic machine for lamination, pointed out that its daily output of rexine sheets laminated exceeded the number of sheets cut daily by all the in-house cutting technologies. Two other medium firms said that, in the absence of financial constraints and a regular supply of football orders, the cutting machines' output capacity could become a firm's production frontier. This gives us sufficient reason to assume that the output of all the cutting technologies owned by a firm can represent its production frontier. Thus, under the most efficient circumstances, the output of its cutting technologies marks a firm's production limits.

4. A General Model for the Cutting Capacity of a Firm

This section develops a general model to capture the maximum output capacity of a cutting technology, θ, used to produce footballs. A football is made up of a combination of different panels. Let the total number of panels in one ball be denoted by γ and each panel type by i.

$$\gamma = \sum_{i=1}^{k} \chi_i \tag{1}$$

where k is the number of panel types in a football and χ_i is the number of pieces of type i panels needed to produce a single football.

T represents the total time spent cutting laminated rexine sheets:

$$T = \sum_{i=1}^{k} T_i \tag{2}$$

where T_i is the total time spent cutting out panels of type i from the laminated rexine sheets. Equation (2) implies that the total time spent cutting rexine sheets is the sum of time spent cutting rexine sheets for each panel type i.

Writing $T_i = t_i^{\theta}.N_i$ and substituting it into Equation (2) gives us

$$T = \sum_{i=1}^{k} t_i^{\theta}.N_i \tag{3}$$

where t_i^{θ} is the time taken to cut a single rexine sheet to obtain type i panels using technology θ and N_i is the total number of sheets cut for type i panels.

$$B_i = \frac{\eta_i^{\theta}.N_i}{\chi_i} \tag{4}$$

Here, B_i is the number of footballs producible, given the number of type i panels available. η_i^{θ} is the number of type i panels obtained from a single rexine sheet, using technology θ The numerator indicates the total number of type i panels.

Conditional on the following,

$$B_i = B_j \ \forall\ i, j = 1 \text{ to } k \text{ and } i \neq j$$

and

$$\frac{\eta_i^{\theta}.N_i}{\chi_i} = \frac{\eta_j^{\theta}.N_j}{\chi_j} \tag{5}$$

and using Equation (3), we calculate,

$$N_i^* = \frac{T}{t_i^{\theta} + \sum_{j=1}^{k} \frac{\chi_j}{\chi_i} . \frac{\eta_i^{\theta}}{\eta_j^{\theta}} . t_j^{\theta}} \tag{6}$$

where N_i^* is a $f(T, \chi_{i,j}, \eta_{i,j}, t_{i,j}, \theta)$ and $i \neq j$. Using the equation below, we can calculate the number of footballs that can be produced in time T using technology θ

$$B^{\theta}_{i,j} = \frac{\eta^{\theta}_{i,j}.N^*_{i,j}}{\chi_{i,j}} \quad \forall\ i, j = 1 \text{ to } k \text{ and } i \neq j$$

This model can be used to estimate:

- The production capacity of a cutting technology meant for any kind of ball
- The number of sheets required to complete an order
- Given the output (the footballs), the number of rexine sheets required for each panel type *i*.

To focus on what we consider the most interesting case in the industry, we will apply the model to determine the production capacity of the cutting technologies generally used in Sialkot's football industry to produce the most common ball: a 32-panel, size 5 football. We also impose the following parameter: the edge-length of the panel size is 43.75 mm.

As mentioned previously, the 32-panel football is a combination of two types of panels: hexagons (denoted by *H*) and pentagons (denoted by *P*). Thus, we have:

$$\gamma = \chi_H + \chi_H \tag{a}$$

$$T = t^{\theta}_{H}.N_H + t^{\theta}_{P}.N_P \tag{b}$$

Conditional on the following,

$$B_H = B_P \tag{c}$$

we get

$$N_H = \frac{\chi_H}{\chi_P} \cdot \frac{\eta^{\theta}{}_P}{\eta^{\theta}{}_H} . N_P \tag{d}$$

Using Equations (b) and (d), we calculate:

$$N_H{}^* = \frac{T}{t_H{}^{\theta} + \frac{\chi_P}{\chi_H} \cdot \frac{\eta_H{}^{\theta}}{\eta_P{}^{\theta}} . t_P{}^{\theta}}$$

$$N_P{}^* = \frac{T}{t_P{}^{\theta} + \frac{\chi_H}{\chi_P} \cdot \frac{\eta_P{}^{\theta}}{\eta_H{}^{\theta}} . t_H{}^{\theta}}$$

$$B^{\theta}{}_{H,P} = \frac{\eta^{\theta}{}_{H,P} . N^*{}_{H,P}}{\chi_{H,P}}$$

where the following are predetermined:

- The total number of pieces per football, $\gamma = 32$
- The number of panel types, $k = 2$
- Panel types i = hexagon (H) and pentagon (P)
- The number of hexagonal pieces in each football, $\chi_H = 20$
- The number of pentagonal pieces in each football, $\chi_P = 12$.

5. Various Cutting Technologies

We now turn to the machine types used, θ This includes specific technologies being used in Sialkot's football industry that play a critical role in cutting laminated rexine sheets into the panels necessary for football production.

The most commonly used machine is the locally manufactured manual press. This particular technology enables firms to cut out panels with the help of a single skilled cutter. The cutting expert adjusts the rexine sheet appropriately under the press while manually holding the metal die in position over the sheet. He then pushes down on a pedal, which sets the press into motion, hitting the metal die that allows it to come sharply down onto the sheet, cutting out the intended panels. The cutter then moves the sheet along the machine, while working the pedal continuously.

The metal die can be any shape. In the case of football production, the most common die comes in a hexagon/pentagon shape and is back-to-back. Going forward, we refer to the double-panel die combined with a manual press as DP-MP. The die cuts out two panels with each stroke of the press. Prior to the double-panel die, the industry used a single-panel die, also in the shape of a hexagon/pentagon. This die cuts out a single piece (either a hexagon or pentagon) from the laminated rexine sheet with each stroke of the manual press. It is still used, but rarely. Hereafter, we refer to this technology as SP-MP.

The larger firms in the industry also use a table cutting (TC) press. Unlike the wheel manual press, this particular technology requires minimal manual intervention. The metal dies are already fixed on the hydraulic press: when the machine is turned on, they descend gradually onto the rexine sheet, cutting out the panels. The only time that human aid is required is when the rexine sheet needs to be spread out on a solid flat surface under the cutting press and when it is finally pulled out after having been cut. Table cutting presses can be used with dies that cut half a rexine sheet (TC-HS) or an entire rexine sheet (TC-FS) with each stroke. Relative to the manual press, this is a faster process, allowing more panels to be cut out in a given period of time.

One of the most technologically advanced cutting processes is the click-press process, which is common internationally. The click press is more mechanized, which means that the machine is operated by clicking two buttons simultaneously. This is far easier and quieter than any of the other processes.

6. Comparing Output Across Cutting Technologies

Since the firm's production capacity is limited by its cutting capacity when it is operating at full potential, this section looks at the differences in potential output among the different technologies we have observed. As Table 1 shows, the SP-MP, which is among the oldest technologies, yields about 600 balls a day. At the next level up, the newer DP-MP can cut almost double that amount.

Table 1: Maximum daily output, by technology

Cutting technology	Maximum daily output
Single-panel manual press*	600
Click press*	413
Double-panel manual press**	1,109
Table-cutting half-sheet**	2,423

Note: * = calculated using firm-level data, ** = calculated using our model.
Source: Authors' calculations based on survey results.

Moving up the technology ladder to the TC-HS process, we see that one machine can cut almost 2,500 balls a day, which is four times the output of the simple SP-MP and more than double the output of the DP-MP. The technologically more advanced click press is the least productive in terms of the number of balls produced, but is used by firms to comply with certain labor standards and certification issues since it requires the least physical effort and is the quietest technology.

At face value, it would seem that moving from the SP-MP to the DP-MP to the TC-HS process is an easy decision. However, while the single-panel and double-panel manual presses both require a single worker (working a six-hour shift), the half-sheet cutting press needs two workers. Table 2 presents the maximum daily output per worker. Again, the DP-MP and TC-HS processes produce far more balls per worker than the other technologies. Since these are the two most prevalent cutting technologies in Sialkot, the numbers agree with the reality on the ground.

Table 2: Maximum daily output per worker, by technology

Cutting technology	Maximum daily output per worker
Single-panel manual press	600
Click press	413
Double-panel manual press	1,109
Table-cutting half-sheet	1,212

Source: Authors' calculations based on survey results.

Tables 3 and 4 convert the daily output to monthly numbers. This is where the story is more revealing. Most firms use DP-MP even though the output of the half-sheet hydraulic press is far higher. We ask why firms do not simply adopt the latter. Are they acting irrationally?

Table 3: Maximum monthly output, by technology

Cutting technology	Maximum monthly output
Single-panel manual press	15,000
Click press	10,325
Double-panel manual press	27,725
Table-cutting half-sheet	60,600

Source: Authors' calculations based on survey results.

Table 4: Maximum monthly output per worker, by technology

Cutting technology	Maximum monthly output per worker
Single-panel manual press	15,000
Click press	10,325
Double-panel manual press	27,725
Table-cutting half-sheet	30,300

Source: Authors' calculations based on survey results.

7. Comparison of Cutting Costs: DP-MP versus TC-HS

Up till now, the story of football production in Sialkot has been simple: firms laminate and cut out pieces from rexine sheets; these are printed and stitched together. The binding constraint to production in the football sector seems to be the number of pieces that can be cut out of the rexine sheets (given the firm is operating at its full potential). Additionally, various technologies are used in the cutting process. As one moves up the technology ladder, these produce more balls (the click press is an exception, but the reason for using it is explained above).

The two technologies we observed that produce the most output per worker are the DP-MP and TC-HS technologies. Since the latter produces more balls per worker, the question that arises is why all firms do not shift from the former to the latter. One potential reason could be that factoring labor costs into the equation makes the half-sheet hydraulic press less attractive. To test this idea, we asked four football manufacturers to tell us their labor costs associated with using the DP-MP technology. One of these firms also uses the TC-HS technology and reported the labor costs associated with it.

Table 5 shows the labor costs for both technologies. What is interesting is that one firm (which uses both technologies) pays the workers who operate the half-sheet table cutting machine a monthly salary, but all the firms (including the 'large' firm) pay cutters using the DP-MP technology a piece rate.

Table 5: Labor cost, by technology

Firm type	Labor cost of cutting (based on piece rate), using DP-MP	Labor cost of cutting, using TC-HS
	Per ball (PRs)	Per month (PRs)
Small	2.00	
Medium-small	3.00	
Small-medium	1.75	
Medium-large	1.20	
Large	1.10	14,000

Note: Firms are categorized by average monthly output.
Source: Authors' calculations based on survey results.

Table 6 converts the monthly salaries of the workers operating the half-sheet hydraulic press into per-ball costs (assuming the firm produces close to its maximum production capacity). Here, we see that the labor cost per ball using the more advanced technology is less than half the labor cost per ball of the older DP-MP technology. Again, this begs the question of why firms are not upgrading their technology. In the next section, we provide some hypotheses. It is also interesting to note that, relative to the others, the 'large' firm has been able to bid down the cutting cost per ball using DP-MP.

Table 6: Labor cost per ball, by technology

Firm type	Labor cost of cutting (based on piece rate), using DP-MP	Labor cost of cutting, using TC-HS
	Per ball (PRs)	Per ball (PRs)
Small	2.00	
Medium-small	3.00	
Small-medium	1.75	
Medium-large	1.20	
Large	1.10	0.46

Source: Authors' calculations based on survey results.

8. Why Aren't All Firms Switching from MP to TC Technology?

In the previous sections, we saw that the higher technology produces more balls per month and more balls per worker per month. It is also cheaper in terms of labor costs per worker (assuming workers are paid a fixed rate). Below, we hypothesize why firms are not upgrading their technology.

8.1 Cost

A key difference between the technologies (other than output and productivity) is their cost. Table 7 shows that there is a significant difference in cost between the older technology and the newer technology, which may hinder small and medium firms from adopting the latter.

Table 7: Cost of technology

Technology	Labor	Price of new machine	Annual repair and maintenance (av.)
		PRs	PRs
DP-MP	1	150,000	16,000
TC-HS	2	400,000	100,000

Source: Authors' calculations based on survey results.

8.2 Operating Capacity

The second issue concerns scale. Are firms producing at levels that would justify the cost of the more advanced technology? Table 8 gives an interesting breakdown of output for five firms of varying size. We then calculate their maximum monthly output potential using the earlier equation (Yc). The firms also reported their estimated maximum monthly capacity (Yp). Next, we give the reported average monthly output of balls produced by each firm (Ya). Finally, we calculate a capacity utilization number that indicates the amount a firm is producing as a percentage of total output (Ya/Yc).

Table 8: Output, by technology and firm type

Firm type*	Code	DP-MP	TC-HS	*Yc*	*Yp*	*Ya*	*Ya/Yc*
Small	S	1	0	27,725	25,000	2,000	7.2
Medium-small	MS	1	0	27,725	20,000	2,400	8.7
Small-medium	SM	2	0	55,450	30,000	7,500	13.5
Medium-large	ML	14	0	388,150	375,000	125,000	32.2
Large	L	4	4	353,200	350,000	291,667	82.6

Note: Yc = monthly output capacity (calculated), Yp = monthly output capacity (firm's estimate), Ya = monthly average output in 2015, Ya/Yc = percentage capacity utilization.
* = firms using neither SP-MP nor TC-FS.
Source: Authors' calculations based on survey results.

The numbers show that the small and medium firms operate far below capacity. The largest firm is the only one operating close to full capacity. Note that one firm is using 14 DP-MPs, but has still not upgraded its technology. The lesson here is that most firms are not operating near their production capacities and do not think their scale justifies moving up the cutting-technology ladder.

8.3 Piece Rate versus Fixed Rate

As discussed earlier, the 'large' firm, which uses both technologies, pays workers who operate the TC-HS machine a monthly salary. By doing so, it is able to reduce the labor cost per worker. There is a significant body of literature available on high-powered incentives (such as piece rates) and low-powered incentives (such as fixed wages) and how these affect worker productivity (see Gibbons & Roberts, 2013).

Ceteris paribus, firms that are producing near full capacity may find it costlier to implement the higher cutting technology if they operate under a piece rate system, particularly given that the machine costs more to repair and maintain each year (see Table 7). For firms with significantly large production, a major incentive to move to the higher technology would be the labor cost saving, but this may only be possible under a fixed rate system and depends heavily on how the firm designs its contracts.

8.4 Slow Adoption of Technology

Another issue is the inertia of existing technologies or slow adoption of new technologies. In other words, firms may be reluctant to move up the technology ladder if they are comfortable with their existing technology and disinclined to change. An interesting case study of this is when the double-panel die was introduced in the late 1970s. Firms found they could use their existing manual presses and purchase the new dies. This required the capital investment of switching from their current single-panel dies (for all football sizes) to double-panel dies; it also entailed the cost of retraining their workers. Despite this, the cost savings were significant. According to estimates,[1] the amount of rexine wasted fell by 20–30 percent, which led to a reduction in costs of almost 10 percent.

Table 9 shows when the sample firms were established and when they adopted the double-panel die to replace the single-panel die. The oldest firm took almost 20 years to switch despite the unambiguous benefits. The newer firms took less time, but even the largest firm, which stood to gain the most, took four years.

Table 9: Date of switching from SP to DP technology

Firm type	Code	Tech. adopted in	Firm established in
Medium-small	MS	2002	1995
Small-medium	SM	2005	1984
Large	L	1991	1987

Note: DP technology was introduced in the late 1970s.
Source: Authors' calculations based on survey results.

8.5 Reluctance to Reduce Labor Force

One of the important findings of this paper is that output per worker is higher for the higher-tech capital. Since firms are constrained in terms of international demand, it is very possible that those that upgrade their technology may end up reducing their workforce. Our interviews with firms show that owners are reluctant to fire workers unless the international demand for footballs were to fall drastically. This means that one reason firms – especially medium firms with constrained demand for their balls – are reluctant to upgrade their technology is that it may entail having to fire workers.

9. Conclusion

This paper has looked at the production process for hand-stitched footballs made in Sialkot. We began by mapping the production process

[1] Estimates recorded from firm interviews.

and used this to determine the main bottleneck (if firms are operating near capacity): the stage at which pieces are cut out of the rexine (artificial leather) sheets. We then looked at each of the technologies used in the cutting process and used the data we had collected to compare these in terms of productivity and labor cost per unit.

Moving up the cutting technology ladder enables firms to produce higher levels of output. One advanced technology, however, is the least productive, but puts less strain on workers. When we look at the maximum daily output per worker, we find that two technologies are the most productive per worker – the DP-MP and the table-cutting process. This makes sense since these are the two most prevalent cutting technologies in Sialkot. Narrowing our focus to these two competing technologies, we see that the more advanced technology (TC-HS) is more productive in terms of labor output than the older one (DP-MP).

This raises the question of why firms are not upgrading their technology. We respond with three hypotheses. First, the significant difference in the cost of the older and newer technologies may act as a barrier to adopting the latter for small and medium firms. Second, the low scale of operation of most firms does not justify technological upgrading. In particular, since most firms are not operating near their maximum production capacity, they feel they cannot justify moving up the cutting technology ladder.

Third, a certain level of ‘technological inertia’ has slowed down the adoption of new technologies: firms may be reluctant to move up the technology ladder because they are comfortable with their existing technology and disinclined to change. We give the example of how firms took years to adopt the previous improvement in cutting technology even though it required minimal investment. Finally, firm owners are reluctant to fire workers, which means that firms may be reluctant to adopt new technology if they feel this will force them to have a smaller workforce.

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Technology in the Sialkot Gloves Manufacturing Sector

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Abstract

This paper uses a unique sample of sports glove manufacturers from Sialkot to develop an index of technological sophistication. The data shows that total factor productivity (TFP) and total revenue productivity (TRP) cluster around their mean levels. The medium-tech and high-tech firms seem to have a higher TFP and LP than the low-tech firms. Another interesting result is that, across firms, the level of retained earnings has a negative impact on TFP and TRP.

Keywords: Technology, manufacturing, gloves, Sialkot, Pakistan.

JEL classification: L67, O14.

1. Introduction

There is a rich body of literature that provides both empirical and theoretical evidence that firms' investment in technology is a key factor in rapid industrial growth (see Amsden & Chu, 2003; Lall & Urata, 2003; Mathews & Cho, 2007). The bulk of the empirical evidence finds that most firms in developing economies fail to invest in technology, which could not only fuel growth, but also lead to export diversification. In this paper, we focus on Pakistani-made sports gloves – a rapidly growing export sector.

There are several reasons for focusing on this sector: First, sports glove exports are growing rapidly and Pakistan is a major player in this market. Its exports of sports gloves increased by $25 million in 2013/14, while exports of other sports goods fell during this period. Second, the glove production process is relatively simple, which allows us to map it and to determine the technologies used in each step. Finally, given the small number of glove manufacturers in Sialkot, our sample of firms is fairly representative of the population.

In comparison to the literature, we focus on the level of technology adopted at each stage of the production process. We also attempt to measure the impact of technology adoption based on how technology is related to

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firm-level measures of productivity. Our main objective is to analyze whether productivity, firm size, management practices, financial constraints, research and development (R&D) and export destinations affect technology adoption at the firm level.

Figure 1 shows where Pakistani-made sports gloves are primarily exported. High-to-medium-quality gloves are exported largely to North America and Europe, while low-quality gloves are exported to Australia and Asian markets.

Figure 1: Export destinations for gloves, by quality of good

Key: ○ High-quality gloves, export destinations
□ Medium-quality gloves, export destinations
△ Low-quality gloves, export destinations

Source: Authors' calculations.

2. Literature Review

During the second half of the 20th century, a number of developing countries, especially in East Asia, experienced rapid growth in productivity and economic performance. This was tied not only to the changing structure of international trade, but also to new factors being introduced into global competition. Porter (1990) highlights some of these factors, which include foreign direct investment, increased product variety, communication and transport networks and the adoption of new technologies. Lall (2001) also focuses on the connection between export performance and firms' adoption of technology.

Many of the empirical studies looking at the link between technology and export performance find mixed results. Cotsomitis, DeBresson and Kwan (1991) and Kumar (2002) find only weak evidence of this link. More recent work has found that technology adoption – measured by R&D expenditure – has a positive impact on export performance (see Kumar & Siddharthan, 1994; Basile, 2001). Lal (2002) finds that the adoption of e-business technologies has had a significant impact on the export performance of small and medium industries in India.

Generally, the theoretical and empirical evidence implies that the adoption of technology plays a role in the performance of manufacturing firms. In this paper, we hypothesize that firm-level technology adoption can explain differences across exporting firms in the Sialkot sports glove industry.

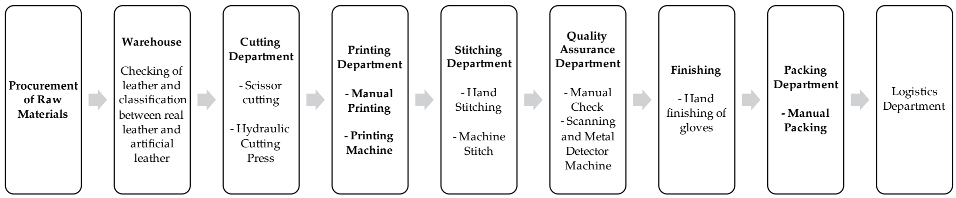
3. Study Sample

The study is based on a field survey of 20 registered small, medium and large sports glove manufacturers in Sialkot, Pakistan. There are about 500 registered glove firms in Sialkot, but we have restricted our sample to those producing sports gloves. According to firm-level information from the Sialkot Chamber of Commerce, there are approximately 35 registered sports glove firms in Sialkot, of which we randomly selected 20 firms to survey. The questionnaire asked respondents about firm size, R&D expenditures, export destinations, production processes and machinery, technology adoption and the cost and the quality of gloves produced. In addition to the survey, we also mapped each firm's production process.

4. Mapping the Gloves Production Process

The production of sports gloves is relatively simple. After the raw materials are procured and checked for quality, the leather or faux leather (rexine) is cut into pieces using a pair of scissors or a hydraulic cutting machine. Next, the designs or emblems are painted onto the cut pieces, which are then stitched together. Finally, they are checked for quality and hand-finished before being packed. Figure 2 shows the production steps.

Figure 2: Glove production process flow

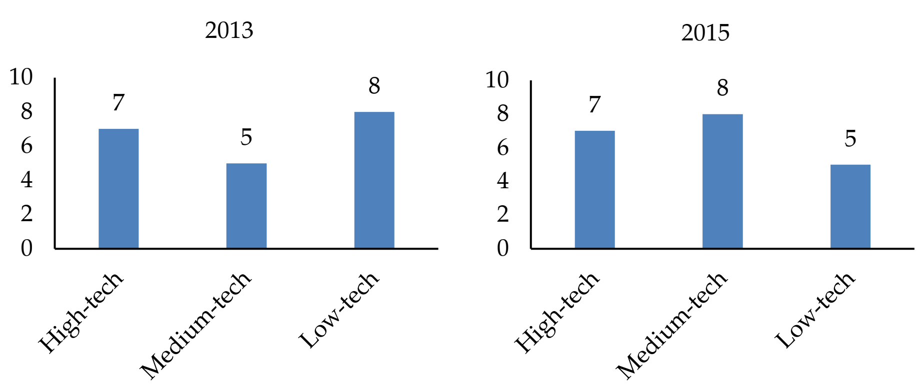


What makes the production process interesting is that all firms tend to rely on manual labor to procure and check the raw materials, and to finish and pack the final product. However, they vary in terms of the technologies used in the cutting, printing and stitching. While some firms carry out the cutting manually (using pairs of scissors), others use hydraulic cutting presses. Similarly, some firms print the emblems on the rexine by hand while others use automated printing machines. Finally, some firms use manual labor to stitch the gloves while others use sewing machines.

5. Measuring Technology in the Production Process

A key issue in this paper is how the level of technology varies across firms. In order to determine technology levels, we create a new firm-level technology ranking based on the sophistication of the technology used at each step of the production process. A firm is ranked 'low-tech' if it uses machinery solely at the stitching stage. A 'medium-tech' firm uses machinery in the cutting and stitching of gloves. A firm is ranked 'high-tech' if it uses machinery in the cutting, stitching and printing of gloves. Figure 3 shows that firms have moved up the technology ladder from low-tech to medium-tech, but not from medium-tech to high-tech.

Figure 3: Technology levels of glove manufacturers



Tables 1 and 2 show that medium-tech production and revenue is about four times that of small-tech production and revenue. Similarly, large-tech production and revenue is about four times that of medium-tech production and revenue. Interestingly, there is less difference between low-tech and medium-tech firms in terms of the cost of capital, but a substantial difference in the cost of capital between medium-tech and high-tech firms.

Table 1: Differences between firms, by technology level

	Production	**Revenue**	**Cost**	**Profit**	**Markup**	**Cap. cost**
Technology	**1**	**2**	**3**	**4**	**5**	**6**
High	3,384,000	2,694,735,000	1,555,355,379	1,139,379,621	73.82	31,735,779
Medium	768,000	925,560,000	517,358,434	408,201,566	66.77	794,262
Low	140,571	23,786,0571	157,553,896	80,306,675	55.00	679,834

Note: 1 = *average annual production*: total number of gloves (quality = high, medium and low) produced by the firm on average in a year.
2 = *average total revenue*: total revenue generated by selling gloves (quality = high, medium and low) on average at their respective prices in a year.
3 = *average total cost*: the sum of the cost of materials, labor, energy and capital for the firm in a year.
4 = *average annual profit*: the difference between total revenue and total cost, including the firm's overheads, in a year.
5 = *average markup*: annual profit divided by total cost.
6 = *average current year cost of capital*: yearly cost of machinery used in the firm's production process, net of depreciation.
Source: Authors' calculations.

Table 2: Percentage differences between firms, by technology level

	Difference in					
% Difference from	**Production 1**	**Revenue 2**	**Cost 3**	**Profit 4**	**Markup 5**	**Cap. cost 6**
Low to medium	446.34	289.12	228.37	408.30	20.84	16.83
Medium to high	340.63	191.15	200.63	179.12	10.56	3,895.63
Low to high	2,307.00	1,033.00	887.00	1,319.00	34.00	4,568.00

Note: 1 = *average annual production*: total number of gloves (quality = high, medium and low) produced by the firm on average in a year.
2 = *average total revenue*: total revenue generated by selling gloves (quality = high, medium and low) on average at their respective prices in a year.
3 = *average total cost*: the sum of the cost of materials, labor, energy and capital for the firm in a year.
4 = *average annual profit*: the difference between total revenue and total cost, including the firm's overheads, in a year.
5 = *average markup*: annual profit divided by total cost.
6 = *average current year cost of capital*: yearly cost of machinery used in the firm's production process, net of depreciation.
Source: Authors' calculations.

6. Measuring Productivity

To determine the link between technology and productivity, we look at three different measures of firm-level productivity: (i) total factor productivity (TFP), (ii) total revenue productivity (TRP) and (iii) labor productivity (LP).

Using a Cobb–Douglas production function with four factors of production (capital, labor, energy and intermediate goods), we estimate TFP and TRP. The Cobb–Douglas specification used in the estimation is:

$$Y_{ij} = A_{ij}\, K_{ij}^{\alpha_{ij}} L_{ij}^{\beta_{ij}} M_{ij}^{\gamma_{ij}} E_{ij}^{\mu_{ij}}$$

where Y_{ij} is output, K_{ij} is the replacement value of machinery for a given year, L_{ij} is the labor cost, M_{ij} is the cost of materials and E_{ij} is the energy cost. Additionally,

$$\alpha_{ij} = \frac{Capital\ cost_{\ ij}}{Total\ cost_{ij}}$$

$$\beta_{ij} = \frac{Labor\ cost_{\ ij}}{Total\ cost_{ij}}$$

$$\lambda_{ij} = \frac{Materials\ cost_{\ ij}}{Total\ cost_{ij}}$$

$$\mu_{ij} = \frac{Energy\ cost_{\ ij}}{Total\ cost_{ij}}$$

Productivity is then measured by:

$$A_{ij} = Y_{ij} / \, K_{ij}^{\alpha_{ij}} L_{ij}^{\beta_{ij}} M_{ij}^{\gamma_{ij}} E_{ij}^{\mu_{ij}}$$

where Y_{ij} is measured in terms of total output to calculate TFP and Y_{ij} is measured in terms of total sales to calculate TRP.

Thus, TFP is estimated as the nonparametric residual term of the production function, where output is measured in terms of the number of gloves sold and the output elasticity of each input factor is calculated as the cost share of that input in total cost. Firm sales are measured by the number of pairs of gloves sold (including the value of all high-, medium- and low-quality gloves). TRP is estimated using firm sales in rupee terms (price x quantity). The capital cost is calculated using data for all types of machinery used in the production process, the years in which they were operational, the expected life of the machines and their depreciation. Labor cost is the sum of the total compensation given to workers directly involved in production. Intermediate goods are determined as the sum of the per unit cost of raw materials and intermediate materials, multiplied by the number of gloves produced.

Next, we calculate LP as total output divided by the number of workers:

$$LP = Y_{ij}/Number\ of\ workers$$

Table 3 gives descriptive statistics for the firms' output and cost of materials, labor, capital and energy according to their level of technology adoption. On average, the output produced by high-tech firms is significantly larger than that of medium-tech and low-tech firms in both 2015 and 2013. Moreover, material, labor, capital and energy costs increase for all types of firms over the span of two years. As expected, high-tech firms have higher total costs than medium-to-low-tech firms.

Table 3: Descriptive statistics: inputs and outputs, by level of technology

Technology level	Output	Materials cost	Labor cost	Capital cost	Energy cost
Average: high-tech 15	3,384,000	1,276,767,450	193,999,650	31,735,779	52,852,500
SD: high-tech 15	3,829,523	1,386,218,298	227,422,172	56,640,351	55,501,760
Average: medium-tech 15	768,000	436,902,600	66,573,000	679,834	13,203,000
SD: medium-tech 15	650,938	358,268,042	41,065,338	545,816	8,351,676
Average: low-tech 15	140,571	123,373,371	27,307,063	794,262	6,079,200
SD: low-tech 15	109,666	124,557,440	32,528,779	678,600	8,027,153
Average: high-tech 13	3,677,143	1,039,784,714	183,462,321	39,780,515	49,029,857
SD: high-tech 13	3,663,230	1,175,298,253	187,543,863	65,630,377	42,219,687
Average: medium-tech 13	688,800	335,551,800	56,563,920	747,816	10,202,400
SD: medium-tech 13	547,537	242,763,836	35,549,384	600,398	5,820,435
Average: low-tech 13	138,000	106,778,700	24,102,750	865,883	5,243,250
SD: low-tech 13	107,283	108,801,517	31,677,437	691,440	7,608,396

Note: SD = standard deviation.
Source: Authors' calculations.

Figure 4 shows the average trend in the firms' TFP. For both years, 2013 and 2015, a significant number of firms are clustered around the mean TFP and only one firm experiences above-average productivity. As Figure 5 shows, in 2015 there are 15 firms clustered around the average TRP, with one firm experiencing higher-than-average TRP. In 2013, more firms are clustered around the average TFP, while only two experience below-average TFP. Figure 6 shows the average LP trend. In 2015, the average LP of the firms improves in comparison to 2013.

In general, Figures 4, 5 and 6 show TFP and TRP clustering around their mean productivity levels. For 2015, the lower tail of the distribution of TFP becomes thicker, which indicates a larger number of low-productivity firms. This is reinforced by the LP distribution, which has a fat lower tail, implying that firms cluster around a lower LP. Figure 7 shows productivity by technology level: medium-tech and high-tech firms seem to have significantly higher productivity than low-tech firms.

Figure 4: TFP of glove manufacturers

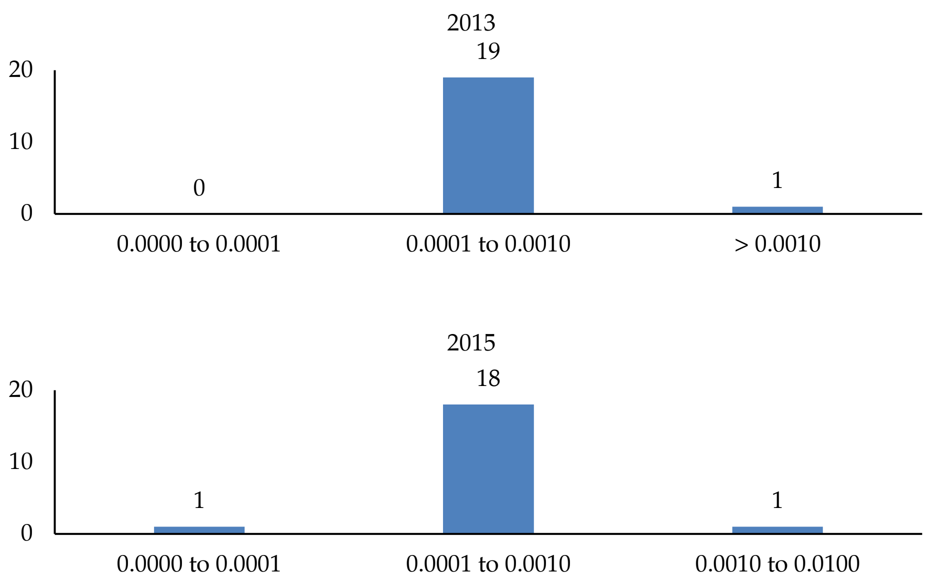


Figure 5: TRP of glove manufacturers

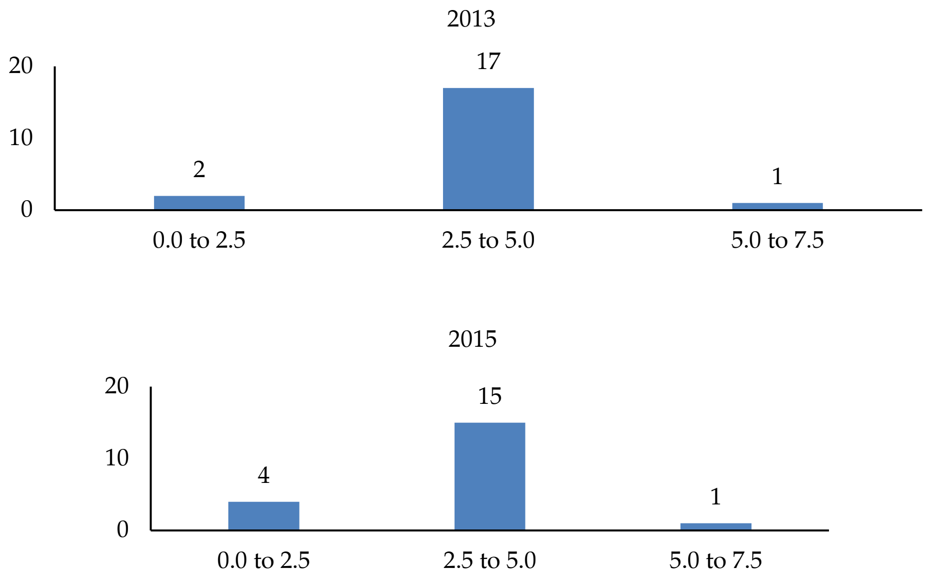


Figure 6: LP of glove manufacturers

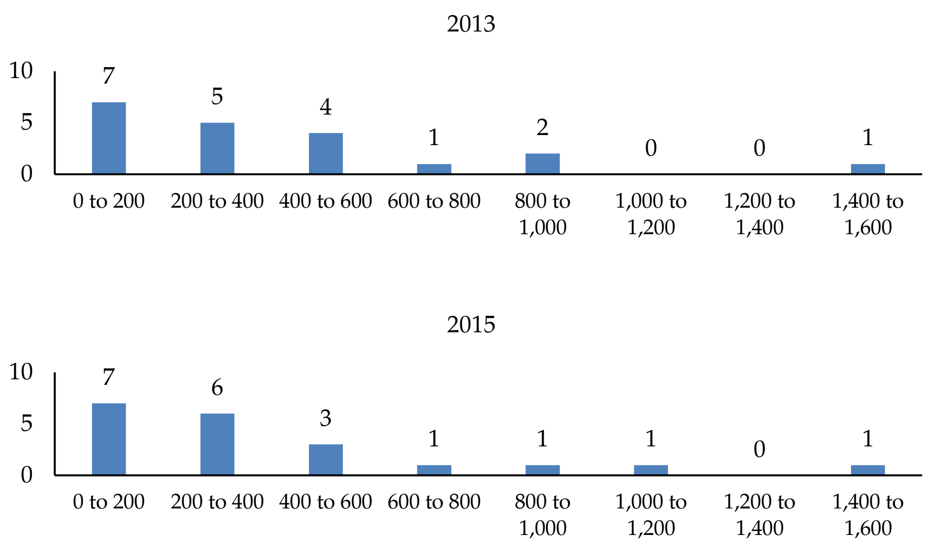
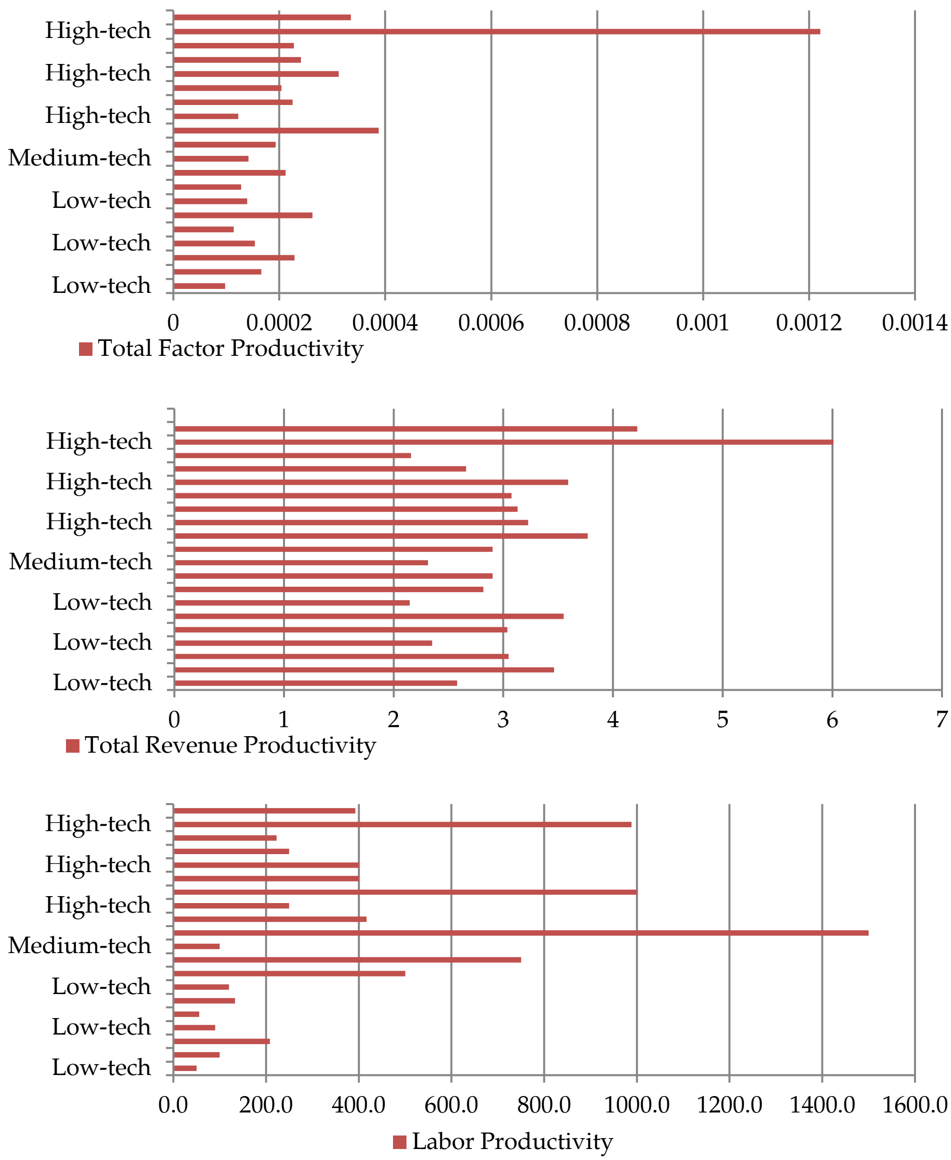


Figure 7: TFP, TRP and LP, by level of technology



7. Estimating Technology Adoption and the Relationship between Productivity and Technology

In order to analyze the correlates of technology adoption, we estimate an ordered logit model that tests the impact of factors such as firm size, age, production, ownership, finance, owner's education, profitability, R&D spending and export destinations on technology adoption. The model is written as:

$$Technology\ adoption = \alpha_0 + \alpha_1 age\ of\ firm_i + \alpha_2 firm\ profitability_i + \alpha_3 R\&D_i + \alpha_4 firm\ size_i + \alpha_5 owner's\ education_i + e_i \quad (1)$$

To see how technology adoption and firm-level characteristics affect TFP, TRP and LP, we estimate:

$$TFP = \alpha_0 + \alpha_1 age\ of\ firm_i + \alpha_2 retained\ earnings_i + \alpha_3 firm\ profitability_i + \alpha_4 technology\ adoption_i + \alpha_5 firm\ size_i + \alpha_6 production\ capacity_i + \alpha_7 R\&D_i + \alpha_8 owner's\ education_i + \alpha_9 education\ of\ owner's\ child_i + e_i \quad (2)$$

$$TRP = \alpha_0 + \alpha_1 age\ of\ firm_i + \alpha_2 retained\ earnings_i + \alpha_3 firm\ profitability_i + \alpha_4 technology\ adoption_i + \alpha_5 firm\ size_i + \alpha_6 production\ capacity_i + \alpha_7 R\&D_i + \alpha_8 owner's\ education_i + \alpha_9 education\ of\ owner's\ child_i + e_i \quad (3)$$

$$LP = \alpha_0 + \alpha_1 age\ of\ firm_i + \alpha_2 retained\ earnings_i + \alpha_3 firm\ profitability_i + \alpha_4 technology\ adoption_i + \alpha_5 firm\ size_i + \alpha_6 production\ capacity_i + \alpha_7 R\&D_i + \alpha_8 owner's\ education_i + \alpha_9 education\ of\ owner's\ child_i + e_i \quad (4)$$

8. Empirical Results

The empirical results in Table 4 show that the age of a firm is negatively related to technology adoption, which implies that older firms innovate less than younger (newer) firms. They are more likely to continue with the conventional production methods in which they have gained expertise over time. The idea is that, while adopting new machines and advanced process technologies can increase firms' output, the cost of switching from old to new technologies is perceived to be too high.

Our interviews with the firms' main decision makers reveal that owners think most of their workforce is relatively unskilled and adopting new technologies would require both a skilled workforce and technical training, which most firms lack. These findings are consistent with the literature: many new firms start as large enterprises and are more likely to adopt advanced technologies in order to obtain a greater market share (see Mahmood, Din & Ghani, 2009; Faria et al., 2002; Bortamuly & Goswami, 2015).

The empirical results also show that firm profitability has a positive relationship with technology adoption. This implies that firms with higher technology have an edge over firms with low technology in terms of higher profit margins. This is probably because firms with higher profit margins invest more in the acquisition of advanced technology. This is in line with the empirical literature, which finds that firms with high profit margins tend to adopt the latest machines to develop and maintain a competitive advantage in their markets (Stoneman & Kwon, 1996; Suri, 2011).

Tables 7, 8 and 9 show that the age of a firm positively affects productivity across specifications. This implies that older firms tend to be more productive than younger firms. Moreover, retained earnings and firm profitability negatively affect productivity across specifications.

This interesting (and counterintuitive) result has several possible reasons. First, the investment objectives of firm insiders (managers, owners, founders and family) are unclear in that, if income streams are linked to the wealth of the firm they manage, they are less likely to favor a high-risk strategy, leading to lower productivity (Ishengoma, 2004). Second, keeping in mind agency theory, the discrete shareholding of large enterprises is related to information asymmetries. This results in poor control by the management, which is in direct conflict with stakeholders' interests. Thus, managers may aim to maximize their respective utilities at the expense of decreased productivity (see Hill & Snell, 1989). Third, as a firm grows older, its productivity stagnates relative to new firms (Huergo & Jaumandreu, 2004).

Table 4: Factors affecting technology adoption

Variable	OLS estimates	Ordered logit estimates
Age of firm	-0.128**	-0.427
	(0.0483)	(0.312)
Retained earnings	16.23***	59.09*
	(5.038)	(33.20)
Firm profitability	1.05e-09***	7.35e-09**
	(3.18e-10)	(3.35e-09)
R&D	-3.44e-09*	1.36e-07
	(1.70e-09)	(4.62e-07)
Firm size	-0.150	-1.569
	(0.231)	(1.596)
Owner's education	-0.0940	-0.599
	(0.0766)	(0.477)
Constant cut1		-3.133
		(5.753)
Constant cut2		0.283
		(6.176)
Constant	1.636	
	(0.951)	
Observations	20	20
R-squared	0.694	

Note: The dependent variable is *technology adoption*, a dummy variable where 1 = low-tech (firm uses machinery in stitching only), 2 = medium-tech (firm uses machinery in cutting and stitching) and 3 = high-tech (firm uses machinery in cutting, stitching and printing).
The independent variables are:
Age of firm: the number of years since the firm started manufacturing gloves.
Retained earnings: the percentage of the firm's retained earnings in 2015.
Firm profitability: the firm's annual profits.
R&D: the yearly cost incurred by the firm on R&D.
Firm size: a dummy variable where 1 = small (0–50 employees), 2 = medium (50–250 employees) and 3 = large (> 250 employees).
Owner's education: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate, 10 = matric/O levels, 8 = middle school, 0 = less than middle school.
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations.

Table 5: Factors affecting TFP

Variable	TFP
Age of firm	1.84e-05**
	(7.67e-06)
Retained earnings	-0.00175*
	(0.000802)
Firm profitability	-2.84e-13**
	(1.22e-13)
Technology adoption	7.52e-05**
	(2.95e-05)
Firm size	3.79e-06
	(2.59e-05)
Production capacity	8.39e-11*
	(4.06e-11)
R&D	8.16e-13***
	(2.30e-13)
Owner's education	1.53e-05
	(8.75e-06)
Education of owner's child	-3.24e-05**
	(1.19e-05)
Constant	0.000364**
	(0.000144)
Observations	20
R-squared	0.947

Note: The dependent variable is *TFP* in 2015.
The independent variables are:
Age of firm: the number of years since the firm started manufacturing gloves.
Retained earnings: the percentage of the firm's retained earnings in 2015.
Firm profitability: the firm's annual profits.
Technology adoption: a dummy variable where 1 = low-tech (firm uses machinery in stitching only), 2 = medium-tech (firm uses machinery in cutting and stitching) and 3 = high-tech (firm uses machinery in cutting, stitching and printing).
Firm size: a dummy variable where 1 = small (0–50 employees), 2 = medium (50–250 employees) and 3 = large (> 250 employees).
Production capacity: the number of gloves produced on average by firms in 2015.
Owner's education: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate, 10 = matric/O levels, 8 = middle school, 0 = less than middle school.
Education of owner's child: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate and 10 = in school.
R&D: the yearly cost incurred by the firm on R&D.
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations.

Table 6: Factors affecting TRP

Variable	TRP
Age of firm	0.0883**
	(0.0387)
Retained earnings	-8.782*
	(4.045)
Firm profitability	-7.81e-12
	(6.17e-10)
Technology adoption	0.325*
	(0.149)
Firm size	-0.0231
	(0.130)
Production capacity	-1.71e-07
	(2.05e-07)
R&D	4.41e-09***
	(1.16e-09)
Owner's education	0.145***
	(0.0441)
Education of owner's child	-0.125*
	(0.0598)
Constant	2.743***
	(0.728)
Observations	20
R-squared	0.871

Note: The dependent variable is *TRP* in 2015.
The independent variables are:
Age of firm: the number of years since the firm started manufacturing gloves.
Retained earnings: the percentage of the firm's retained earnings in 2015.
Firm profitability: the firm's annual profits.
Technology adoption: a dummy variable where 1 = low-tech (firm uses machinery in stitching only), 2 = medium-tech (firm uses machinery in cutting and stitching) and 3 = high-tech (firm uses machinery in cutting, stitching and printing).
Firm size: a dummy variable where 1 = small (0–50 employees), 2 = medium (50–250 employees) and 3 = large (> 250 employees).
Production capacity: the number of gloves produced on average by firms in 2015.
Owner's education: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate, 10 = matric/O levels, 8 = middle school, 0 = less than middle school.
Education of owner's child: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate and 10 = in school.
R&D: the yearly cost incurred by the firm on R&D.
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations.

Table 7: Factors affecting LP

Variable	LP
Age of firm	22.98
	(30.76)
Retained earnings	-3,531
	(3,216)
Firm profitability	8.44e-07
	(4.90e-07)
Technology adoption	257.5*
	(118.5)
Firm size	-53.49
	(103.7)
Production capacity	-0.000326*
	(0.000163)
R&D	2.35e-06**
	(9.21e-07)
Owner's education	43.73
	(35.10)
Education of owner's child	9.971
	(47.58)
Constant	-321.4
	(578.9)
Observations	20
R-squared	0.764

Note: The dependent variable is *LP* in 2015.
The independent variables are:
Age of firm: the number of years since the firm started manufacturing gloves.
Retained earnings: the percentage of the firm's retained earnings in 2015.
Firm profitability: the firm's annual profits.
Technology adoption: a dummy variable where 1 = low-tech (firm uses machinery in stitching only), 2 = medium-tech (firm uses machinery in cutting and stitching) and 3 = high-tech (firm uses machinery in cutting, stitching and printing).
Firm size: a dummy variable where 1 = small (0–50 employees), 2 = medium (50–250 employees) and 3 = large (> 250 employees).
Production capacity: the number of gloves produced on average by firms in 2015.
Owner's education: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate, 10 = matric/O levels, 8 = middle school, 0 = less than middle school.
Education of owner's child: a dummy variable where 16 = postgraduate, 14 = undergraduate, 12 = intermediate and 10 = in school.
R&D: the yearly cost incurred by the firm on R&D.
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations.

Most importantly, our results show that technology adoption has a positive impact on firm-level productivity across specifications. This result is supported by Mayer (2001), who develops a theoretical link between technology adoption and productivity. Hasan (2002) looks at this relationship for Indian manufacturing firms and finds that embodied technology inputs result in significant productivity growth rates. Bartelsman, Van Leeuwen and Nieuwenhuijsen (1998) find a significant relationship between the adoption of advanced technologies and productivity growth levels for firms in the Netherlands.

Finally, our results indicate that production capacity and R&D have a positive effect on productivity across specifications, unlike the simple OLS and ordered logit results. Lichtenberg and Siegel (1991) obtain similar results for a sample of US firms, as do Hall and Mairesse (1995).

9. Conclusion

This paper uses a unique sample of sports glove manufacturers from Sialkot to develop an index of technological sophistication by mapping the various technologies used at each step of the glove manufacturing process. We estimate the TFP, TRP and LP of each firm to see if productivity is related to technological sophistication. A casual inspection of the data shows that TFP and TRP cluster around their mean levels. The thick lower tail of the TRP distribution implies that the sample includes a large number of low-productivity firms.

This result is reinforced by the LP distribution, which has a fat lower tail. This means that firms cluster around a lower LP. The medium-tech and high-tech firms seem to have a higher TFP and LP than the low-tech firms. Moreover, in our empirical analysis, we look at the correlates of technology adoption and productivity in the sample. A key result is that higher levels of technology have a positive and significant impact on productivity.

Another interesting result is that, across firms, the level of retained earnings has a negative impact on TFP and TRP. This may reflect the fact that firms that retain higher earnings are not investing in R&D or technology. This could indicate that, in an uncertain environment such as Pakistan, firms are more concerned about present earnings than making investments that might pay off in the future.

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Entrepreneurship and Innovation in the Digital Economy

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Abstract

It is believed that Pakistan's digital economy will follow a similar growth trajectory to India, but with a lag of about five to six years. This implies that the digital economy in Pakistan carries immense potential and is likely to see very rapid growth in the next five years or so. This paper provides an overview of Pakistan's digital economy in terms of international players, successful local businesses and rising stars in different segments of the industry. We also evaluate the role played by incubation centers. The industry's emerging financial landscape appears to be attracting international venture capital firms, which is surprising, given the country risk and monitoring and control issues that are usually seen as binding constraints to investment. However, these investors use models tested in Silicon Valley and in countries such as India to estimate the potential for increase in the capital valuation of digital businesses in Pakistan. This development has also started to attract local investors. As a result, we are seeing the emergence of a venture capital industry in Pakistan. Finally, we examine the policy environment in the country and find that the existing tax policies, which were designed for traditional businesses, could be a major obstacle to the growth of the digital economy. We conclude by recommending that the government review its tax policy in view of the different nature of digital businesses and adapt it accordingly.

Keywords: Entrepreneurship, innovation, economy, Pakistan.

JEL classification: L26.

1. Introduction

The digital economy has grown rapidly since the 1990s and, today, is a dominant force in the world economy. According to the European Commission (n.d.), "the digital economy now contributes up to eight percent of the GDP of G-20 major economies [and is] the single most important driver of innovation, competitiveness and growth." In a recent report, McKinsey

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estimates that, in 2015, the value of world trade in digital services surpassed that of goods (Manyika et al., 2016). This dominance is also evident from the fact that, in 2016, five of the ten largest companies in the world by market capitalization were technology companies: Apple, Alphabet, Microsoft, Facebook and Amazon (PricewaterhouseCoopers, 2016).

India's higher economic growth since the 1990s owes a great deal to the rapid expansion of information technology (IT) and IT-enabled service exports (which, in 2015, exceeded $80 billion) and more recently to the rapid growth of digital businesses catering to the domestic economy in areas such as e-commerce, on-demand services, finance and media. IT companies such as Tata Consultancy Services and Infosys are among the top five companies by market valuation in India.

In most developing countries, the vast majority of first-time Internet users go online using their mobile phones rather than computers. Digital businesses catering to the domestic market in India, therefore, took off only with the availability of fast mobile Internet services, following the launch of 3G/4G services in 2009. Since then, its digital economy has expanded rapidly. A number of companies, such as Flipkart, Snapdeal, Shopclues (e-commerce marketplaces), Olacabs (on-demand transportation), Paytm (fintech), Hike and Zomato (social), are now counted as global "unicorns" – private companies with a market valuation of over $1 billion (CB Insights, n.d.).

Pakistan has a number of well-established IT companies such as Systems Ltd and NetSol, but digital business startups catering to the domestic market are a more recent phenomenon. The growth of digital businesses and new startups has accelerated since the launch of 3G/4G services in Pakistan in mid-2014. The Fletcher School at Tufts has developed a digital evolution index (DEI) that analyses the key underlying drivers and barriers governing a country's evolution into a digital economy. Its report states that "each emerging e-commerce market will chart its own path … but neighborhoods matter … [that is] countries in close geographic proximity seem to display similar trajectories" (Chakravorti, Tunnard & Chaturvedi, 2014).

Thus, in a sense, Pakistan could be about five years behind India in this area. In 2013, a year before 3G/4G services were launched, Pakistan was not among the top 50 countries based on its DEI, while India was ranked at 42, having shown among the highest rates of improvement in its DEI in the period 2008–13. One can expect a similar improvement in Pakistan's DEI score by 2018.

In this paper, we look at digital businesses and startups in Pakistan in terms of the entrepreneurial environment, the growth trajectories of selected successful businesses and startups and the constraints to growth in this sector.[1] The aim of the paper is threefold. First, we show that the digital economy is expanding rapidly in Pakistan and that emerging companies could be a major source of investment and growth over the next decade. Second, highlighting the immense potential of the digital economy and identifying the constraints to its growth may persuade policymakers and other stakeholders to take measures to mitigate these constraints. Third, since the process from startup to established company in the technology sector is very rapid,[2] this allows us to clearly gauge which factors either hinder or promote entrepreneurship in Pakistan. This could provide useful insights for developing policies to promote entrepreneurship in the rest of the economy as well.

The rest of the paper is organized as follows. Section 2 examines the potential of the digital economy in Pakistan, assuming that it will follow a trajectory similar to that of India. Sections 3 and 4 provide an overview of emerging players and segments of the digital economy. This is followed by a more detailed look in Section 5 at some of the success stories in the industry. Section 6 describes the role of incubation centers and co-working spaces in promoting digital startups. Sections 7 and 8 look at the emerging financial landscape induced by the financing needs of new digital businesses and the associated potential for capital gains. Section 8 examines policy issues, particularly those that might retard the growth of the digital economy, and Section 9 concludes the paper.

2. The Potential of the Digital Economy

The digital economy is sometimes called the new economy or the Internet economy, but a more concrete definition is provided by a US Department of Commerce report, *The Emerging Digital Economy*, which "characterizes a digital economy [as] based on industries and forms of IT-enabled business activity …. These [activities] include the IT industry itself, electronic commerce among businesses, the digital delivery of goods and

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[1] We have interviewed a number of people involved with the digital economy in various capacities (see Appendix).

[2] Entrepreneurs go from an idea to a company with a capital valuation of over Rs1 billion in only a few years.

services and the IT-supported retail sales of tangible goods and services" (cited in Kling & Lamb, 2000, p. 296).

In Pakistan, the third segment is already fairly well developed, with activities ranging from provision of software and business services to international and local businesses by firms such as Systems and NetSol to gaming studios, mobile app developers and freelancers.[3] However, in this paper, the term 'digital economy' refers only to the fourth segment: the IT-supported sale of goods and services to consumers.

The potential of the digital economy in Pakistan is tremendous, given the country's large consumer base. Its population is over 190 million, of whom more than 50 percent are in the 10–40-year age group (Pakistan, Ministry of Finance, 2014), that is, people who are mostly literate and comfortable using digital technology. Moreover, Pakistan is probably one of the most urbanized countries in South Asia. A recent World Bank report on urbanization in South Asia points out that,

> According to the agglomeration index, an alternative measure of urban concentration, the share of Pakistan's population living in areas with urban characteristics in 2010 was 55.8 percent. This compares to an urban share of the population based on official definitions of urban areas of just less than 36 percent, suggesting the existence of considerable hidden urbanization (Ellis & Roberts, 2015).

Thus, a large proportion of the population has exposure to a wide range of consumer goods and advertising and is within easy reach of private delivery services. Finally, there is also considerable spending power: Credit Suisse's Global Wealth Report for 2015 notes that Pakistan's middle class consists of 6.27 million people,[4] making it the 18th largest middle class worldwide (Shorrocks, Davies & Lluberas, 2015).

The key to realizing the potential of the digital economy is widespread access to the Internet. This access has grown exponentially in Pakistan since the launch of 3G/4G services in 2014. For instance, the total number of broadband subscribers (including cellular subscribers) has increased from 3.8 million in 2013/14 to 34.5 million (including 3G/4G subscribers) in July 2016 (Pakistan Telecommunication Authority, 2016). Just how phenomenal this growth has been is evident from the fact that, in 2016,

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[3] Pakistan is among the top five freelancing countries in the world (Elance, n.d.).

[4] This is more than one fourth as large as India's middle class, which was 23.67 million in 2015.

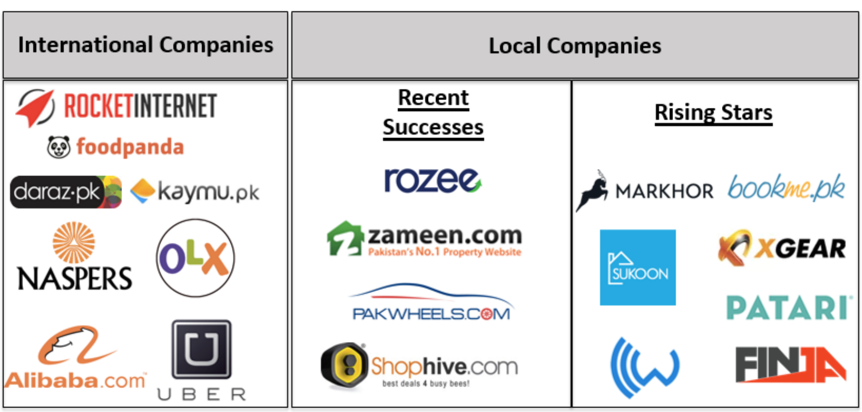
17.8 percent of Pakistan's population had Internet access compared with 11.4 percent in India, where 3G/4G services were launched in 2009.[5]

In brief, the size of Pakistan's consumer market is in the range of one sixth to one quarter that of India and Internet access is, if anything, higher. Thus, as noted above, the e-commerce market in Pakistan should follow a similar trajectory to that of India. Estimates of India's e-commerce market in 2015 ranged from $13 billion to $23 billion and it is projected to be growing at about 30 percent per annum. This provides some indication of the future of Pakistan's e-commerce market, which was estimated to be in the range of $30 million to $60 million in 2015, that is, it should reach between $2 billion and $5 billion by 2020. This would imply a growth rate of over 100 percent per annum, which is similar to the rate achieved in the last five years.

3. The Digital Players

As today's web economy develops rapidly, several categories of digital players have emerged: from new businesses entering the industry to the global giants. These digital players are classified broadly as (i) international companies operating worldwide, (ii) the successful digital companies within the Pakistani ecosystem and (iii) rising stars – businesses that have shown a remarkable growth trend and received risk financing in the short time since their establishment (Figure 1). These categories are discussed below. Since case studies of several successful digital companies are presented later in this paper, this section describes only some prominent rising stars.

Figure 1: Categories of digital companies in Pakistan



[5] In April 2016, there were 151.1 million broadband subscribers in India, including 133.5 million 3G/4G subscribers (Telecom Regulatory Authority of India, 2016).

3.1 International Companies

As the Internet economy fundamentally reduces the need for space and physical presence, today's international giants have no geographical limits. With the growth of the digital economy and as e-commerce expands, global players see Pakistan as a potentially lucrative market. Despite security risks and other concerns, a number of international companies have set up operations in Pakistan in the last few years. One of the biggest entrants is Rocket Internet, a Germany-based Internet company valued at more than $8 billion. It has launched several ventures in Pakistan, including Daraz (an online shop for shoes and fashion), Foodpanda (an online food delivery service), Kaymu (an online marketplace for used or new items), Lamudi (a property portal) and Carmudi (an online platform for the sale and purchase of cars, motorcycles or commercial vehicles).

In September 2015, Daraz, which operates in Bangladesh, Pakistan and Myanmar, raised $56 million (€50 million), not from Rocket's regular investing partners, but with the CDC Group[6] leading the round (ProPakistani, 2015). Simultaneously, there has been substantial investment by Naspers[7] in expanding its OLX venture in Pakistan (a classifieds platform with a presence in more than 40 countries). The launch of Uber Technologies in Pakistan in March 2016 shows growing international recognition of the market potential of the country.

3.2 Recent Local Successes

The mid-2000s saw the first wave of local online business startups in Pakistan. Recent successes in this group include Zameen.com, Rozee.pk, PakWheels.com and Shophive.com (see Section 5 for case studies). These companies had the first-mover advantage and, as pioneers in the services sector, established their brand names as leaders in markets such as real estate, jobs and automobiles.

The success of such firms has attracted additional e-commerce investment. Some of these businesses have even drawn international venture capital funds of approximately $39 million from the US, Southeast Asia and Europe. With such injected capital and ever-expanding Internet access, these companies are constantly changing scale and consistently creating new opportunities. These investments are used not only to expand capability, but also for advertisement and promotion. The latter has helped these firms

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[6] A development finance institution owned wholly by the UK government.
[7] A global Internet and entertainment group and one of the world's largest technology investors.

establish (in their stakeholders' eyes) their brands as valuable commodities to achieve the expansion targets set together with their parent investors.

3.3 Rising Stars

A wave of young entrepreneurs in the digital economy has emerged since 2012. They have turned novel ideas into promising startups, with innovations in areas ranging from e-commerce to music and broadcasting and from food to transportation and entertainment. The availability of real-time information to consumers and the low cost of accessing it has transformed the way people shop. Some entrepreneurs who quickly realized that this change was a window of opportunity have embarked on the road to building the new digital economy and, in a few years, made a name for themselves.

A few such companies are described below to show the diversity and innovativeness of the types of businesses being established.

- Markhor (2012) specializes in quality footwear for men by producing shoes in Pakistan and selling them directly to customers in the US. Its unique selling proposition is to eliminate intermediaries and provide an alternative to mass-produced shoes. The company became popular when it successfully ran a Kickstarter campaign. It was able to generate more than $100,000 from Kickstarter on receiving more than 500 orders. Markhor has been recently incubated with Y Combinator in San Francisco (Husain, 2015a).
- XGear (2014) aims to revolutionize vehicle and driving management with an innovative device that can be plugged into the car's on-board diagnostics port under the steering wheel. Once connected, it transmits data wirelessly to the owner's online account. This data can be accessed online via mobile phone or computer. It has proved very useful in the fleet management of company cars (Imran, 2014).
- Wifigen (2014) gives business owners innovative ways to understand their consumers and let them communicate with each other, using a marketing and analytics tool for customers and brands. It provides free Internet access to its customers and in return gains a social media following and customer data, which helps these brands target their customers more effectively. The company was recently funded, bringing its valuation to $1 million (Husain, 2015c).
- Patari (2015) is the largest Pakistani music streaming network. Patari aims to bring all the music produced in Pakistan onto one digital

platform through which users can access this collection. The website currently hosts some 600 artists and 20,000 songs. These numbers are expected to grow in the future (Salahuddin, 2015).

- Finja (2016) is a fintech startup that aims to revolutionize payment processes from traditional banking to new ways of digital banking. The founders of the company are industry veterans such as Qasif Shahid, who has over 20 years' banking industry experience. It also receives support from Monis Rahman (of Rozee), who has helped Finja secure an investment of $1 million from a venture capital firm based in Stockholm (Dodhy, 2016b).
- Sukoon (2016) is a Karachi-based home repair service that aims to revolutionize how people employ handymen at their homes and offices. It provides services such as plumbing, electrical work, painting, masonry, AC repair and carpentry. Sukoon was also funded recently by a pool of Pakistani investors that include Humayun Zafar of CresVentures, DotZero and The Indus Entrepreneurs (TiE) (Islamabad chapter) (A. Rizwan, 2016).

4. Segments of the Digital Economy in Pakistan

The growing digital economy has had a sizeable impact on traditional services offered in the market. Given the hyper-connectivity among consumers, single vendors and third-party sellers, digital businesses are now taking away the market share of traditional businesses. Digital companies offering these services are empowered by the extensive information available on their customers. These changes are taking place in the consumer goods segment as well as in the services sector. We identify four broad segments of the digital economy: (i) marketplace or classifieds, (ii) e-commerce, (iii) services and (iv) digital advertising and web enablement, which are briefly discussed below.

4.1 The Marketplace (Classifieds)

An online marketplace aims to provide a single trading platform to multiple third parties. It might cater to a single or multiple genres of products or services. Marketplaces in the digital economy operate in three forms: land markets, job markets and multiple markets (Figure 2). Zameen and Lamudi are successful examples of marketplaces servicing real estate players. Zameen has acquired funding of $29 million, making it the biggest provider in the online land market. Other mega-players operating in

Pakistan include Rozee (the job market), OLX (multiple markets, including second-hand or used goods) and PakWheels (automobiles).

Figure 2: Market types and companies

Online classifieds are a convenient, cost-efficient way of exchanging products and services and pose tough competition to existing mechanisms of classified advertising. Traditionally, selling many items such as furniture, used electronics and automobiles was very difficult and people relied largely on references or brokers to make the sale. These platforms provide a way for sellers to expose their products to an enormous customer base.

4.2 E-commerce

Pakistan has seen a rise in e-commerce in the last five years, with many businesses rapidly launching their services online. Typically using the Internet, e-commerce facilitates the trading of goods between different parties. Such commerce is divided into two segments: business-to-business (B2B) and business-to-consumer (B2C).

In Pakistan, most e-commerce is B2C and can be further divided into three types, which overlap in some cases, although it is still useful to make the distinction (Figure 3). The first category includes the online stores of traditional retailers with brick-and-mortar stores. Many successful local brands such as Bareeze, Khaadi and StoneAge now have online stores. The second type are digital retailers such as Homeshopping, Shophive and Symbios, which have their own inventory and a limited number of selected sellers, but deliver all goods themselves. The third segment of e-commerce includes digital businesses such as Daraz and Kaymu, which provide a platform for third-party sellers and span a wide range of products from hundreds of sellers.

Figure 3: E-commerce types and companies

E-Stores of Brick & Mortar Stores	Electronic Retail	Marketplace for 3rd Party Sellers
Khaadi	HomeShopping	daraz.pk
Bareezé	Symbios.pk	kaymu.pk
STONEAGE	Shophive.com	

4.3 *Services*

Some noteworthy innovations have been made in the online services industry in Pakistan. Significant new entrants have emerged in major areas such as transportation, delivery and entertainment (Figure 4). Most known brands in each category have seen tremendous growth and acceptance in a short span of time. Careem, Uber and Savari have all started successful operations in the personal transportation (ride-on-demand) segment, while delivery services have grown rapidly because of companies such as Roadrunner, Delivery Chacha, Foodpanda and EatOye. Other service providers such as Bookme, Javago and MyTicket help in booking cinema tickets, hotel rooms and airline, train and bus tickets.

Figure 4: Service areas and companies

Transportation	Delivery	Cinema/Hotel & Travel Bookings
CAREEM	ROADRUNNER	MY TICKET
UBER	Delivery Chacha, EatOye!	JOVAGO
SAVAREE	foodpanda	bookme.pk

4.4 *Digital Advertising and Web Enablement*

These companies provide a range of services with the aim of delivering complete online solutions to their clients. The key services they offer include e-commerce solutions for traditional services sector businesses (brick-and-mortar retailers), including website development and web-based customer services. They also provide alternative marketing and brand development services through social media marketing and website solutions that allow media companies (in print, TV and radio) to monetize their content and services. Bramerz is a market leader in this field (see Section 5).

5. Some Success Stories

This section provides a number of case studies, describing their operations and associated challenges and constraints.

5.1 Rozee

Rozee was founded in 2005 by Monis Rahman as a job portal to post jobs online for his existing venture, Naseeb (a social networking site he had developed earlier).[8] In 2007, he began turning it into a business and hired the first salesperson. Those who had invested in Naseeb, which was listed in the US as a C-corporation, were rolled onto Rozee, a Pakistani private limited company. After the first round of investment, Rozee became a fully owned subsidiary of Naseeb.

Rahman feels that his experience as an entrepreneur in Silicon Valley has been very beneficial. In addition, having worked with an organization in the US has fostered his investors' trust in the business and helped transactions be carried out faster. Following US regulations in terms of finance also gives his investors a sense of security.

5.1.1 Business Model and Operations

As an online job marketplace, the company has changed how Pakistan looks at online enablement. Rozee caters to employees with an FSc degree or higher, but predominantly advertises jobs that require at least a Bachelor's degree. It has moved from processing around 700 job applications a day in 2008 to 40,000 job applications a day in 2015/16. The Rozee team, which consisted of around 18 people in 2008, has grown to 280 people across its offices in Lahore, Sialkot, Faisalabad, Gujranwala, Riyadh and Jeddah.

Initially, Rozee did not charge employers for job listing, but for conducting CV searches. The business model has evolved over time and Rozee now offers supplementary services around its core product of job

[8] This case study is based on the authors' interview with Monis Rahman, the CEO of Rozee.

listings for all those who can pay for the additional services. 'Insta-match' is an algorithm that highlights people who have not applied for the job, but are predicted as a good match. There is an option to brand jobs, where Rozee highlights an employer's brand name and they can post their logo with it. Rozee also develops hiring sites for organizations such as Mobilink and Engro. These jobs are posted on Rozee's website. It also sells banner advertisements on its website to monetize the substantial traffic it receives.

Rozee's philosophy is that it does not, and will never, charge jobseekers to apply for a job. Over time, it has realized the need for improved CV writing as very qualified people were losing out because their CVs were so poorly written. Now, Rozee charges from Rs1,500 to Rs12,000 for senior management level CVs. It also includes a priority feature for Rs3,000 a year that gives jobseekers insight into jobs and analytics such as Linkedin's premium account or Glassdoor. The analytics include the median and mean pay for similar jobs, the number of applicants and the customer's relative rank. Rozee believes there is scope for improving this service. It plans to add an assessment arm to its functions whereby it will offer tests that employers can use to gauge a prospective employee's credentials. These can also be added to an applicant's CV.

By allowing employers and employees to connect online, Rozee has enabled around a million people to find jobs at a fraction of the money and effort involved in traditional newspaper advertisements. Companies, especially startups, which initially found it very hard to advertise jobs, can now do so cheaply and this helps them grow faster.

5.1.2 Financing

In 2008, Rozee became the first Internet company in Pakistan to raise a venture capital investment of $2 million. In 2010/11, it issued a convertible note in the US. The investors included both old investors and a few new ones. The note was converted into equity along with the round Rozee did in May 2015 when $6.5 million was raised from a Swedish and UK-based fund, which are both organized by one group. With more negotiating power and conditions in Pakistan improving, Rozee was able to choose from four funds and had very entrepreneur-favorable terms.

5.1.3 Constraints and Challenges

Although Rozee is an 'online' job portal, only 25–30 percent of its 280 employees are part of the IT department. Finding it hard to convince companies to hire online, it has a massive sales team that accounts for more than 50 percent of its staff. In terms of human capital, Rozee believes that Pakistan lacks certain skills largely because the ecosystem does not incentivize people to learn those skills. There are many jobs for which it has had to 'groom' employees who were smart enough to learn quickly. However, it has not faced any shortage of IT employees, requiring fewer than 100 employees in that capacity.

Rozee has been used by 65,000 employers to date. Around 400 organizations in Pakistan use hiring sites through Rozee. These include large organizations such as the United Nations, banks and telecom firms. The product is very cost-effective for companies as Rozee charges them only a fraction of what it would cost in-house. However, as a pioneer in this segment in Pakistan, it was very difficult for Rozee to convince companies to join it. It had to plan and execute job fairs on the ground, which were attended by around 145,000 jobseekers. Employers were invited to set up booths. This was one way Rozee was able to show that its online presence was a reality and not just virtual. It also employs a large sales team that interacts with employers in person and persuades them of the potential benefits of moving online so that they are comfortable with the idea of posting jobs online.

It is now working on an advertisement campaign to reach the mass market of employers who have yet to work with Rozee. It has hired an advertising agency and plans to use conventional channels such as the television and print media, which is necessary to change people's views. The scale it is aiming at needs such advertisement to reach small towns. Rozee targets mainly businesses and not jobseekers. People are hesitant to hire online because they have never done so. Over time, it will gain acceptance, but by undertaking this kind of advertising, Rozee is speeding up the process.

Although Rozee is eyeing other foreign markets, having established a reputation in the Middle East for being hardworking, it is waiting to prove itself before expanding abroad any further. In Saudi Arabia, it caters to the domestic market where it matches local people to local jobs. Rozee also plans to work down the chain and include jobs for unskilled workers. With this, it wants to establish itself for blue-collar job openings. Rahman has a personal interest in this segment. However, the financial feasibility of such a task is very long-term. Currently, blue-collar workers are hired at their own expense in the Middle East. Employers do not pay to hire them as they do for white-collar jobs.

Rahman is also incubating or mentoring six companies. Being part of the industry gives him an opportunity to identify good ideas and support them either financially or through nonfinancial mentoring. Easy Tickets is a website that allows customers to buy movie tickets in real time. It is linked to 12 cinemas all over Pakistan and is integrated with all banks with kiosks at the cinema where tickets bought online can be printed. Travelplay caters to airline tickets, car rentals and hotel bookings. He also supports Pring, an SMS platform, and Checkin, an air travel-related online startup.

Rahman is risk-averse when it comes to investing in startups. He invests only when entrepreneurs have started showing numbers and their ideas appeal to him. The funding is on an individual basis: he and his friends club together like an informal venture fund. Everyone gets the same investment terms and they trust his decisions. The goal is to invest $100,000 or so and ensure the startup reaches the traction stage and begins growing from a revenue perspective. With Rahman's links to international funds, they aim to raise an investment round of $1 million–3 million.

5.2 PakWheels

PakWheels, an online marketplace for buying and selling used cars, was founded in 2003 by Hanif Bhatti and a few friends. It has now become a platform for automotive enthusiasts.[9] The CEO of PakWheels, Raza Saeed, along with his friend Suneel Sarfaraz, bought PakWheels in 2008. Saeed had started a software development and consultancy business named Uraan. Later, in 2005, he cofounded Confiz with Zartash Uzmi. Confiz employs over 300 people and provides mobile solutions, enterprise resource planning and content management services to Fortune 500 companies such as Macys and Walmart.

In 2008, in partnership with Sarfaraz, Saeed acquired PakWheels. It was still a small venture but Sarfaraz's significant business experience and Saeed's knowledge of software solutions made it possible for them to improve the business model significantly. PakWheels has grown by 20 times as much, making it the largest online community-based automobile website in Pakistan.

5.2.1 Business Model and Operations

PakWheels has been in business for about 13 years and is therefore ahead of other companies in terms of market penetration. It is a platform

[9] This case study is based on the authors' interview with Raza Saeed, the CEO of PakWheels.

for buyers and sellers to purchase and sell used vehicles online, and also serves as a discussion forum for users to share information and suggestions on new automobiles or brands available or to discuss issues regarding their automobiles.

The website offers research on new cars, compares different cars and provides blogs and other news. It also provides specialized reviews that people find useful when deciding which car to buy, used or otherwise. The decision to buy a car is the second biggest decision a person makes and PakWheels provides services for every step, from the decision to buy a motorcycle to the decision to upgrade to a new car. Specialized tools such as CarSure and car valuations have been added to the site. Under the CarSure option, customers can have their cars inspected by a team.

PakWheels has multiple sources of revenue, primarily the advertisements that FMCGs put up on the website to reach the customer base of the company. Advertisements by car companies and specialized offers for dealers are also posted on the website. Even private dealers who wish to sell used cars have their ads featured on the website for Rs1,000.

5.2.2 Financing

PakWheels was acquired using money raised from Confiz. The equity is divided between the owners and shareholders who own a significant minority. PakWheels has had only one round of venture capital funding in which it managed to raise $3.5 million from an international investor. The company has made small investments, such as in Autogenie. It has also invested in two external startups (urbangalleria.com and tripkar.com) and incubated several other startups. Saeed believes it is important to give startups time and nurture them properly if investing in them.

5.2.3 Issues and Constraints

PakWheels has around 150 people working in Karachi, Lahore and Islamabad. The workforce consists of both IT professionals as well as people with a business background. There are 20 product engineers, 10 marketing people and the rest are part of the car inspection and sales teams.

According to Saeed, technology companies have not been able to create more skill sets and there is a problem finding the right talent for an organization. The basic skill set required at PakWheels is project management, analytics, user experience, user interface design, sales and digital marketing. Managing employees becomes difficult when certain skill sets are in great demand. In future, PakWheels aims to be with the customer through all steps related to car purchase and maintenance. Car inspection and transaction services on the customer's behalf are a prospect it plans to consider.

5.3 *Shophive*

Arslan Nazir, a graduate of the Nottingham Business School, started an online retail business in electronics in 2002 as his family had run a similar business for some years. In 2006, he launched Shophive.[10] He started the business with limited resources and worked from home. He then hired two people for content and delivery. Within a year, he had moved into an office with six employees.

For the coding and design of his website, he gave two of his friends a 20 percent stake each in the business as he was short of cash. Nazir used bootstrapping to keep costs low and reduce the need for external finance. Within a short time, his friends lost interest in the idea and started fulltime jobs of their own, while Nazir invested even more in the company, seeing immense potential in the industry. Later, he bought back the 40 percent equity his friends had owned, giving him 100 percent ownership of the company.

5.3.1 Business Model and Operations

Shophive was initially used by customers as a reference website for comparing prices and products. Gradually, its own sales started growing. Publicizing the business online was hard at the time as social media were not as active. In order to promote the business, Nazir offered friends a discount of up to 30 percent to change their status on MSN to "Shophive" and spread the word. This worked as people became curious and found out more about the business. Shophive has yet to market its brand widely and relies on repeat orders and referrals as its main source of traction.

Shophive was a pioneer in e-commerce in Pakistan when it began in 2006. It focused on providing 'genuine' goods, which it identified as an important niche, given the large number of fakes and copies being sold in the market. When it initially tried to market this idea, people did not trust it and the company had to state it was a genuine seller on the website. Over time, people realized that Shophive dealt in genuine products and the word spread. It expanded from electronics to other goods and now sells over

[10] This case study is based on the authors' interview with Arslan Nazir, the CEO of Shophive.

30,000 products. The company is focusing on bigger-ticket items, based on the trust it has earned among its customers. Shophive has four different modes of functioning: a just-in-time purchase system, inventory, resale and imports. Imports take around two to four weeks for delivery and orders are placed in advance.

Shophive receives 60 percent of its orders from Lahore, 15 percent from Karachi and the remaining from Islamabad, Rawalpindi and the rest of the country. It delivers to more than 200 areas in Pakistan through TCS. It currently has one large warehouse in Lahore. For most items, orders are delivered on the same day within Lahore. For other cities, delivery takes a day. Bigger products such as refrigerators are delivered within three to five days overland. There are also two pickup points in Lahore that cater to clients who want to avoid paying delivery charges.

Shophive has only one retailer for each product it offers, who is thoroughly examined against quality parameters to ensure the quality of the supplier and reduce any confusion for the consumer. It also makes sure that retailers have authentic rights to sell the product. Everything sold on the website is guaranteed to be genuine. Once the product is ordered, it is sent by the retailer to Shophive, where it is checked against the order, inspected and delivered to the client in time.

5.3.2 Constraints and Challenges

When Shophive began operations, cash-on-delivery was not functional in Pakistan, not even in Lahore. It then opened small back-end offices in Faisalabad and Islamabad so that its riders could deliver via cash-on-delivery. Nazir believes this was a blessing in disguise as the company had to provide excellent service to attract clients. Initially, clients purchased cheaper products, but the good service they received built trust and bigger-tickets items became more popular. At the time, online card payment did not work very well and Internet bank transfers were used instead. Even today, bank transfers are preferred, particularly for big-ticket items. The industry average is 95 percent cash-on-delivery and only 5 percent in online payments, whereas Shophive has 25 percent in online payments, which includes 20 percent through Internet banking and 5 percent via credit card.

Shophive has signed up as a payment merchant and accepts all credit cards. It will start accepting debit cards as soon as OneLink is integrated with its system. The payment system is 3D-protected and customers are redirected to Mastercard or Visa websites to complete the payment process, which ensures the security of their financial information. Currently, payment methods such as Easy Paisa, Mobicash, U-pay and Time Pay are also used, but they are expensive alternatives and are usually used only for small-ticket items.

Initially, Shophive's policy on returns was to replace defective items without any restriction. This created problems when clients started taking undue advantage of the policy, forcing Shophive to pay out of its own pocket to avoid negative online reviews. Nazir used this as a marketing strategy and clients who had used the policy to their benefit spread the word. Over time, Shophive changed its policy and currently offers a seven-day replacement policy in case of a manufacturing defect or damaged item. If the product does not match its details online, the entire amount is refunded.

In terms of human capital, Shophive has not had any issues. It now has around 60 employees, with seven to eight staff in managerial positions, seven to eight in IT, ten in sales and the rest in accounts, fulfilment centers, deliveries and packing. Nazir handles business development and customer services himself. His employees have been working at Shophive for four to nine years and since they are well taken care of, turnover remains low. The company uses referrals from existing employees when hiring new staff.

The heavy tax burden and complex FBR rules for the industry pose a problem. Shophive has to comply with tax laws such as withholding tax and sales tax, which are cut at source. Unlike offline retailers, all Shophive transactions are fully documented and there is no possibility of tax evasion. The nature of cash-on-delivery is problematic as some delivery staff have taken money from clients and not deposited it with Shophive.

Although Nazir attends startup events if he has time, he does not plan to incubate any firms as he wants to focus on Shophive. In 2011, he started a clothing website, Collection.pk, which he closed down two years later as it made him lose focus on Shophive. While Shophive is already one of the largest electronic retailers in Pakistan, Nazir has ambitious growth plans and is considering venture capital funding, specifically from international funds. One of the main reasons he is looking towards external funds is to expand the marketing budget. He plans to open warehouses in Karachi and Islamabad and multiply the number of pick-up points from six to 30 by 2020, with a presence in other cities. Moreover, Nazir plans to continue the horizontal and vertical growth in products that has always been part of his vision for Shophive.

5.4 Bramerz

The name of the company, Bramerz, is derived from the first names of its founders: Badar Khushnood, Amir Sarfraz and Zeeshan Saleem.[11] All three are alumni of Government College and the Lahore School of Economics. The company was started in 2005 as a small-scale, part-time project. They started working on it seriously in 2008 while all three still had fulltime jobs. They hired a small team to work with them part-time, which went well for a while, but was extremely challenging.

At the time, Nestle was looking for a Google-certified digital agency. Bramerz was shortlisted because Sarfraz, one of its founders, was Google-certified in advertising. Thereafter, Bramerz grew very quickly into a digital marketing agency. By 2012, it was functioning as two agencies: Bramerz and 3scrowd. The need for this arose as Bramerz was competing with clients such as Samsung, Huawei, Nestle and Pepsi. The agencies were kept physically apart on separate floors of the building.

5.4.1 Business Model and Operations

In its early stages, Bramerz catered to all the digital needs of its clients. Providing a full range of services on the digital spectrum sets it apart from its competitors. It offers a wide variety of products and services that include, but are not limited to, software production, publishing, digital media and social media. Bramerz does not charge for its services, but instead takes a fraction of the revenue. This is an innovative performance-based model: Bramerz makes money if its clients do.

Bramerz is the only Google-certified agency for content monetization in Pakistan and only one of forty such agencies in the world. It helps companies go online, which is its key contribution to the Pakistani IT ecosystem. It places advertisements in the content, using priority advertising and ad networks optimally to maximize views. It is impossible to manually manage the 80 million-page views that Bramerz handles and it has developed a sophisticated model and software for this purpose. It also uses direct advertising and other means it has on offer. For content monetization, Bramerz boasts a no-cost solution. It uses a revenue-sharing model with clients: there are no upfront costs and the revenue generated is divided as

[11] This case study is based on the authors' interview with Badar Khushnood, entrepreneur-in-residence at Bramerz.

stated in the contract. For e-commerce platforms, it uses a revenue-sharing model that specifies a percentage in the budget for digital marketing.

Bramerz was recently taken on board by Radio Pakistan to bring 50 years of its archives online. Its customers in terms of advertising include many Fortune 500 companies such as Nestle, Pepsi and Samsung. Its founders leverage their marketing and business background in conjunction with technology to create products that cater to the needs of companies in a rapidly moving world. Bramerz offers its clients four unique products: Publishrr, Fishry, Olaround and Anytickets. Publishrr was launched to help newspapers and news channels go online. The Nation and Nawa-e-Waqt were the first to use this service, which was later productized. Over time, the team has acquired companies such as the Daily Times, Qudrat, Dunya News and Samaa TV.

Publishrr is its flagship product. Fishry is an e-commerce platform through which the company manages all the needs of a business from website development to mobile applications. Dominos was its first major client and now it has more than 50 local brands on its portfolio. Fishry helps brick-and-mortar stores go online and reach a wider market. Olaround is a loyalty and discount application launched in 2012, long before 3G access in the country. The fact that powerful smartphones and 3G were not available then created issues regarding growth and the product was shelved. Anytickets was started in October 2015 as its newest venture. This is a cinema ticketing site that currently caters to the Cinestar cinema in Township, Lahore.

The Pakistan Super League, which had its first tournament in 2016, was completely digitalized by Bramerz, including the website, live scoring, live streaming, a fantasy league, a mobile app and merchandise sale via e-commerce platforms. Bramerz used cutting-edge technology to make sure the website did not crash with the huge traffic online. This venture helped generate good leads and companies now want to purchase the fantasy league app while Geo TV wants to buy the mobile app.

Even with a very low budget, Bramerz accepts such contracts to create leads. Its products are created with the aim of just covering costs. The strategy is to make money from successive leads. Now that sports can be productized, Bramerz can sell to any cricket club as the requisite backend is ready. This is the vision the company wants to scale up.

5.4.2 Financing

The founders pooled in the seed investment of Rs1.8 million. Drawing only salaries, they plough back all profits into the business. Their capital is currently estimated at around Rs60 million to 70 million. Bramerz has thus seen excellent growth and is now looking at international venture capital funds for a path to quicker growth.

5.4.3 Constraints and Challenges

In terms of human resources, 70 percent of Bramerz employees have a background in business and the rest in computer science. Given the dearth of talent the company needs, it selects fresh, energetic graduates and trains them. The downside is that many young recruits tend to change jobs quickly, often leaving within a year or two. As trained employees, they are offered higher salaries at bigger companies, which Bramerz finds hard to match. However, in more than half a dozen cases, old employees returned because they had found the work environment at Bramerz very attractive. This is one way Bramerz feels it can retain employees, even on lower salaries. It also uses its profit-sharing model with top employees.

Bramerz states that one reason for its success is its stringent legal contracts, which are necessary in Pakistan. Clients tend to negotiate the price down and then expect to widen the scope of services later. Therefore, the company makes sure every detail of its responsibilities to the client is clearly written down for future reference. Another reason is the comprehensive list of services provided in-house, which means that customers need not contact different agencies for distinct digital requirements. As the only Google-certified agency for monetizing content in Pakistan and one of forty such certified agencies in the world, Bramerz has a special niche in the industry and a competitive edge over its rivals.

An interesting constraint it identified was that no bank was willing to give the company a special corporate lease rate for laptops. They would provide such rates for cars, but not laptops, which are essential to the IT industry. Moreover, getting credit cards for people working in the industry was a problem due to certain regulations. Sending payments abroad was identified as a concern, along with complex regulations and the high direct and indirect taxes on the industry. Such companies in the digital economy work on a low margin and high volumes to generate profits, which means their revenue numbers are extremely large and their profits relatively small. The recent turnover tax (8 percent), which is on revenue and not profits, will make it impossible for such companies to survive.

6. Incubation Centers and Co-Working Spaces

A major contribution to the wave of startups since 2012 has been the emergence of a large number of incubation centers in the country. There are over 30 incubators (mostly IT-based) currently operating in Pakistan and about half a dozen are very active. They provide support services such as mentorship, stipends, office space, uninterrupted power supply, broadband Internet, training and development, funding opportunities and legal advice. Most new technology entrepreneurs are young: many have only an undergraduate education, if that, and very limited financial resources. However, they are bright and have the energy and hunger it takes to succeed.

6.1 Services Provided

The selection process for a place at an incubator is very competitive and plays an important role. At this stage, the idea is vetted by experienced professionals and the capability of the team behind the startup – most incubators insist on there being a minimum of three partners – is assessed. The services the incubator provides to the startups that are selected help ease many of the constraints they face as well as providing the support they need to get through the initial stages of the process, including a collegial environment where they can refine and test the practicality of their ideas. The main services provided are outlined below:

Mentorship. Incubators/accelerators have mentors who guide and advise startups on various matters. Mentors are generally successful entrepreneurs or industry experts selected from across industries so that they have a broad spectrum of knowledge and experience from which the teams can benefit. Mentors also provide the inspiration necessary to keep young entrepreneurs motivated.

Stipends. Startups that are incubated are either at the idea or early development stage and so their product is not generating any revenue. Most young entrepreneurs are straight out of university or college and have no savings to meet even their limited personal expenses. Therefore, a number of incubators/accelerators provide a meagre stipend, mostly per person, to cover basic costs. A few incubators also require a share in equity in return for providing stipends to the founders.

Office space. Rent is a major cost that acts as a barrier to entry for startups. Most incubators provide office space within their buildings to the selected startups. This is almost always free, with a few exceptions. Founders are provided a working area, supported by other amenities such as conference rooms, printing facilities, cafeterias and common areas.

Uninterrupted power supply. Pakistan has faced critical energy shortages in the last few years, with power cuts becoming the norm. Although this is a major constraint to industries in the manufacturing sector, which rely heavily on energy supplies, it also hinders growth in the digital economy. Using generators or UPS units can be very expensive. Incubators and accelerators generally provide uninterrupted power supply to startups by installing generators and bearing the full cost of power.

Broadband Internet. Internet access is the core of the digital economy around which these startups grow. Incubators/accelerators, therefore, make sure that high-speed broadband is available to startups.

Training and development. Founders of startups are given technical know-how of entrepreneurship at the incubation centers. They are taught about product development, business development, financial planning, pitching, marketing and corporate communication. Coupled with mentorship, this provides the perfect environment for young entrepreneurs to learn and evolve. Some incubators go to the extent of providing grooming and language classes.

Funding opportunities. One of the most sought-after dimensions of an incubator is the networking it can provide. This gives entrepreneurs the opportunity to grow individually, receive feedback on their product and find angel investors who are willing to put money into the business. Accelerators focus on funding because the startup is mature enough to absorb investment and has figures for revenue and customers, which are then used in the pitch to attract investors.

Legal advice. Legal advice is very costly and startups necessarily require legal protection in terms of intellectual property rights or patents. In addition, getting a business registered can be time-consuming as well as costly. Unambiguous, contractually binding arrangements between partners are essential for the long-term success of a new business. Incubators offer these services free or at minimal cost and the quality of the legal advice is far superior to what they would get even if they were able to pay for it.

6.2 *Active Incubators and Accelerators*

As mentioned above, there are about half a dozen very active incubators and accelerators, three of which we discuss below. These include the best known ones in the sense that they were involved in the development of many of the rising stars discussed in this paper. The aim is to give a feel of how incubators or accelerators work as well as how they contribute to the success of a startup.

The three selected cases are Plan 9, the LUMS Center of Entrepreneurship (LCE) and Nest I/O. These represent a range of possible models and sponsors for such activity (Figure 5). All three select their startups through a rigorous process whereby successful entrepreneurs and industry gurus scrutinize the best ideas of a large pool of business ideas presented. Once selected, the startup is inducted for a period of four to six months. Each incubator/accelerator has two or three cycles a year.

Figure 5: Most active incubators and accelerators

	Plan9	LUMS Center for Entrepreneurship	The Nest I/O	invest2innovate
Type	Incubator	Incubator/ Accelerator	Incubator	Accelerator
Date Established/Location	2012 Lahore	2014 Lahore	2015 Karachi	2011 Islamabad
Major Supporter	Punjab Information Technology Board	LUMS	PASHA Samsung & Google	DotZero Pasha Fund
Number of Cycles/Annum	2	3	3	1
Duration	6 months	4 months	4 months	4 months Virtual/ 6 in person weekends
Successful Startups	Patari, Bookme, Wifigen	Maro Tandoors Autogenie	Wedding Planit, Mandi Express	DoctHers, Popinjay
Equity	No	Yes; 2.5 – 7.5%	No	Yes; Small startup cost + 0.5-1% Equity
Stipend	Yes	Yes – if 7.5% Equity	No	Yes

6.2.1 *Plan9 and PlanX*

Plan9 is one of the early entrants, providing a facility for budding entrepreneurs and a platform for young startups to test their business ideas, pitch them to industry leaders and gain initial recognition. Plan9 is an initiative of the Punjab government under the Punjab Information

Technology Board (PITB). It started operations in 2012 under the leadership of Dr Umar Saif, who is currently chairman of the PITB and vice-chancellor of Information Technology University (ITU). In the last four years, Plan9 has incubated more than 118 startups, helping them to shape their business models and to work efficiently in the environment on their own. Plan9 provides a startup with six months of incubation, where each founder is also given a stipend of Rs20,000 per month for up to five members in a team. It is a world-class facility based in Arfa Tower, Lahore.

The PITB also runs another operation simultaneously by the name of PlanX (an acceleration center), which provides acceleration services to startups that have shown some traction in business and started commercial activity. PlanX inducts startups once they have begun making sales and serving early customers. It guides these startups in efficient business techniques, establishing contacts in the industry, learning best practices to achieve growth and helping them find suitable employees, partners and investors

6.2.2 LUMS Center of Entrepreneurship

The LCE was formed in 2014 by LUMS to support young entrepreneurs. It does not limit the induction to LUMS students. Rather, it invites people from all across Pakistan. Khurram Zafar, the executive director, is the inspiration behind the center and was one of the founding board members of Plan9. He has extensive international experience, having co-founded two software product startups in Silicon Valley and been part of the founding team of two global IT consulting firms.

LCE offers multiple plans for startups and they can opt for monthly stipends of approximately Rs25,000 per person on the team in return for 7.5 percent equity in the firm. Startups can also be incubated under a 'non-resident' acceleration program in which, for 2.5 percent equity, they are given mentoring sessions, talks, some marketing/PR support and pitching rights at the startup summit. Graduation from the LCE is in the form of an investors summit that gathers businesspersons, industry leaders and local and international investors. Startups pitch their business ideas to these people for investment. This platform has proved to be very successful and companies have raised significant investment via this method.

6.2.3 NEST I/O (P@SHA's Tech Incubator)

The latest addition to the list of incubators in Pakistan is NEST I/O, launched in 2015 in Karachi. This is an initiative by the Pakistan Software Houses Association (P@SHA) and has been funded and supported by Google for Entrepreneurs, Samsung and the US Consulate General in Karachi. It is managed by Jehan Ara, the current president of P@SHA. She understands the entrepreneurial landscape and future potential of IT in Pakistan, having served as president of P@SHA for more than eight years.

NEST I/O has a similar strategy to Plan9 and LCE, whereby it incubates startups for four months and provides initial advice and services. The program comprises four different phases: power building (nest), gaining momentum (ramp up), revving up (propel) and gearing up and taking off (fly). These modules help startups in various areas, such as defining their mission and vision, team building and HR skills, raising funds, managing cash flows and law-related issues.

6.3 Co-Working Spaces

Incubators and accelerators have proven very successful in the last few years. The only drawback of such programs is that startups can become too dependent on mentors, professional advice and excellent facilities: this can become an obstacle once they have graduated from an incubation program. However, another innovation, co-working spaces, can make this transition easier by providing the kind of facilities and work environment a startup has got used to at the incubator, but for a reasonable fee.

Most such companies start either at home or an incubation center. Once they outgrow the space at home or graduate from the incubation center, it is a challenge to move into an independent office space. Money is usually tight and investing in any assets that will not help them fuel business growth is a low priority. Thus, renting a new office, utility bills, back-up energy arrangements and printing and Internet facilities can become a serious problem for startup founders.

To address this problem, co-working spaces have opened up across the country from Peshawar to Karachi. These venues provide founders and their employees with office space, Internet access, meeting rooms, gaming zones for recreation and relaxation pods. Some of the best known co-working spaces are DotZero (Karachi), The Hive (Islamabad) and OfficeSpace (Lahore). On average, the charges range from Rs8,000 to

Rs12,000 per month per seat. This amount falls as the number of people within the startup increases.

These spaces are a good opportunity for startup teams to save on the fixed cost of assets. They also help teams network with the community by arranging meetings and other programs. Such spaces are very popular among the freelancer community. Power outages and infrastructure requirements pose a challenge to young freelancers and these spaces play an integral role in providing a good platform at relatively affordable prices.

A recent entrant in this area is Tech Hub Connect, a PITB initiative that aims to promote entrepreneurship and freelancing in Pakistan by providing a world-class facility for the community. The center is located in Arfa Tower, Lahore, next to Plan9 and PlanX, and is a good opportunity for young startup graduates and freelancers to join free of cost. Its location gives freelancers exposure to IT companies, ITU, Plan9, PlanX and other industry-related offices.

The LCE plans to arrange for the services of accountants and lawyers as well as professionals in marketing and other business-related areas. Startups will be charged for these on a time/usage basis. The center will charge startups on a monthly basis. To encourage them to move out as they get bigger, the per-head cost will increase as the number of team members increases.

7. Emerging Financial Landscape

Financing for small and medium enterprises (SMEs), particularly new businesses, has always been problematic because traditional lenders such as banks require documentation and collateral, which both SMEs and new startups lack. However, the ability of digital businesses in Pakistan to raise risk capital has been a revelation and is a key reason for the rapid growth of these businesses and the excitement surrounding digital startups.

There have been numerous attempts – many supported by international development institutions – to establish venture capital funds in the country, but none have succeeded so far. The two main reasons for this are (i) the inability of investors to control expenditures and monitor the performance of the firms they have invested in and (ii) the lack of an exit strategy in the face of an underdeveloped capital market.

These two constraints do not seem to be binding in the case of digital businesses. Direct control and monitoring of a company is not necessary because online traffic and transactions are easily observed by investors and there are established models for estimating the capital valuation of a company at any time. Since global players are always interested in expanding their operations in new markets, and acquiring successful firms in new markets is the most cost-effective way of doing so, venture capitalists have an effective exit strategy. As a result, both international venture capital funds and local investors have begun investing in digital businesses in Pakistan, giving birth to a venture capital industry in the country (Table 1).

Table 1: Equity investments in Pakistani companies, 2015 and 2016

Company	Product	Amount raised	Investors
Daraz	Shopping portal	$56 million	• Asia Pacific Internet Group • CDC Group
Zameen	Property portal	$29 million	• Undisclosed
Rozee	Job portal	$6.5 million	• Vostok Nafta • Piton Capital Lead Investment
Vivid Technologies	Voice technology	$350,000 (seed investment)	• Sunbridge Ventures • Rosemont Group • Telefonica • Conrad Labs
Finja	Fintech	$1 million	• Vostok Emerging Finance
Beauty Hooked	Home beauty services	$280,000	• Fatima Ventures
Travly	Transport	$200,000	• Cres Ventures • Faisal Sherjan

Sources: Dodhy (2016a, 2016b); Husain (2015b); ProPakistani (2015, 2016); TechJuice (2015), "Zameen.com raises $20 million," (2016).

8. Sources of Financing

A key milestone for startups on graduating out of the incubation cycle is to obtain funds for product development, operations, marketing, human resources and other requirements for their business model to succeed. We have seen financing evolve from traditional to venture financing in Pakistan. Traditionally, new businesses source investment from family and friends and, subsequently, by ploughing back their earnings. In this new era of financing, startups are not valued by asset size or existing operations, but by their future growth trajectories. Such investments may be seen as risky for not having any physical asset base, but they are preferred by international investors as there is less country risk since all operations run on cloud services.

According to Monis Rahman, the CEO of Rozee, there is a growing trend of international investors from the Far East and Europe: they see huge potential in the economy in the years to come (personal interview). There were a number of international investments in 2015, ranging from as low as $100,000 to $20 million for Zameen. Pakistan provides these investors with a very good option for returns based on the size of the country and market growth potential. There are several different players in this field and are discussed briefly below.

8.1 International Investors

Globally, investors look to invest in emerging markets, which yield a greater rate of return than investing in developed countries. International investors see Pakistan as a potential emerging market and are very hopeful for the future. There were multiple investments in 2015/16, which were clearly made with the expectation of future growth in the country. Frontier Digital Ventures, a Malaysia-based venture capital firm focusing on online classified businesses in emerging markets, has invested $3.5 million in PakWheels. As stated by Shaun Di Gregorio, founder and CEO of Frontier Digital Ventures, "We love frontier and emerging markets and have a wealth of expertise and a proven track record of extracting value in the opportunities these markets present" (TechJuice, 2014).

8.2 Local Investors

As more and more international investors eye Pakistan as an emerging economy and assess its potential for growth, the local community is also picking up cues and trying their hand at investing in these startups. There are several kinds of investors operating locally.

8.2.1 Venture Capital Companies

Venture capital is a relatively new phenomenon in Pakistan: only a handful of companies have explored this space and provide opportunities to young startups. The founders of these investment firms personally scout for new startups by attending entrepreneurship events such as business plan competitions and startup summits and visiting incubation centers.

The pioneer players are CresVentures in Lahore and DotZero Ventures in Karachi, which have already made some investments in local startups (see Box 1). DotZero was set up as a seed and angel investment fund in 2015, having started in August 2013 as a nonprofit foundation for IT to help local entrepreneurs and foster entrepreneurship in Pakistan. It started by providing office space, mentorship and networking opportunities to startups. Seeing greater opportunities, it decided to relaunch itself as a seed and angel investment fund. The company invests in early-stage startup companies that demonstrate a mass appeal for the product or idea. It has invested in eight startups, which include Popinjay, Dealtoday, Sukoon, PerkUp and others. DotZero employs a pool of advisors and individual investors who evaluate ideas and invest as a fund or individually as suited to all stakeholders.

For both companies, on average, the ticket size of their investments ranges from $100,000 to $200,000 and disbursements are tied to quarterly targets. Startups are also provided mentorship, advice and direction by these venture capital firms as their founders have significant experience in the industry. They also understand venture capital, having spent a portion of their lives in the US or worked with companies based there, which has given them exposure to international venture capital firms.

Box 1: CresVentures: A case study

The founder and CEO of CresVentures, Humayun Mazhar, in collaboration with his friend Aizaz, started a company by the name of CresSoft in the 1990s: the first company in Pakistan to exclusively focus on IT export services.12 At the time, he was managing his family business and when his jute production plant closed down, he decided to focus on developing his IT business.

Unfortunately, CresSoft suffered two major setbacks in 2001. The IT bubble in the US burst in March 2001 and, as a result, many clients lost businesses. IT spending by other companies was severely curtailed. While CresSoft was struggling with this, 9/11 occurred and US blue-chip companies became reluctant to do business with Pakistani companies. CresSoft's clients wanted risk-averse strategies put in place and Mazhar had to open offices in Dubai so clients would feel safer. Some clients stayed with CresSoft, but many left, affecting 70 percent of its business dealings. Finally, in 2004, Mazhar decided to shut down CresSoft.

[12] This case study is based on the authors' interview with Humayun Mazhar, the CEO of CresVentures.

In 2013, after assessing the progress and potential of new startup companies in Pakistan, he decided to set up a venture capital firm because at that time, most people who turned to banks for loans were unable to get them due to the stringent evaluation criteria. In preparation, Mazhar took a course on venture capital in Berkeley in which he learned about angel funds and super angel investors. He decided to start an angel fund in Pakistan. An angel fund requires an experienced board of advisors with IT and business backgrounds to help choose appropriate candidates who want to start their own business. Three of Mazhar's former CresSoft employees came on board, helping him undertake investments in healthcare, innovative agriculture and e-commerce.

CresVentures focuses on local market monetization because parallel markets operate in India and a learning model is already available against which to compare ideas. In its assessment, it looks at the skills and abilities of the owners more than the idea itself. A soft launch of CresVentures took place in October 2015, with the provision of investment to potential startup companies in the portfolio such as PerkUp, Sukoon and Travly. PerkUp is a Karachi-based setup that offers customer loyalty and engagement services to consumers and businesses by helping them obtain loyalty rewards from various businesses. This encourages customers to revisit stores, reenergizes lost customers and involves them on birthdays and anniversaries (F. Rizwan, 2016). In this way, merchants are able to segment customers into groups and send targeted offers and track redemptions.

Sukoon.com.pk is a recent Karachi-based online home repair venture. CresVentures invested $200,000 in Sukoon, followed by investment by TiE's Islamabad chapter and DotZero Ventures. This investment is unique in that the top angel funds in Lahore, Islamabad and Karachi are sharing risks and cooperating in the development of a tech startup. Travly was started in Lahore in 2013 after being incubated at Plan9. It joined the PlanX accelerator and collaborated with the Lahore Transport Company to digitize bus routes in Lahore. It helps customers plan bus trips or book rickshaws online; it even provides logistical services.

Companies in the portfolio are chosen based on their growth potential. Once selected, they are provided investment, mentorship and domain expertise. Evaluating a company is an art and can be a challenge to assess if its growth targets are being met. Once the company achieves its set targets, CresVentures and its co-investors hunt for a chief investment officer (who has the experience needed and is based in Pakistan) to monitor the next round of pooled investment.

In some cases, among young entrepreneurs who have the potential to grow, trust issues may arise in terms of the shareholding agreement. As CresVentures demands 30 percent equity upfront before investing in an idea, many entrepreneurs are reluctant to approach the company for fear of a takeover in the future (it also has control over accounting and co-investment by other investors and funds). In 2014/15, approximately Rs300–400 million in investment was raised through startups such as Sukoon and PerkUp, although meeting its estimate for the current year will be hard. While the number of companies is increasing, finding startups with good-quality founders and ideas to incubate has become more difficult.

8.2.2 IT Companies

With the rise in IT in Pakistan over the last 30 years, companies such as Systems, Netsol and Confiz Solutions have expanded by providing B2B services, primarily to international clients. They are also looking to participate in the digital economy and are exploring ideas internally as well as promising startups to support.

Successful digital businesses such as Zameen and Rozee are also looking to expand through promising startups. Their owners have been in the industry long enough to understand this new shift in the digital economy. They actively participate in national business plan competitions held by universities and incubation centers and when they see a promising startup, may offer funding. These companies have a big local presence and are able to provide startups with investment as well as office space and amenities. Startups can also seek technical support from such companies as they have in-house talent in software engineering and related areas.

8.2.3 Traditional Business Families

The latest addition to local investors includes corporations or traditional business families, although many of them find it hard to evaluate startups, given the concept of investing in a new business that has no physical assets. As Khurram Zafar, the director of LCE, says, "Our local businessmen and local industrial groups are sitting on a goldmine with a lot of liquid cash and they are just waiting for a success story, which will motivate them to invest" (personal interview). However, he also noted that these businesses found it hard to understand how companies in the digital economy functioned and thus needed to become familiar with investing techniques in this context.

Currently, they see every investment as a joint venture with the founders of the startup. They also expect the founders to invest a similar amount if they are to be partners: the latter's passion, hard work and ideas are not enough to be accepted as a valuable asset. These investments are at a nascent stage and traditional companies are still exploring this space. Some local players that have made investments include the Fatima Group, SEFAM and others. However, once more and more prominent business groups start investing in startups, other business groups will also become interested.

9. Policy Issues

The active startup scene and rapid expansion of the digital economy in Pakistan indicate that there are some positives in the country's policy environment. The most important of these may be its liberal foreign investment policies. Pakistan allows 100 percent foreign ownership and there are no restrictions on the repatriation of profits and capital. Another important positive is the role played by the Punjab government through the PITB (and ITU) in terms of providing a voice to the emerging industry on policy issues, establishing, as already discussed, one of the first and most active incubators (Plan9) in the country and facilitating the entry of major international companies into Pakistan.[13] The importance of providing a voice on policy issues can be seen from a recent example. In 2015, all the provinces (including Punjab) levied a 19.5 percent tax on Internet services, but lobbying by the PITB and others succeeded in having the tax withdrawn in Punjab. Today, it is the only province in the country that does not tax Internet services.

However, there are still a number of concerns with regard to government policies such as the regulatory environment and, more importantly, taxation, which can hamper the growth of the digital economy. These arise in part because, as noted by the former IBM vice-president and investor in Wifigen, John Russell Patrick, "Pakistan's business laws are still structured around an industrial economy with tangible assets. By contrast, technology startups are based on ideas and knowledge for which there is no regulatory framework" (Nazar, 2016).

This is also true of policies and laws with regard to taxation. In countries such as India, the IT industry was able to grow rapidly in the 1990s because it escaped the pervasive controls and regulations that had stifled the growth of traditional industries. Unfortunately, the ignorance of the government is no longer an advantage. In Pakistan, in the last few years, the

[13] For example, at the time of the launch of Uber in Lahore in March 2016, the Uber team met the Punjab chief minister, who assured them of the government's support and initiated discussions on establishing a partnership to promote the use of technology in facilitating the transport sector.

government has focused on increasing tax revenues. While this is clearly necessary, given the weak tax administration machinery and strong pushback from the present government's traditional constituencies, it has found it very difficult to increase the collection of direct taxes. Therefore, it has attempted to increase tax revenues by imposing withholding taxes, in lieu of income tax, on turnover, which is borne disproportionately by the formal, documented sectors and businesses in the economy.[14]

The implications of such a tax policy for established businesses in the formal sector are bad enough; for new businesses in the digital economy, they can be disastrous. There is a very high level of documentation in this sector, as information is available on every aspect of a business from the number of visitors to the company's portal to every transaction that takes place online. The approach of digital businesses in the early stages is very different from businesses in traditional sectors as their aim is not profits, but growth and increase in capital valuation. Amazon, for example, was a multibillion dollar company before it started to make a profit. Uber, which has a capital valuation of over $60 billion and had over $2 billion in gross revenues in the second quarter of 2015, is still making losses on its worldwide operations (Solomon, 2016).

To illustrate the absurdity of the tax regime facing digital companies in Pakistan, we can look at a hypothetical situation. If Uber were a Pakistani company, it would have had to pay an 8 percent turnover tax on $8 billion in gross revenues, i.e., $640 million despite a loss of over a billion dollars. In addition, Uber would have had to withhold income and sales tax (15 percent and 16 percent, respectively) from over 5 billion dollars it paid that year to its driver contractors. In other words, if Uber were a Pakistani company, it would have closed down a long ago or moved to Dubai. The latter is what a number of successful digital businesses in Pakistan are thinking of doing.

Another issue is the taxation of the Internet, which is the backbone of the digital economy and is heavily taxed in Pakistan. Both businesses and individual consumers pay a 10 percent withholding income tax and a 19.5 percent provincial sales tax (except in Punjab) on Internet services, including mobile Internet access. In terms of the cost of doing business, this represents a 30 percent surcharge on the basic price charged by the service provider. In addition, it reduces the demand for Internet services and the profitability of the service providers and thus adversely affects the quality of, and investment in, critical Internet infrastructure in the country.

[14] In theory, individuals and businesses that file income tax returns can get a refund against excess withholding tax payments, but in practice it is virtually impossible to get an income tax refund in Pakistan.

10. Conclusion

This paper has shown that the digital economy has huge potential for growth in Pakistan. The direct benefits of this are large: not only will it boost economic growth in the country, but it will also provide good jobs to a substantial portion of the young people coming out of Pakistan's rapidly expanding higher education system. This is important not only from an economic point of view, but also for political reasons as a large number of educated unemployed persons could be a problem for the security and stability of the country.

The growth of the digital economy would also give rise to a new generation of entrepreneurs and boost investment in the economy, both of which are in short supply at the moment. Moreover, its indirect benefits may be even larger, as it could play an important role in increasing documentation of the economy and improving the functioning of key markets. For example, the labor market in Pakistan is highly fragmented; information on the availability of jobs and salaries is an important reason for this fragmentation. Employment portals such as Rozee make information on job openings and salaries in all skills, industries and parts of the country available to anyone interested. This should result in enhanced labor mobility, improved job-to-skill matching and reduced downtime for new entrants as well as those between jobs. At the moment, these portals cater to white-collar jobs, but it is only a matter of time before blue-collar jobs are also covered.

Another market that would benefit greatly from the development of the digital economy is agriculture where, for most products, there is a large wedge between the prices received by farmers and those paid by consumers in cities. By bringing buyers and sellers together, marketplace websites have the potential to greatly reduce this wedge, thus benefiting both farmers and consumers and increasing the production of high-value crops. Marketplace websites also expand the reach of SMEs and help promote their sales and, therefore, growth.

However, to realize the full potential of the digital economy, the government must recognize its importance as well as how it is different from traditional industries and introduce appropriate changes in the relevant tax and regulatory policies. If such policies are put in place, there is every reason to expect that, in five years' time, the digital economy will be in excess of $2 billion and its high growth rate could transform Pakistan's economy. Together with CPEC, the digital economy could be the new driver of Pakistan's economic growth.

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Appendix

People interviewed by the authors

Name	Position	Company or organization	Date of interview
Nabeel A. Qadeer	Director	Plan9	19 Jan 2016
Monis Rahman	CEO	Rozee	2 Feb 2016
Imran Ali Khan	Co-CEO	Zameen	24 Feb 2016
Badar Khushnood	Entrepreneur in residence	Bramerz	26 Feb 2016
Arslan Nazir	CEO	Shophive	28 Apr 2016
Humayun Mazhar	CEO	CresVentures	3 May 2016
Aezaz Hussain	CEO	Systems Limited	5 May 2016
Khizra Munir	CEO	CO Pakistan	3 May 2016
Faisal Kapadia	CEO	Mindmap Communications	1 Jun 2016
Farzal Dojki	CEO	DotZero Ventures	2 Jun 2016
Fawaad Saleem	CEO	Digital Tribe and Startup Grind	2 Jun 2016
Jehan Ara	President	P@SHA and NEST I/IO	3 Jun 2016
Raza Saeed	CEO	PakWheels	10 Jun 2016
Khurram Zafar	Executive director	LUMS Center of Entrepreneurship	29 Aug 2016

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Promotion of Innovation and S&T: The Role of Finance

Saeed Ahmed and Mahmood ul Hasan Khan*

Abstract

Promotion of innovation and S&T enables economies to achieve sustainable economic growth. In addition, firms engaged in medium- to high-tech production tend to gain more from innovation and are, on average, more productive compared to enterprises which are limited to low-tech systems. Innovation is, in turn, inextricably linked to the availability and nature of financing. Empirical studies in developing countries reveal that bank financing and FDI can play a vital role in this regard. This paper provides an overview of: (a) the role of financing in facilitating innovation and S&T; (b) State Bank of Pakistan's policy initiatives to make financing available, both in general, and also to specifically facilitate innovation and S&T in the country; and (c) the role of innovations in expanding access to finance in Pakistan.

Keywords: Technological innovation, R&D, policy, banks

JEL classification: E61, O32, G21.

Introduction

The role of innovation and S&T can hardly be over emphasized for sustainable economic growth. Paul Romer, an economist and policy entrepreneur, has aptly used the kitchen metaphor to describe innovations and production in an economy. "The cooking one can do is limited by the supply of ingredients… If economic growth could be achieved only by doing more and more of the same kind of cooking, we would eventually run out of raw materials… History teaches us, that economic growth springs from better recipes, not just from more cooking… Every generation has underestimated the potential for finding new recipes and ideas. We consistently fail to grasp how many ideas remain to be discovered. Possibilities do not add up. They multiply."

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It is well documented in the literature that innovative firms are more productive than non-innovating counterparts. Moreover, the firms in less-developed countries tend to experience greater productivity gains from innovation compared to developed country peers; innovation in the latter occurs at the technology frontier, and might involve both hits and misses of previously untested products and processes (Dabla-Norris et al, 2010).

More often than not, a country's propensity to innovate is not a chance event; rather, it is an outcome of conscious policy decisions. Specifically, the polices towards education, R&D, intellectual property rights, contract enforcement, creditors' rights, availability of external funding, etc., create an enabling environment to promote innovations and S&T. Policymakers, however, face tough choices when making allocation decisions about expenditures on R&D, health, education, infrastructure, defense and other priority areas. While, in principle, few policymakers (if any) would suggest that public expenditure on R&D is devoid of merit, such spending may be constrained by fiscal limitations.

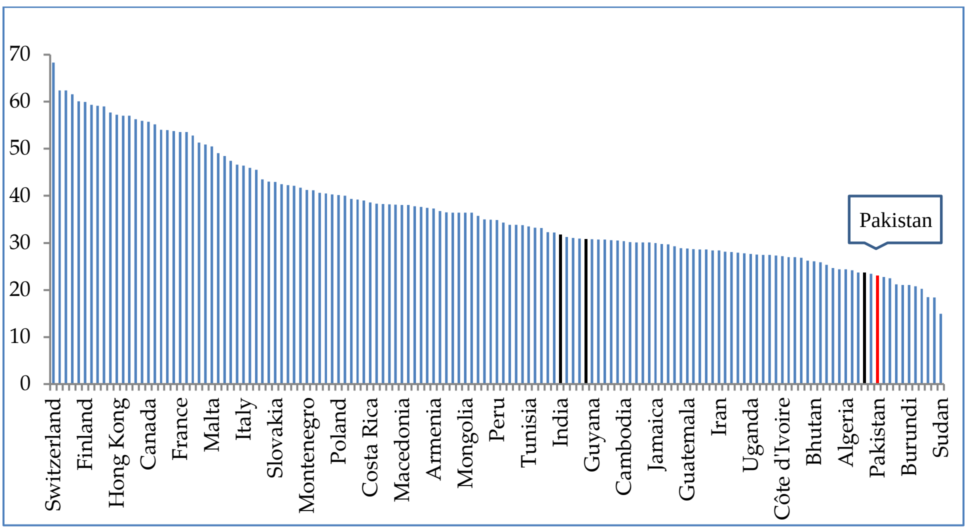
On the one hand, the role of traditional finance merits discussion in the context of innovation and S&T, since availability of financing is a vital enabling factor leading to increased firm innovation. Ayyagari et al (2012) argued that bank financing is a vital source of external financing which leads to innovation, and is particularly relevant for SMEs in developing countries. On the other hand, if traditional financing modes are insufficient, the discussion may be expanded to alternative forms of financing which can play a complimentary role, such as venture capital from private actors. In these settings, this paper provides an overview of: (a) the role of financing in facilitating innovation and S&T in case of Pakistan; (b) State Bank of Pakistan's policy initiatives to make financing available, both in general, and also to specifically for targeted sector; and (c) the role of innovations in expanding access to finance in Pakistan.

The remainder of this paper proceeds as follows: Section I provides some background on innovation in a global context; Section II discusses the role of financing in facilitating S&T and innovation; Section III highlights SBP's policy initiatives to make financing available, both in general, and also to specifically facilitate S&T and innovation in the country; Section IV outlines the role of innovations in expanding access to finance in Pakistan; and finally, the last section offers concluding remarks.

Section I. Global background- Where do we stand?

The Global Innovation Index (GII) 2015, which ranks innovation performance of 141 countries, reveals that India is the most innovative economy in the Central and South Asian region, whereas Singapore is the top ranked within Southeast Asia. Global rankings of interest include: Singapore (7), China (29), India (81), Bangladesh (129), and Pakistan (131) (**Figure 1**). Incidentally, China and India are among the countries identified as "innovation achievers" - those who "perform at least 10 percent better than their peers for their level of Gross Domestic Product". Moreover, the GII places India and Pakistan in the same peer group (along with Sri Lanka, Bhutan and Uzbekistan), which makes India a relevant country for comparison by Pakistani policymakers and academics.

Figure 1: Global Innovation Index



To understand where the country is really lagging behind compared to its peers, we need to analyze the subcomponents of the GII.[1] **Table 1** highlights Pakistan's comparative ranking on selected indicators. Referring to rankings from **Table 1**, political stability and security concerns, on which Pakistan ranks the lowest, add to uncertainty among investors and other stakeholders. Additionally, the country's rank on school life expectancy, which reflects the years of schooling that a child can

[1] The index comprises seven broad pillars – institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative inputs – which together represent 79 specific indicators.

expect to receive, is also a weak link: Pakistan's 128th ranking places it 33 spots behind India and 63 spots behind Sri Lanka.

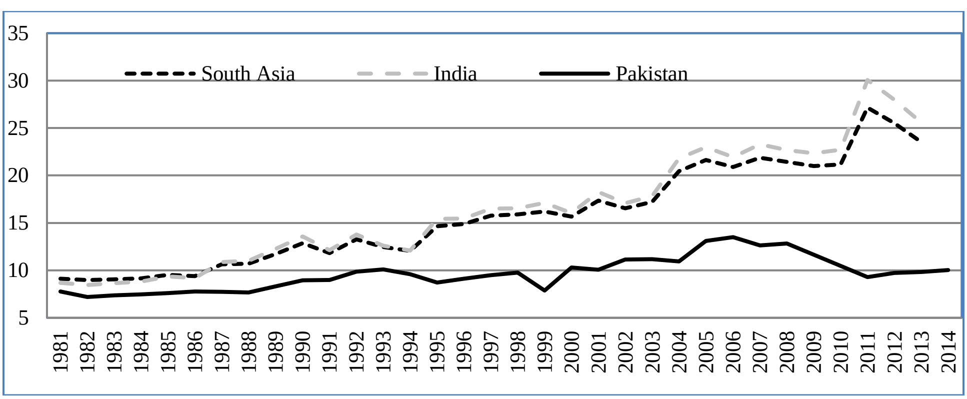
Table 1: Ranking on select GII 2015 indicators

	Pakistan	Bangladesh	India	Sri Lanka
Political stability & absence of violence/terrorism index	141	134	124	101
School life expectancy (years)	128	116	95	65
Gross capital formation % of GDP	130	24	14	15
Firms offering formal training, % firms	107	87	98	94
New business density (registrations/thousand population 15-64 years old)	104	101	99	88
Total value of stocks traded, % GDP	48	40	25	55
Communications, computer & information services exports, % total trade	34	121	1	12
Ease of protecting investors	21	41	7	49

Source: Global Innovation Index 2015

The gross capital formation indicator presents the starkest contrast among ranking for Pakistan (130), Bangladesh (24), India (14) and Sri Lanka (15). It implies that low level of investment is acting as a major constraint to innovation and growth in Pakistan's economy. This finding is further corroborated if we view a plot of gross fixed capital formation in the private sector for India and Pakistan over time (**Figure 2**).

Figure 2: Gross fixed capital formation in the private sector (% of GDP)



Source: Haver Analytics/World Development Indicators, World Bank

Meanwhile, **Table 2** reveals the R&D expenditure allocated by Pakistan and a few select countries over time. While there are some breaks in the series and comparative data is not available beyond 2013, the numbers unambiguously reflect how Singapore and India have maintained a stable policy towards R&D allocations, while China has consistently increased spending, reflecting an emphasis on boosting innovation and S&T.

Table 2: R&D expenditure percent of GDP

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	0.75	0.90	0.95	1.06	1.13	1.22	1.32	1.38	1.38	1.46	1.68	1.73	1.79	1.93	2.01
India	0.71	0.74	0.72	0.71	0.71	0.74	0.81	0.80	0.79	0.84	0.82	0.80	0.82	n.a	n.a
Pakistan	0.12	0.13	0.17	0.22	n.a	n.a	0.44	n.a	0.63	n.a	0.45	n.a	0.33	n.a	0.29
Singapore	1.82	1.82	2.02	2.07	2.03	2.10	2.16	2.13	2.34	2.62	2.16	2.01	2.15	2.00	n.a

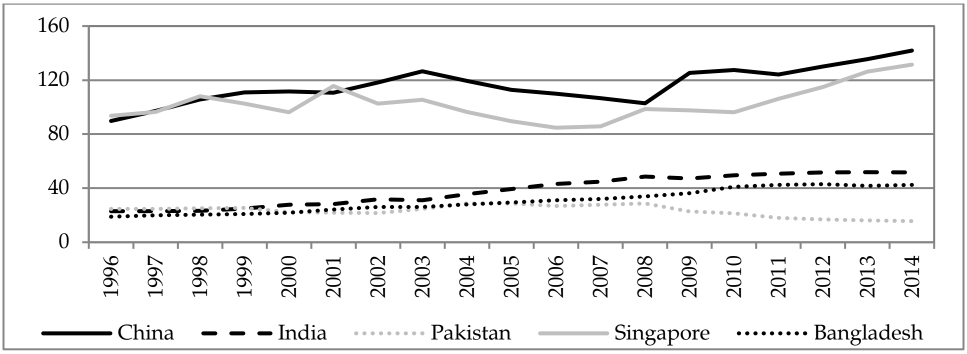
Source: World Development Indicators

Pakistan's policy, however, appears to have reversed course somewhat since 2007, with R&D expenditure on the decline as of the last reported value in 2013. This trend appears to contradict a core objective of the country's National Science, Technology and Innovation Policy 2012, prepared by the Ministry of Science and Technology (MoST), which envisioned expansion of R&D expenditure to 1 percent of GDP by 2015 and 2 percent by 2020. The policy also recommends extension of tax holidays, rebates and other incentives – particularly for firms which can integrate into global production networks or those engaged in information and communications technology, high-tech manufacturing, and the renewable energy sector. However, a case can be made that breakthrough results from such proposed incentives have either yet to materialize, or have not been documented and brought forward effectively into public knowledge.

Section II. Availability of Finance

Turning our attention to finance, Pakistan has been outperformed by its peers in terms of domestic credit extended to the private sector (**Figure 3**). More worryingly, a downward trend has been observed for this indicator since 2008. By contrast, China, Singapore, India, and Bangladesh have all witnessed an increase in their credit to GDP ratio.

Figure 3: Domestic credit to private sector (% of GDP)



Source: World Development Indicators

Decomposing loans to private businesses in Pakistan down further, we find a severely lop-sided distribution which is skewed in favor of big corporations, while SMEs and agriculture sector are underserved. **Table 3** indicates that, as of FY15, only 1.8 percent of total borrowers (including large corporations receiving loans in excess of Rs 10 million) were receiving over 80 percent of loans to private businesses. Furthermore, this situation has deteriorated over time, as evidenced by referring to FY05 figures.

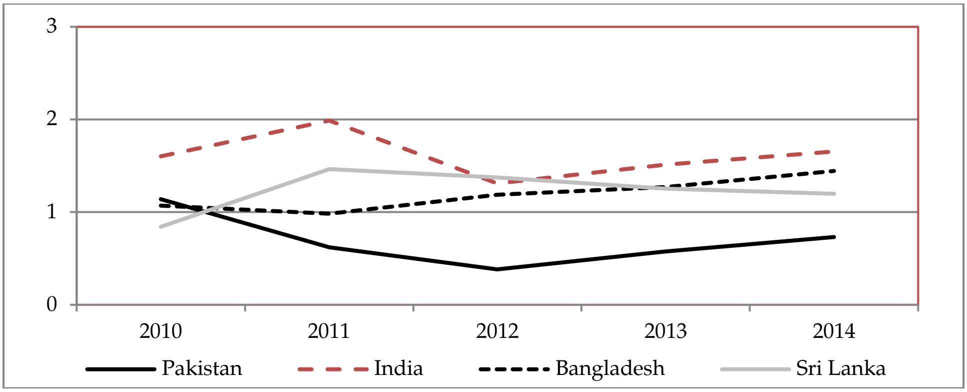
Table 3: Distribution of loans to private businesses by size percent of total number of accounts and percent of total amount of loans

	FY05		FY15	
	No. of accounts	**Percent of total loan amount**	**No. of accounts**	**Percent of total loan amount**
Less than Rs 10 million	99.2	27.2	98.2	18.7
More than Rs 10 million	0.8	72.8	1.8	81.3

Source: State Bank of Pakistan

Foreign direct investment can also give a boost to innovation. On the one hand, it involves an injection of capital and financing; secondly, inflows are typically accompanied by technology and expertise transfer from foreign to local firms. Here, too, Pakistan has some catching up to do compared to its peers, seen in light of net inflows of FDI over the 2010-2014 period (**Figure 4)**. The good news is that FDI inflows for Pakistan posted a modest uptick during Jul-Apr FY16, amounting to US$ 1,017 million, compared to US$ 965 million in comparable period of the previous fiscal year. Inflows from China on account of China Pakistan Economic Corridor (CPEC), in particular, hold promise in the medium to long term.

Figure 4: FDI, net inflows percent of GDP



Source: World Development Indicators

Apart from bank credit and FDI, venture capital (VC) is also a viable source of funding for innovative startups. India has made notable gains in this avenue: in 2014, it received $ 5.2 billion in venture capital funding, which was thrice the level of funding received in 2013.[2] In 2015, these investments rose to $7.9 billion.[3] At least part of India's success with VC can be credited to policy making. Guidelines for venture capital funds were introduced in 1988, and consolidated in 1996 by Securities and Exchange Board of India (SEBI). More recently, the government of India launched an ambitious package to support growth of the VC industry and startup community. Proposals include setting up a $1.5 billion fund for startups and providing tax breaks for the first three years in which they register profits.

By comparison, Pakistan's VC industry is still in its nascent stages. The country's startups were estimated to have raised US$ 71.1 million in 2015.[4] While this is dwarfed by the US$ 7.9 billion raised in India, the trajectory holds promise nevertheless: VC funding for Pakistan had amounted to a mere US$ 10.5 million only a year earlier, in 2014. From a regulatory perspective, the Securities and Exchange Commission of Pakistan (SECP) has introduced a number of related rules and regulations over the years. This includes, among others, the Private Equity and Venture Capital Fund Regulations 2008, the Private Funds Regulations 2015, the Non-Banking Finance Companies (NBFC) and Notified Entities Regulations 2008, which saw a number of subsequent amendments. An

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[2] Ernst & Young's Venture Capital Insights 4Q14 report

[3] KPMG and CB Insights' Venture Pulse Q42015 report

[4] Tech in Asia report, accessed from: https://www.techinasia.com/state-venture-capital-asia

improved regulatory framework, consistent policies, and improved macroeconomic indicators and security situation could inspire further confidence in investors and see Pakistan's VC participation increase in the current year.

Section III. SBP's financing initiatives

Pakistan's central bank is playing an active role in facilitating the provision of financing for technology upgrades, innovation and balancing, modernization and replacement (BMR) through the following schemes:

1. *Long Term Financing Facility (LTFF):* provides funds for procurement of new local and imported machinery used in eligible export oriented projects;
2. *Refinancing Facility for Modernization of SMEs:* provides long term financing for local purchase/import of new machinery for BMR of existing SME units, setting up of new SME units and purchase of new generators up to 500 KVA;
3. *Scheme for Financing Power Plants Using Renewable Energy:* provides long term financing for imported and locally manufactured plants, machinery and equipment to be used in new power projects with capacity of up to 20 MW using renewable energy sources; and
4. *Financing Facility for Storage of Agricultural Produce (FFSAP):* enables private firms to obtain refinancing for establishment/expansion of silos, warehouses and modern cold storage facilities.

Additional features and impact of these schemes, which are being executed in conjunction with participating banks and DFIs, is summarized in **Table 4**.

Table 4: SBP's long-term financing schemes

Name of Scheme	Year of Introduction	Maximum Period	Total amount disbursed (Billion Rs)	Outstanding amount (Billion Rs)
LTFF for plant & machinery	31-12-2007	10 years	100.7	39.800
Refinancing facility for modernization of SMEs	02-09-2009	10 years	0.3	0.090
Scheme for financing power plants using renewable energy	01-12-2009	10 years	0.2	0.173
FFSAP	04-06-2010	7 years	4.0	1.900

Source: SBP Development Finance Review, 2015

In the domain of microfinance, SBP has launched the microfinance credit guarantee facility to reduce the risks against loans extended to microfinance providers by commercial banks. Further measures include introduction of regulations for Microfinance banks (MFBs) in 2001; creation of a microfinance credit information bureau (m-CIB) from 2009-2012; and high investment in the Institutional Strengthening Fund. The interest of microfinance clients were also safeguarded via measures like the Client Protection Initiative (CPI), executed in conjunction with the Pakistan Microfinance Network (PMN).[5]

SMEs are also an underserved segment in terms of financing from commercial banks. An important factor in this regard is the high infection ratio prevalent among SMEs, compared to other borrowers (**Table 5).**

Table 5: Composition of Banks' Advances and Infection ratio percent

	CY08	**CY09**	**CY10**	**CY11**	**CY12**	**CY13**	**CY14**	**CY15**
Banks' Advances								
Corporate	63.16	61.86	62.72	64.58	65.77	66.89	66.72	66.30
SMEs	11.75	10.42	9.34	8.11	6.59	6.30	6.07	5.97
Agriculture	4.87	4.69	4.56	4.72	4.85	5.12	5.36	5.46
Consumer financing	10.41	8.05	6.99	6.47	5.96	6.06	5.96	6.30
Commodity financing	7.37	12.54	12.31	11.68	12.22	10.63	11.13	11.15
Other	2.45	2.46	4.08	4.44	4.60	4.99	4.75	4.82
Infection Ratio								
Corporate	8.9	12.6	15.4	17.1	15.2	13.4	13.0	12.3
SMEs	15.8	22.1	28.0	31.4	34.6	32.3	30.5	26.1
Agriculture	15.8	16.5	17.9	19.3	14.5	14.0	12.4	13.0
Consumer financing	6.9	12.2	16.9	18.6	17.5	13.6	11.6	8.7
Commodity financing	1.4	1.1	1.3	1.1	1.1	1.1	1.0	1.2
Others	n.a	n.a	15.4	13.3	10.8	8.9	7.1	8.6
Total	10.5	12.6	14.7	16.2	14.5	13.0	12.3	11.4

Source: State Bank of Pakistan

[5] CPI was a 3-year project funded under SBP’s Financial Inclusion Program from January 2013 to March 2015. It consisted of two components: a) pricing transparency, to promote responsible and transparent pricing practices among microfinance practitioners (MFPs); and b) client protection monitoring, via third party assessments of PMN’s member MFPs, to ensure compliance with global benchmarks

In this backdrop, the central bank has taken following steps specifically for provision of financing for SMEs: assignment of targets to commercial banks, with the aim of extending nearly Rs 100 billion in SME financing in the calendar year 2016[6]; formulation of a regulatory framework encompassing SME financing, revised in 2013; establishment of e-Credit Information Bureau; and ongoing work for creation of a secure transaction registry for extending small-scale loans.

Furthermore, the Export Finance Scheme (EFS) contains some special measures for SMEs who export significant portion of their products, such as the requirement that banks apportion a minimum 10 percent of their EFS limit to such enterprises. In general, the EFS scheme, introduced in 1973, provides short term financing facility for exports of a wide variety of manufacturing goods (especially value-added products).[7] As per EFS Part-I, which is a transaction based facility, commercial banks provide export finance to exporters against firms' export orders, contracts or letters of credit. This facility has a tenor of up to 180 days, with a rollover option for further 90 days subject to fulfillment of certain conditions. Meanwhile, EFS Part-II is a performance based facility, whereby the entitlement of an exporter for revolving export finance limit is equal to 50 percent of export proceeds realized through export of eligible commodities in the preceding financial year. As of June 30, 2015, outstanding financing under EFS amounted to Rs 191.1 billion.

Meanwhile, given the importance of the agriculture sector, Prudential Regulations for Agriculture Financing have been introduced and revised as necessary by SBP to ensure that farmers have due access to financing. A Livestock Insurance Scheme also offers livestock owners a buffer against hazards and disease-induced losses, while the Crop Loan Insurance Scheme has also been enhanced. Progress was also made during FY15 to develop Warehouse Receipt Financing and credit guarantee scheme for small and marginalized farmers. SBP has also facilitated trainings featuring international experts to train local participants regarding innovations and global best practices in the domain of agriculture financing.

Women also represent an underserved segment of the economy, though gains have been made in the past few years. SBP's Access to

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[6] Outstanding SME financing was Rs 305 billion as on 31st December 2015, according to SBP's Quarterly SME Financing Review (December 2015)

[7] Some basic and primary commodities/raw materials, mentioned in negative list, are excluded from EFS

Finance (A2F) 2015 survey reveals that 43 percent of Pakistani females are financially included as of 2015, compared to 33 percent in 2008. Narrowing down further to the banked segment, 11 percent of women are classified as banked, compared to 4 percent in 2008.[8] The A2F 2015 findings suggest that lower participation by females in the labor force and economic life compared to men is an important determinant of financial exclusion; those classified as housewives were not significantly less informed about financial services. Initiatives like WomenX, a pilot program which provides business education and support services to female SME owners, as well as preferential treatment for women by organizations like the Pakistan Poverty Alleviation Fund, are either directly addressing women's needs for financing, or indirectly facilitating inclusion by involving women in economic activities to a greater degree.

Other notable steps taken by SBP to promote financial inclusion in the country include:

- Adoption of Branchless Banking Regulations in 2008
- Execution of nationwide Financial Literacy Program in 2012
- Development work for an Inclusion, Stability, Integrity and Protection (I-SIP) methodology in 2014
- Provision of support in setting up the Prime Minister's Youth Business Loans scheme, including training workshops for participating banks.

However, the overall financial inclusion scenario remains challenging. Recognizing the need for further measures, SBP introduced the National Financial Inclusion Strategy (NFIS) in 2015. The NFIS provides a five-year action plan to guide public and private actors in the drive to increase financial inclusion. It covers priority areas such as branchless banking, SME finance and infrastructure, microfinance, rural, and agriculture finance, housing finance, Islamic finance, digital payment systems, consumer protection and financial literacy, and insurance and pensions. The Ministry of Finance and the Securities and Exchange Commission of Pakistan are among key stakeholders taking leadership role along with SBP in implementation of the strategy.

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[8] Banked individuals are those who (a) are owners or users of bank accounts at any formal institution (except the National Savings Center), and/or (b) are owners or users of mobile accounts (as of 2015; did not exist in 2008)

The NFIS vision is for individuals and firms in Pakistan to have access and use a range of quality payments, savings, credit and insurance services which meet their needs with dignity and fairness. The link with innovation and S&T is several-fold: the strategy encourages the introduction of new products and services which address the needs of the under-served; it promotes development and expansion of innovative channels, such as branch-less banking and digital transaction accounts; by including marginalized segments, like women and micro, small and medium enterprises (MSMEs), increasingly into the fold, it opens up opportunities to engage in S&T activity which was previously limited on account of lack of financial access or inadequate funding.

Section IV. Role of innovation in expanding financial access

Technology itself is accelerating the pace of financial inclusion. Thus, digital technologies and mobile financial services can, on the one hand, lead to an increase in financial inclusion. On the other hand, this increased access to finance can further open new avenues for various actors – MSMEs and entrepreneurs in particular – to avail funds for the launch of technology based ventures, or modernization of existing businesses.

The NFIS recommends the use of technology and innovative risk assessment models in serving the needs of Pakistan's MSMEs. By 2020, it targets an increase in SME lending as a proportion of total bank credit to the private sector to 15 percent, from 7 percent originally. Meanwhile, the overarching NFIS target is to increase access to formal accounts from 10.3 percent[9] of adults with a transactions or other type of formal account to 50 percent by 2020.

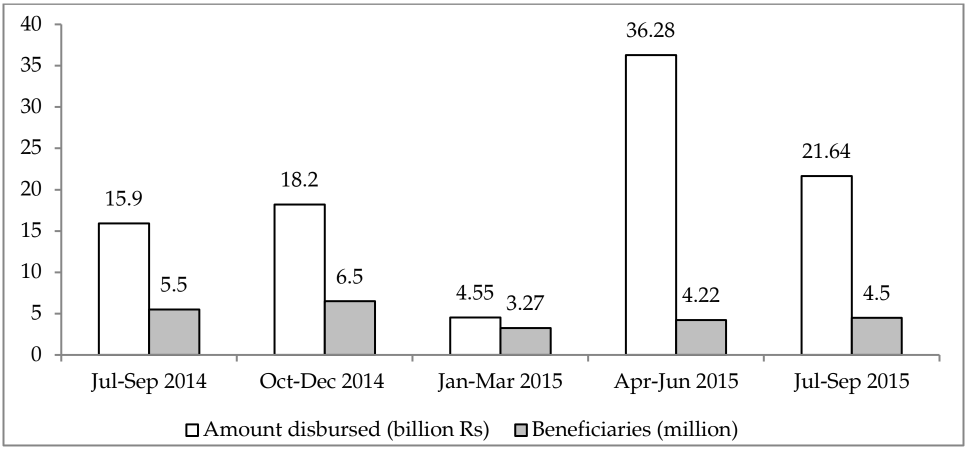
Mobile technology in particular holds great promise. On average, nine out of ten households in the country have access to a mobile phone and SIM card. According to the World Bank Global Findex 2014 database, 5.8 percent of Pakistani adults had mobile accounts, compared to the South Asian average of 2.6 percent. Moreover, a similar pattern was observed in rural areas, which is important in the context of universal financial inclusion.

Encouraged by the Branchless Banking Regulation Act and subsequent regulatory initiatives taken by SBP, Pakistan has become one of the fastest growing markets for branchless banking in the world, with Tameer MFBs 'EasyPaisa' providing a widely heralded success story.

[9] Financial Inclusion Insights 2014

Complimentary steps taken by the central bank include the execution of National Financial Literacy Program and improvement in payments and settlement system.

Figure 5: Periodic trend of G2P disbursements



Source: SBP Quarterly Branchless Banking Newsletter, Issue 17, Jul-Sep 2015

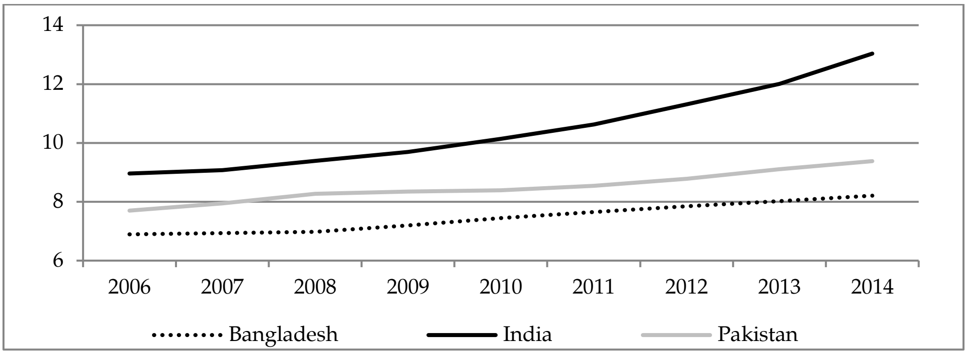
The government is also keen on promoting branchless banking, as evidenced by growing digitization of Government-to-Person (G2P) payments, including efforts to digitize payments made to Benazir Income Support Program (BISP) beneficiaries. **Figure 5** reveals the periodic trend in G2P disbursements, facilitated by branchless banking. An amount of Rs 21.6 billion was disbursed to 4.5 million beneficiaries in Jul-Sep FY15, comprising BISP (Rs 15.5 billion to 3.5 million beneficiaries), IDP (Rs 5.4 billion to 141,080 beneficiaries), EOBI (Rs 388 million to 68,369 beneficiaries) and others (Rs 256.9 million to 720,804 beneficiaries).[10]

Furthermore, the Pakistan Telecommunication Authority (PTA), National Database and Registration Authority and 1Link are also playing an active role in developing the infrastructure. Recent measures include SBP and PTA's efforts to introduce interoperability among branchless banks, and the central bank's development of an online application to monitor branchless activity and prevent any misuse of funds. SBP and 1Link also inaugurated the first domestic payment scheme, PayPak, in April 2016, with the new card offering the benefit of low cost, ease of affordability and security to ordinary citizens.

[10] SBP Quarterly Branchless Banking Newsletter, Issue 17 (Jul-Sep 2015)

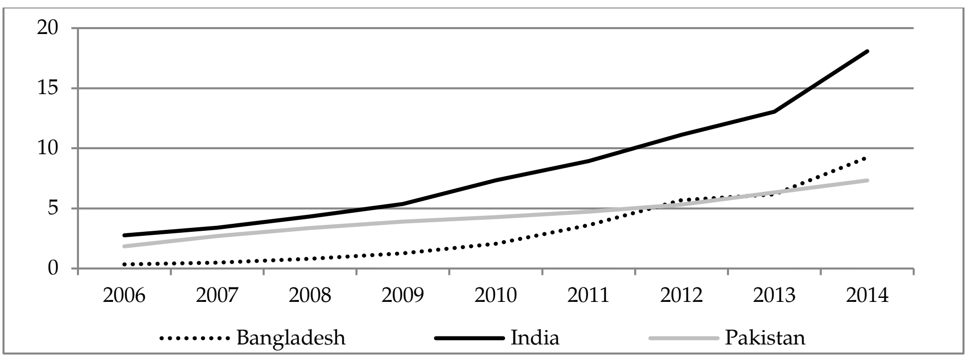
Pakistan has made some gains in expanding the geographical outreach of financial services, even though it has been outpaced on these dimensions by Bangladesh and India (**Figures 6 and 7).** ATMs, in particular, represent an instant, safe and convenient way to access funds. Meanwhile, expanded access opens up further possibilities of innovation, as evidenced by global trials of card-less ATMs which employ smartphones instead of debit cards.

Figure 6: Commercial bank branches per 100,000 adults



Source: IMF Financial Access Surveys

Figure 7: ATMs per 100, 000 adults



Source: IMF Financial Access Surveys

Improved access has, in turn, resulted in a noteworthy shift towards modes of electronic banking. Specifically, FY14 saw the number of transactions using E-banking overtake the number of transactions via traditional, paper-based instruments (**Table 5)**.

Table 5: Number of Transactions millions

	FY11	FY12	FY13	FY14	FY15
Paper based instruments	343.8	357	359	362	362
Electronic banking	234.9	277.4	320.5	403.7	469.1
Real time online banking	74.4	83.1	89.1	98.5	113.8
ATMs	137.7	166.2	199.8	258.5	300.3
Point of sale terminals	14.3	17.5	17.3	24.3	32.1
Internet banking	4.4	6.9	9.6	15.6	16
Mobile banking	3.3	3.1	4.2	6.2	6.1
Call center	0.8	0.7	0.6	0.7	0.8

Source: SBP Payment Systems Review, FY15

In addition, another project leveraging innovation being implemented by SBP is the Financial Innovation Challenge Fund (FICF). This fund, with provision of grants worth GBP 10 million (sponsored by UK Aid), consists of several thematic rounds; themes identified to date include 'Financially Inclusive G2P Payments', 'Innovative Rural and Agriculture Finance in Pakistan', and 'Promoting Excellence in Islamic Finance'. The fund provides seed capital and envisages the scaling up of new ventures with support from donors and private sector agents.

Finally, SBP has set up three Centers of Excellence in Islamic Finance (CEIFs) in order to promote quality research and development and a knowledge environment which promotes innovation. The CEIFs have been established at IBA (Karachi), LUMS (Lahore), and Institute of Management Sciences (Peshawar).

1. Conclusion

We have seen that countries which prioritize S&T and innovation, as reflected by indicators like R&D expenditure, reap the benefits in terms of economic growth and development. In addition, availability of bank financing tends to spur innovative activities. Pakistan has lagged behind in this regard compared to countries like India and Singapore, and is paying the price as a result. We have also touched upon the venture capital industry, and how India has tapped into this alternative source of funding for innovative enterprises with some degree of success.

SBP has taken a number of initiatives to make financing available, especially for underserved segments and those entities which require funds to upgrade their processes and technology resources. These measures include promoting access to finance for SMEs, agriculture sector, and export-oriented firms, for the establishment of new units, import of machinery and expansion/BMR of existing facilities. The central bank has also provided impetus for spread of innovative banking models, like branchless banking, under the umbrella of ambitious strategies targeting nation-wide financial inclusion and digitization of processes. Collectively, these measures constitute a regulatory framework which supports S&T and innovation in the country.

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Access to Finance and Agency: An Overview of the Constraints to Female-Run Enterprises

Farah Said*

Abstract

A large proportion of women in Pakistan engage in home-based production rather than wage employment in the public space to generate an income. This article provides an overview of the literature on the role of access to finance and women's decision-making power (at the household level) on the likelihood of business creation and growth by women. The literature shows that finance has little impact on business and household outcomes; this suggests that other constraints are at play when it comes to women setting up an enterprise or making business decisions. This overview shows how self-control – risk aversion and present biasedness – can inhibit business investment. Household members may also 'capture' a woman's financial resources, including business loans or savings, and put them to unproductive use. Further, social and cultural norms may dictate whether setting up an enterprise is seen as an 'appropriate' activity for women. Against the backdrop of several government and private initiatives to promote enterprise, exploring these issues provides us with important insights into how female-run businesses can be encouraged and supported.

Keywords: Entrepreneurship, microfinance, credit constraints, household decision-making, norms.

JEL classification: D14, J16, 012, P34, P36.

1. Introduction

Pakistan has had a long-standing low labor participation rate: the national rate of active labor participation stands at a little under 46 percent.[1] Such low indicators are particularly troubling for a developing country trying to combat poverty and inequality. Labor participation is

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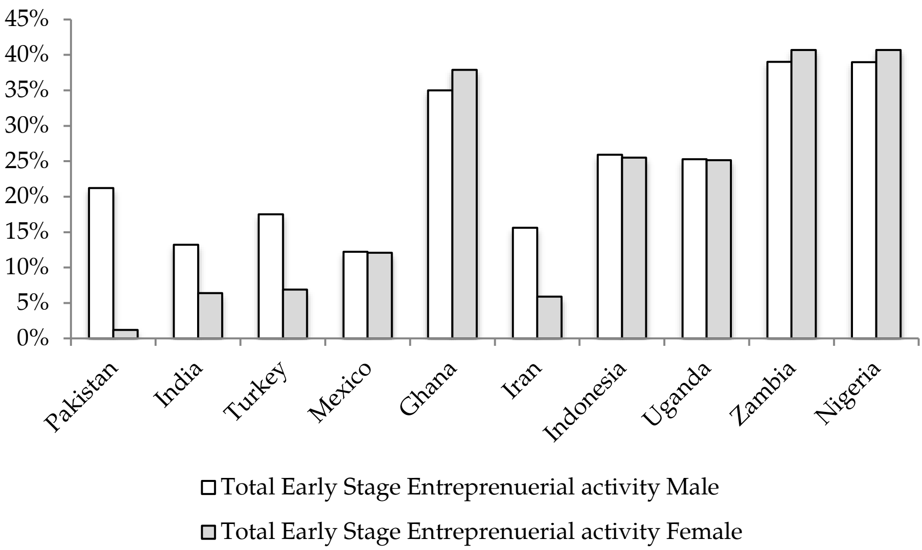
[1] All figures are from the Labor Force Survey for 2013/14 (Pakistan Bureau of Statistics, 2015). It is worth noting that the survey uses a liberal definition of 'currently active': it includes all employed and unemployed individuals aged 10 and above, who are either looking for work or are involved in paid employment or the trade of goods and services in the market for own consumption or barter.

disproportionately low among women: at 22 percent, the female participation rate is one third that of the male participation rate. The disparity between male and female participation is even greater in paid employment (13 percent for women versus 43 percent for men) and formal microenterprises (19 percent for women versus 41 percent for men). In the informal sector, the gender ratio is more equitable, albeit low, at 38 percent for women and 42 percent for men. According to data from the Global Entrepreneurship Monitor, there are 17 male entrepreneurs to every female entrepreneur at the startup stage (Figure 1). This gender ratio is lower than in other developing countries in South Asia and Africa.

Figure 1: Total early-stage entrepreneurial activity, by gender



Source: Global Entrepreneurship Monitor 2012/13, retrieved from http://www.gemconsortium.org/data/key-indicators

Should we be concerned about this gender disparity? The answer is, undisputedly, yes. The literature shows that the welfare impact of a cash infusion in the household will be very different depending on the recipient of the inflow. Household welfare, as measured by child health, nutrition and education, tends to be higher when cash is allocated by a woman as opposed to a man (see Yoong, Rabinovich & Diepeveen, 2012, for a literature review). Of course, one can argue that economic empowerment has a value per se that ought not to be concentrated in only the male members of the household. That we should be concerned about gender disparity is not disputed. What is less clear is what might explain the gender gap in economic activity.

Part of this gap can be explained by the returns to education. Male and female educational attainment is vastly different, particularly beyond the primary level. However, a plausible reason for this gap (including that in educational attainment) may also be the difference in access and opportunity. Social and cultural norms affect the role of a woman in society, often delineating her as a caregiver – any paid employment she seeks outside the home must not then interfere with her responsibilities at home. This limits her to finding employment closer to home. One argument is that society and the institution of purdah frowns on – if not disallows outright – the woman from working outside the home at all. This may explain why more women engage in home-based production rather than wage employment in the public space to earn an income.

Other than access to financial and technical resources, female-run enterprises in Pakistan are, therefore, limited by sociocultural concerns. Notwithstanding government grants and policies, the needs of micro-entrepreneurs among the disadvantaged in Pakistan are met largely by the microfinance sector. While not catering to the ultra-poor, microfinance organizations provide small, short-term loans to those just above the poverty line, who are unbanked by the traditional financial sector. A detailed exploration of this issue, including a robust empirical investigation, will be directly useful to policymakers and practitioners.

The role of enterprise in economic growth has long been recognized (see Knight, 1921; Schumpeter, 1942; Baumol, 1968) and its importance for women as an acceptable form of income generation makes it all the more pertinent to improving welfare and growth. The Government of Pakistan has already shown keen interest in encouraging entrepreneurship, a testament to which is the Prime Minister's Youth Business Loan Program whereby young people (aged 21 to 45) are provided subsidized financing.[2] The program specifically requires that half the funds be disbursed to female borrowers. Against this backdrop, the findings of such a study will be of direct interest to the government as it decides how best to extend credit to these entrepreneurs.

Section 2 provides an overview of the microfinance sector in Pakistan. Section 3 gives a detailed literature review on microenterprise growth and creation in general and on female-run businesses in particular.

[2] Prime Minister's Youth Program (http://youth.pmo.gov.pk).

It also discusses studies that have attempted to measure household dynamics and social norms. Section 4 concludes, with brief suggestions for future research.

2. Microfinance for Women in Pakistan: An Overview

Typical credit products offered by commercial banks do not cater to micro-entrepreneurs. Muhammad Younis revolutionized the field of credit in the 1990s when he introduced financial products targeting the poorest men and women in Bangladesh – a segment that was typically unbanked, with limited or no access to traditional finance provided by commercial banks. Since then, this model of finance has been adopted worldwide, with regional and cultural variations. However, such loans are typically un-collateralized, small, short-term and offered at higher interest rates. Default is minimized by various checks and balances, joint liability and/or guarantee systems. Clients tend to be from marginalized segments and are often women. Arguably, given women's limited mobility, fraud and default are lower. In addition, access to financial resources has the potential to improve the welfare of the recipient as well as the household.

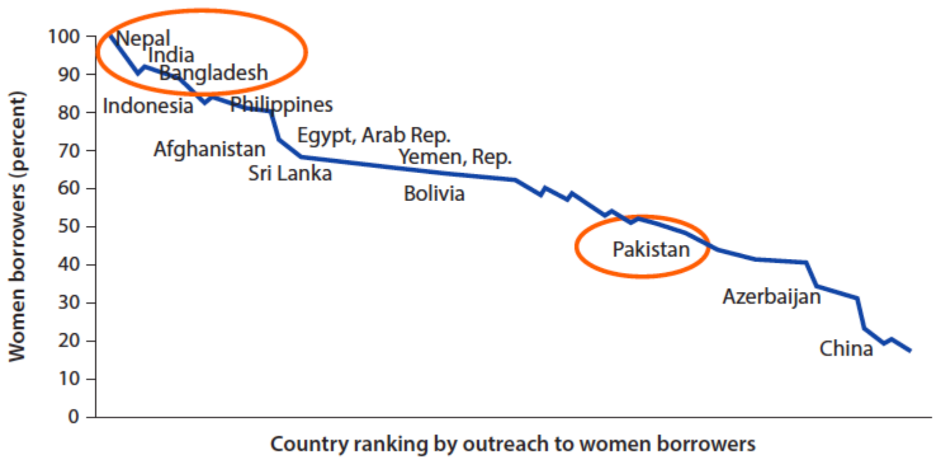
Microcredit was first introduced by the Aga Khan Rural Support Program and the Orangi Pilot Project in the early 1980s. The microfinance sector in Pakistan is one of the more developed sectors in the region (Economist Intelligence Unit, 2012) in terms of market capacity and the commitment shown by its regulators, but it lags behind its neighbors in terms of adoption (Villasenor, 2016). Outreach is unevenly spread, with most microfinance institutions providing access to markets in Punjab and Sindh and very little presence in most of Balochistan. With an estimated 1.7 million active borrowers and a loan portfolio of more than US$460 million,[3] the sector has institutional support from the State Bank of Pakistan[4] and boasts a robust growth rate.

However, the gender ratio is less favorable to women than in other countries (Figure 2). While 94 and 91 percent of borrowers in India and Bangladesh, respectively, are women, the corresponding ratio for Pakistan is only 59 percent (Safavian & Haq, 2013). Why does Pakistan have a lower proportion of women borrowers? Is it for lack of demand among women or are microfinance institutions unwilling to lend to them? Safavian and Haq (2013) estimate that 90 percent of women require permission from their

[3] Microfinance Information Exchange (www.mix.org).
[4] This includes the Microfinance Institutions Ordinance 2001, the Prudential Regulations for Microfinance Banks and the central bank's strategy for expanding microfinance outreach.

husbands to apply for a loan, while two thirds of women in rural areas and about a third in urban areas report being able to use the loan for their own purposes. The remainder of borrowers report that the loan was used by male family members.

Figure 2: Country ranking, by microfinance outreach to women



Source: Microfinance Information Exchange (2010, cited in Safavian & Haq, 2013).

Further, 60 percent of women report having to persuade their husbands to pay back the loan. On the supply side, there is no evidence to suggest that microfinance institutions discriminate against women borrowers. On the contrary, some NGO-based microfinance institutions focus explicitly on women clients, e.g., the Kashf Foundation and Aga Khan Rural Support Program – two of the largest and oldest microfinance providers in Pakistan. Others have gender-neutral policies that do not discourage women borrowers: women constitute 70 and 20 percent of the borrowers of the National Rural Support Program and Khushali Bank, respectively.[5]

A few quasi-experimental academic studies[6] have looked at the impact of access to finance on both men and women in Pakistan. Using propensity score matching, Asim (2009) finds that participation in microcredit programs does not significantly affect household or female empowerment outcomes in a sample of 275 borrowers and existing

[5] Pakistan Microfinance Network, *Microwatch*, issue 22, 2011.

[6] This includes academic research by independent researchers, not official reports from microfinance providers or funding agencies.

microenterprises. Setboonsarng and Parpiev (2008) use a similar technique to show how significant income generating activities, such as agricultural production, are associated with the provision of microloans. Ghalib, Malki and Imai (2011) show that microcredit has a statistically significant positive impact on the economic wellbeing of households in rural Punjab.

Evidence on the impact of microfinance on women has been mixed. As yet, no study has used robust experimental techniques to measure the direct impact of microfinance on household and business outcomes for women borrowers, nor looked at the long-term impact of microfinance or the sustainability of any change in outcomes.

3. Literature Review

The development potential of microfinance has recently been challenged by empirical studies that show limited improvements in household and business outcomes. This section provides an overview of the literature on the role and impact of access to finance, technical knowledge and the household and society in facilitating or constraining microenterprise by women in developing countries.

3.1 Access to Finance

The literature provides some direction for thinking about the likely impact of borrowed funds on women who do not run an existing business. However, most studies focus on the growth of existing businesses rather than the creation of new ones. Measuring the impact of a group lending program in Hyderabad, India, Duflo et al. (2013) find that, 15–18 months later, the profits of pre-existing businesses had increased. Although access to finance had helped a small number of women start their own enterprise, it was not significantly effective in helping them escape poverty. Similar results are found for Mexico (Angelucci, Karlan & Zinman, 2015), rural Mongolia (Attanasio et al., 2015), Morocco (Crepon et al., 2015), Ethiopia (Tarozzi, Desai & Johnson, 2015) and Bosnia and Herzegovina (Augsburg et al., 2015).

Banerjee et al. (2015) outline a series of randomized trials conducted across a total sample of more than 10,000 individuals in six countries (Ethiopia, Ghana, Honduras, India, Pakistan and Peru). The program in question offered financial grants as well as training and support in the form of frequent coaching visits by field officers. The results indicate no impact on household or business expenditure or on women's empowerment within the household 24–36 months later, but they do show an increase in total household assets and consumption and more time spent on productive activities. Fafchamps et al. (2014), on the other hand, find that cash grants have an insignificant impact on both male- and female-run enterprises, casting doubt on the role of finance alone in enhancing business growth. Their results imply that the mechanism through which assistance is provided to women matters: cash assistance alone may not be enough to benefit an enterprise and/or sustain profit improvements.

These mixed results might be explained by the nature of microfinance loans – small loans at high interest rates may be inherently ill-suited or insufficient to promote long-term microenterprise growth or creation. Bandiera et al. (2013) find that, for the ultra-poor in rural Bangladesh, sizeable asset loans (worth approximately US$140) helped increase earnings by almost 40 percent, even after the assistance was withdrawn. They also find a substantial shift among women from agricultural labor to running a business. Beaman et al. (2014) believe that the success of large borrowers may have to do with self-selection. Using a randomized controlled trial to evaluate the impact of agricultural loans, they find that farmers who experience the highest returns are more likely to borrow in the first place.

Other studies find that business outcomes improve when borrowers are given a grace period before repayment commences (Field et al., 2013). In addition, a highly elastic demand may crowd out viable borrowers (Karlan & Zinman, 2013), while equity-like loans – as opposed to joint-liability loans – are more efficient in encouraging enterprise among women micro-entrepreneurs (Fischer, 2011).

3.2 Training and Technical Knowledge

The results cited above reflect that loans in themselves may not be enough to prompt the efficient and productive use of funds and need to be complemented with skills or training (Blattman et al., 2015). Valdivia (2015) shows that business outcomes improve for recipients of technical training in Peru. McKenzie and Woodruff (2014) conclude that, while training may help start an enterprise, it does not necessarily ensure business growth. Their evidence implies that training hastens the entry of businesses that were going to enter the market regardless; it does not boost the entry of businesses that would not have otherwise been set up.

3.3 Microenterprise Preferences: The Role of the Individual, Household and Society

A detailed analysis of the characteristics of borrowers who succeed in improving business outcomes under the traditional microfinance structure provides further insights into why enterprises may be constrained. For example, a low level of initial assets has been shown to inhibit self-control (Bernheim, Ray & Yeltekin, 2013) and may limit the productive use of resources. We can also expect investment in a business with delayed or riskier returns to be lower among risk-averse or present-biased entrepreneurs. The lower (if not insignificant) growth of female-run enterprises could also be a result of the household dynamics under which women have to operate. For instance, de Mel, McKenzie and Woodruff (2009, 2012) find that the gap between male-run and female-run business outcomes in Sri Lanka is lower for women from more 'cooperative' households where they are more involved in household decision making.

Examining an intervention involving business loans and intensive training for micro-borrowers in Pakistan, Giné and Mansuri (2011) find no improvement in business knowledge among female entrepreneurs. They argue that it is not necessarily the ablest women who self-select into enterprise. Rather, given the social and cultural constraints to their mobility, female entrepreneurs may see enterprise purely as a source of 'appropriately' earned income that does not require them to leave home. As a result, they may not be motivated enough to improve business outcomes. Similarly, if women fear the 'capture' of their earnings by a spouse or other household members, this may remove their motivation to increase their income beyond subsistence level.

Empowerment is broadly defined as the process by which individuals become able to make strategic life-choices (Kabeer, 1999). Ngo and Wahhaj (2012) show that the empowerment-enhancing potential of a loan to a woman can depend on whether her spouse has an incentive to capture her resources for personal or household use. Capture is less likely if the woman carries out an autonomous activity and her spouse does not have an alternative activity that provides comparable returns. Similarly, the relative economic contribution of men and women is positively correlated with their degree of influence over household decisions (Grasmuck & Espinal, 2000). Insofar as this may have to do with the greater fungibility of cash, coupled with internal or external pressure to use those funds in a way that provides immediate benefit to household members

(Fafchamps, Kebede & Quisumbing, 2009; Jakiela & Ozier, 2012), the impact of a loan on business is likely to be small and transitory.

It is only recently that experimental techniques have been used to obtain objective measures of empowerment levels. Indeed, studies based on field experiments highlight the motivation for disempowered household members to 'hide' loans or funds available to them to prevent capture. In a study on the Philippines, Ashraf (2009) gave married couples the option to deposit an experimental endowment in either a joint account with their spouse or in a private account, but at a cost. She found that both men and women are more likely to deposit money in private accounts if their spouse controls the household finances; this is true even if they have to give up a portion of the endowment to do so. In a subsequent study, Ashraf, Karlan and Yin (2010) find that women who are able to open private savings accounts experience an increase in decision-making power in the household.

Mani (2011) and Fiala (2015) show that spouses in India and Uganda, respectively, are willing to sacrifice the efficient investment option in an experiment to determine which option provides greater control over returns. Further, as Ashraf (2009) also shows, this is less likely to happen when men have positive 'interaction' with their wives outside the experiment. In a similar experiment for Senegal, Boltz, Marazyan and Villar (2015) find that individuals who choose to 'hide' their income do so in trying to escape pressure to share from household members.[7] Other studies have looked at the concept of capture in the context of patriarchal and nuclear families (see Kazianga & Wahhaj, 2015), bargaining power (see Murillo, 2015), asymmetric information on household finances (see Hoel, 2015) and information asymmetries imposed by geographical distance in migrant families (see Ambler, 2015).

If the resources owned by the less empowered are likely to be captured, then providing loans may not be enough to create new enterprise or increase the welfare of the recipient. Given the social and cultural context, women are likely to be the more disadvantaged members of the household (Carlsson et al., 2012) and may not be able to exercise control

[7] Almas et al. (2015), Castilla and Walker (2013), Castilla (2014) and Schaner (2015) conduct similar field experiments and find that spouses who lack information on each other's financial resources and come from noncooperative households where they do not have a say in decision making are more likely to hide their earnings or investments. In a study on Ethiopia, Kebede et al. (2011) find that individuals are likely to share less of their endowment with a spouse if the size of the endowment remains hidden from the latter.

over funds. In his seminal paper, Chiappori (1988) rejects the notion of a Pareto-efficient household utility model: households cannot be characterized by a single utility function (see also Chiappori, 1997). Theoretically, a married woman's relative weight in household decisions is larger if (i) she comes from a wealthy family before marriage, (ii) the customary divorce laws are favorable to women (Dercon & Krishnan, 2000), (iii) the distribution of income or household-sharing rule is skewed toward women (Browning, Chiappori & Lechene, 2006; Browning, Chiappori & Lewbel, 2006) or (iv) there is symmetric information among household members (Chen, 2013).

The 'unitary' model of household utility has been rejected by several empirical studies in different contexts.[8] Studies have also shown that the welfare impact of financial and information interventions differs by the gender of the decision maker (Duflo, 2003; Duflo & Udry, 2004; Bobonis, 2009). In addition, there may be psychological costs of hiding resources. Ashraf, Field and Lee (2014), for instance, find that women who hide contraceptive decisions from their spouse suffer from a lower subjective wellbeing.

Finally, loan recipients may be subject to certain social or familial standards or norms of behavior. These standards may be accepted norms of behavior enforced by peer pressure or fear of condemnation or through internalized shame or guilt over a broken social rule. When these standards are (implicitly) enforced, they can limit the discretion a female borrower has over use of the loan. Recognizing the role of social pressures, Krupka and Weber (2013) have designed a novel game intended to elicit an individual's perception of social norms. Their results imply that individuals care about more than monetary incentives when undertaking entrepreneurial activities.

4. Conclusion and Suggestions for Future Research

One cannot look at the constraints to setting up an enterprise without looking at the environment in which entrepreneurs operate. In the case of women, there may be other constraints aside from a difficult business environment. Cultural and social norms play an important role in determining the decision to set up and/or operate a business, sometimes superseding the (female) entrepreneur's own decision. Access to finance is a partial answer to encouraging enterprise, but any

[8] See, for instance, Iversen et al. (2011); Munro, Bateman and McNally (2008); Robinson (2012).

investigation of the constraints women might face in setting up or sustaining an enterprise is incomplete without considering self-discipline and family as well as social pressures.

Empirical experiments have fast become the gold standard in academic research. Quantitative research is far from perfect, often providing an incomplete picture of the impact. Such studies may be able to measure the quantitative change in outcomes, but without uncovering the process through which this change occurs. However, empirical research has the advantage of being able to measure the causal impact of alleviating a constraint objectively and quantitatively, e.g., providing loans to set up a business. With a well-designed intervention, researchers may be able to measure the expected average or representative impact of the intervention.

Measuring an individual's preference for hiding his or her earnings and family or social pressure to share these is problematic if one relies on self-reported data through survey questions. Individuals may react very differently when responding to a survey question about a hypothetical situation and when reacting in a real-life situation. Recently, there has been a move toward lab experiments to uncover behavioral tendencies. While these originated in labs in the developing world, they have shifted to simple pen-and-paper exercises where individual decisions are tied to monetary incentives. These lab-in-the-field experiments are meant to mimic real life, using hypothetical situations in which decisions can have real-life monetary consequences.

Lab-in-the-field games have the added advantage of creating a within-subject panel dataset with multiple decisions by the same individual; this allows one to control for individual-level unobservables. Further, these games can be used to "force choices in starkly different options" in a contrived yet familiar context, allowing multiple tests of theoretical predictions (Hoel, 2015). While this is an improvement on survey questions, we may still find that individuals behave differently in real life. In gender dynamics, interactions outside the lab may also influence behavior within the experiment. However, the literature provides some guidance on how to capture these dynamics using cleverly designed experiments.

In a currently ongoing study, we use a randomized controlled trial involving microenterprise loans for women in Punjab (Pakistan) to measure the impact of access to finance on business creation in this sample[9]. In addition, we use incentivized survey questions and lab-in-the-field experiments to identify social and household norms regarding the 'acceptable' level of autonomy available to female borrowers in deciding how to use their funds. At the time of loan disbursement, these women were not different in terms of measurable variables such as income, education, marital status, household assets and expenditure. A year later, there is evidence to suggest that household and social dynamics may have influenced which women used the loan to set up an enterprise. For instance, compared to the views held by housewives, self-employed women view society to be more favorable towards female entreprenuers. This may reflect the pressures women consider when deciding whether to set up their own business.

To my knowledge, such experiments have not been conducted using a sample of microenterprise loan applicants. This fills a gap in the literature by directly testing for the role of constraints – credit, social norms and household dynamics – in determining enterprise, household and individual-level outcomes. This study also addresses a specific gap in the literature on Pakistan by using a randomized controlled trial to study the impact of a microfinance product on the borrower's household and individual outcomes. The results from this and similar studies could help design pro-poor policies in Pakistan and other developing countries. They will also be directly relevant to microfinance organizations operating in Pakistan, often with a focus on women's empowerment through access to finance, and to policymakers who have recently shown considerable interest in promoting enterprise among women and youth.

[9] This study is a joint work between Azam Chaudhary, Mahreen Mahmud and Farah Said.

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Explaining Pakistan's Premature Deindustrialization

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Abstract

Recognizing that Pakistan faces premature deindustrialization, this paper seeks to explain the phenomenon. The country experienced wild swings in industrialization during the 1950s and 1960s. The period 2001–10 was characterized by fairly strong growth, followed by contractions in other periods. Pakistan's manufacturing sector is dominated by clothing and textiles exports. Periods of manufacturing growth were associated with pro-manufacturing and import substitution policies, while slumps were characterized by deregulation and a relatively high exchange rate. The evidence shows that the relative stagnation of manufacturing (regardless of the policies implemented) can be explained by the lack of a dynamic industrial policy targeting technological catch-up and leapfrogging. Moreover, where rents were distributed in the form of incentives, there was no emphasis on monitoring and appraisal.

Keywords: Deindustrialization, industrial policy, economic growth, Pakistan.

JEL classification: L52.

1. Introduction

Deindustrialization, which has gained substantial traction among scholars since the 1980s, is sometimes viewed as the cause of diverging per capita incomes between developed countries (Rowthorn & Wells, 1987). In the past, deindustrialization was considered to occur when the share of value-added in GDP and that of manufacturing employment in total employment began to fall (Kaldor, 1967). However, the proliferation of automation and machinery in manufacturing has reduced the significance of employment as a measure of deindustrialization. Thus, the share of manufacturing employment in total employment is likely to drop before a commensurate fall in the share of manufacturing value-added in GDP. Rasiah (2011) argues that deindustrialization is characterized by a fall in the GDP share of industry value-added in general and of manufacturing

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value-added in particular, rather than by a fall in the share of manufacturing employment in total employment.

Positive deindustrialization occurs as a result of the falling share of manufacturing in GDP while manufacturing productivity continues to rise. This type of deindustrialization is inevitable even among countries experiencing rapid technological change and productivity growth as production shifts to more capital-intensive and knowledge-intensive activities. Negative deindustrialization, which is undesirable, occurs when the share of manufacturing in GDP falls in the face of falling manufacturing productivity (Rowthorn & Wells, 1987).

Rasiah (2011) defines premature deindustrialization as the falling share of manufacturing in GDP, accompanied by low manufacturing productivity growth when manufacturing industries have yet to mature technologically. This type of deindustrialization is a pathological phenomenon, where simple disequilibrium restricts the economy from fulfilling its development potential. Premature deindustrialization entails not only the falling share of manufacturing in GDP, but also a downward structural shift from high-value-added to low-value-added economic activities or manufacturing stagnation in the latter. In Malaysia, this occurred as a consequence of the substantial import of low-skilled foreign labor into the manufacturing sector.

The most severe form of negative deindustrialization arises in low-income and middle-income economies when manufacturing contracts prematurely and is still characterized by low-value-added activities, declining productivity, stagnant output growth and shrinking jobs. When such countries experience negative deindustrialization that is accompanied by either a contraction or slowdown in the growth of per capita income, they become vulnerable to undesirable structural change as they are trapped in low-productivity services.

Indeed, many countries in Asia, Africa and Latin America have experienced an expansion in low-productivity services, which offer little potential for long-term growth. Such premature deindustrialization is a threat to sustained economic growth in low- and middle-income countries on two counts. First, such countries have appropriated few of the 'growth-enhancing' benefits of manufacturing. Second, manufacturing tends to be replaced by unproductive rather than productive services, including informal services.

In contrast, when 'mature' or positive deindustrialization sets in, the shift toward productive services helps to build knowledge-synergizing linkages characterized by technological upgrading and productivity increments (Rowthorn & Wells, 1987; Kollmeyer, 2009; Rasiah, 2011). It is only then that the services sector becomes an engine of growth: its growth stimulates not only the sector's own expansion, but also that of the other sectors in the economy. Such policies are likely to deindustrialize the economy. Both the deregulation of tariffs too quickly, without giving manufacturing the time to restructure, as well as the continued application of protection and other forms of rent without stringent performance standards to drive technological upgrading contribute substantially to deindustrialization (Rasiah & Nazeer, in press).

With a population of 188.9 million in 2015, Pakistan has been saddled with serious political security problems, a number of which remain unresolved. This is partly to blame for its economic stagnation. After showing some promise during Ayub Khan's military regime in the 1950s and 1960s, the country started to deindustrialize prematurely in the 1970s although it showed some signs of growth in the late 1990s until 2006. Pakistan is the world's fourth largest producer of cotton and chief exporter of yarn. Several factors have restricted manufacturing expansion in the country: (i) poor basic infrastructure (including power supply and transport networks), (ii) weak high-tech infrastructure (including the lack of incentives for R&D and weak university–industry links) and (iii) inadequate integration with the external economy (customs coordination, exchange rate appreciation caused by remittances from abroad and huge inflows of cheap imports).

While, on one hand, the institutional infrastructure for manufacturing is not conducive to expansion, on the other hand, Pakistan has never had a profound industrial policy targeted at stimulating technological upgrading. The industrial policy implemented under the Ayub Khan regime was led by import-substituting industrialization. This was characterized by high real effective protection rates – low tariffs on raw materials, intermediate goods and capital goods, but high tariffs on final goods – without any emphasis on monitoring and disciplining infant firms so that they might reach the technology frontier.

Lacking the monitoring and appraisal instruments to tie rents to technological upgrading as done in South Korea (Amsden, 1989) and Taiwan (Fransman, 1985), the 1960s saw the creation of an industrial class that could not upgrade to high value-added activities. In addition, the administration of tariffs, bureaucratic control and several modes of licensing to control entry into industries exacerbated red tape (the 'license raj'), thereby reducing the efficiency and competitiveness of manufacturing industries (Devarajan & Nabi, 2006). While Pakistan's efforts to dump industrial policy are argued to have been a disastrous mistake by some scholars (see Hamid & Khan, 2015; Haque, 2015), the lack of a sound framework to stimulate technological upgrading in the 1950s and 1960s suggests that it would not have lasted long: it would have been a drain on the country's foreign exchange resources, as happened in Malaysia and the Philippines in the 1950s and 1960s (Rasiah, 2009).

This paper aims to explain why Pakistan has deindustrialized prematurely, to extend the succinct analyses begun by Hamid, Nabi and Zafar (2014), Haque (2015) and Hamid and Khan (2015). The next section presents some theoretical considerations to locate the analysis. Section 3 discusses government policies that either stimulated or undermined industrialization in Pakistan. Section 4 examines the structure of GDP and the growth of manufacturing, trade and productivity trends in Pakistan's manufacturing sector. Section 5 concludes the study.

2. Theoretical Considerations

The idea of industrialization was advanced by Smith (1776) and Young (1928) as being important to support economic progress, given its capacity to stimulate the differentiation of economic activities, thereby extending the division of labor and increasing returns. Gerschenkron (1962), Abramovitz (1956), Chang (2003) and Reinert (2007) document how the process of industrialization transformed today's developed countries. Technological catch-up through learning and innovation has been central to successful industrialization in Germany, the US, Japan, South Korea and Taiwan.

As latecomers, Japan, South Korea and Taiwan sought to catch up by providing protection and subsidies to support the acquisition of knowledge from the more developed countries in the industries they were promoting (Amsden, 1991). Not all countries implementing industrial policy managed to become developed. Countries that did not do so well either had governments captured by clientelist interests, which resulted in the dissipation of rents created through protection, subsidies and grants, or did not introduce a sound policy to stimulate technological upgrading.

The Philippines and Indonesia are examples of countries that had industrial policies until the 1980s and 2000, respectively, but were simply undermined by their instrumental alignment with clientelists. Recent latecomers that developed successfully through industrial policy, such as South Korea and Taiwan, not only offered protection, subsidies and grants to national firms, but also launched a proactive technological catch-up policy. Stringent evaluation, monitoring and appraisal and quick termination of rents to dissipaters ensured rapid technological catch-up and upgrading from low- to high-value-added manufacturing activities in Japan, South Korea and Taiwan (Johnson, 1982; Amsden, 1989; Wade, 1990).

While the drivers of economic progress are now well documented, albeit not in a way that new latecomers can track easily, not much is clear about negative and premature deindustrialization. Deindustrialization is generally said to occur when there is a long-term declining trend in the contribution of manufacturing in particular and (with its appendages of utilities and construction) of industry in general (Kaldor, 1967). This decline is normally measured by a fall in the share of manufacturing value-added in GDP and/or a fall in the share of manufacturing employment in total employment. While positive deindustrialization is desirable, as manufacturing productivity drives the growth of value-added in other sectors, negative deindustrialization is undesirable because it undermines structural change from low- to high-value-added activities.

As noted in the introduction, premature deindustrialization is also undesirable as the manufacturing sector's contribution to the economy begins to decline before it has matured. The consequences of premature deindustrialization have a negative impact on economic growth and structural change. First, a decline in the sector's productivity will reduce its competitiveness in the international economy. Second, the premature transfer of employment from manufacturing to services may reduce wages. Third, the falling competitiveness of manufacturing may aggravate balance-of-payments problems.

The lack of an effective industrial policy to stimulate technological upgrading is central to why countries face premature deindustrialization (Rasiah, 1995; Lall, 2000). Indeed, for developing countries, moving forward becomes increasingly difficult as the international trading system becomes more liberal (Lall, Weiss & Zhang, 2005). Burgeoning balance-of-payments problems can aggravate government finances so as to undermine a country's capacity to pay for essential services such as health and education.

Successful industrializers such as South Korea and Taiwan achieved rapid industrialization by targeting economic diversification from low- to high-value-added activities – both within industries and by shifting to other industries (Amsden, 1989; Wade, 1990). While Amsden suggests getting relative prices wrong to stimulate technological catch-up, Rodrik (2007) emphasizes the opposite. Amsden (1989) is right in arguing that South Korea departed from the orthodoxy prevailing in World Bank and International Monetary Fund circles to introduce and finance heavy and high-tech industries in which it enjoyed no comparative advantage in the 1970s. Instead, relative prices were manipulated through subsidies on loans and tariffs on imports to give infant national firms space to mature. Stringent performance standards through export quotas were applied to reduce the dissipation of these rents.

Hence, we seek to examine efforts to promote industrialization in Pakistan, especially if instruments such as protection using tariffs and subsidies and technological upgrading were used by the government. Three aspects of the government's role are important: the provision of rents in the form of tariffs and subsidies, the introduction of technological catch-up milestones and appraisal mechanisms to ensure that rents translate into industrial upgrading. Since Pakistan has begun deindustrializing prematurely, we focus on whether any or all of the above were poorly executed. One would expect Pakistan's misfiring manufacturing sector to have faced little transformation from low- to high-value-added economic activities in output and exports or even a shift from consumer and intermediate goods to capital goods.

3. Industrial Policy

Pakistan's industrial policies are characterized by different phases and have been an integral part of the country's five-year development plans. Burki (2008) traces five industrial policies launched in Pakistan, the impact of which is evident in the performance of the manufacturing sector.

While the Ayub Khan government confronted various conflicts and grappled with the political and economic organization of the country in the 1950s, Pakistan enjoyed a sensational pace of growth in manufacturing. Production and investment in large-scale manufacturing grew by 20 percent in the period 1950–55. The strong growth continued in the 1960s as manufacturing grew by 10 percent per annum on average during 1960–70 (Abbasi, 2009). The focus then was on import substitution through tariff protection.

However, the populist Bhutto government that was elected toward the end of the 1960s began a nationalization program in the manufacturing sector. The government was short-lived and overthrown by the military in 1977. The new regime began economic deregulation, which undermined the import-substituting industries so that manufacturing grew on average by only 5.4 percent per annum over 1970–80. Nevertheless, manufacturing grew on average by 8.2 percent per annum in the 1980s (Zaidi, 2005). The causes and consequences of this growth had mixed effects for Pakistan.

The military government under Zia-ul-Haq, which lasted till 1988, abandoned both state capitalism and state socialism to pursue Islamization and the redistribution of economic rents (Sayeed, 1995). The market-friendly policies of deregulation, de-control and denationalization were introduced to stimulate private investment. The influence of the military in the economy increased as army officers were appointed to key positions (Khan, 2000; Noman, 1988). Import substitution was abandoned as tariffs were lowered and flexible exchange rates introduced. Controls on the capital account and public enterprises were also removed.

These reforms helped stimulate industrial exports from industrial zones as the production of steel, cement, fertilizer and vehicles began to rise. The public steel mill began production in 1982 and reached its highest capacity operation in 1984/85. Attractive incentives through direct export subsidies on customs duties and sales tax were introduced in 1978/79 to help stimulate manufactured exports. The investment environment also improved as the government gave assurances against future nationalization and offered other tax concessions. Consequently, manufacturing grew by 9.5 percent per annum in the period 1978–83. The private sector's share in new industrial investment had risen to over 90 percent by 1988 compared to about 25 percent in 1976/77.

The restoration of private industrial investment privileges also aided an upsurge in the production of traditional industries such as cotton textiles and cement. The textiles and clothing sector received priority due to its low gestation and instant profit-making potential. However, the structure of incentives did not condition value addition, so that cotton yarn remained a major export despite receiving substantial subsidies (Nadvi & Sayeed, 2004; Hasan, 1998). Whereas exports of grey fabric and cotton yarn expanded sharply to make the industry the main employer in the country, the lack of upgrading policies confined it to low-wage, low-productivity activities (Nadvi & Sayeed, 2004).

Indeed, such an input-driven framework generated a severe drain on Pakistan's reserves, which aggravated the fiscal and current account deficits in the 1980s. Increased military expenditure exacerbated the country's public debt. Defense spending rose by 9 percent per annum to an average of 6.5 percent of GDP, while development spending grew by 3 percent per annum in this period. Manufacturing growth slowed down in the 1990s not only because the provision of generous incentives could not be sustained, but also because the lack of technological policies restricted industrial upgrading from low- to high-value-added activities.

Except in 1997/98, when a reduction in sales tax, credit provision, tariff rationalization and better sugarcane production increased manufacturing growth slightly to 5.5 percent per annum (Kemal, 2004), the large government expenditures in the earlier period restricted further manufacturing growth. Average annual manufacturing growth fell to 3.5 percent per annum in the early 1990s. Along with stagnation in agriculture, the slowdown in manufacturing resulted in a sharp drop in GDP growth after 1988 as inflation and poverty escalated.

The most serious effects of this culminated in 1993 and 1996 when Pakistan faced a foreign exchange crisis. Unfortunately, the subsequent governments under Benazir Bhutto and Nawaz Sharif were either unwilling or unable to halt the decline. A sharp fall in foreign remittance inflows between 1987 and 1990, precipitated by the Gulf War, aggravated Pakistan's current account deficit, although it enjoyed reasonable growth in exports.

The devaluation of the Pakistani rupee and improved incentives aided export growth and a contraction in imports (Sarmad, 1992, p. 866). Falling remittances from overseas workers were substituted for by other sources, including inflows of funds held overseas by Pakistani nationals and nonresident Pakistanis as they were allowed to open foreign currency accounts in Pakistani banks. These accounts were freed from income and wealth taxes and those holding foreign currency accounts were also allowed to obtain rupee loans against such accounts (Khan et al., 2005). Consequently, between June 1991 and June 1996, Pakistan had $4 billion flow into its foreign exchange accounts (Wizarat, 2002, p. 27).

Between 2000 and 2005, manufacturing enjoyed a strong average annual growth rate of 10 percent per annum (Table 1). Similar to the Zia-ul-Haq regime, General Pervez Musharraf's government, which took power in October 1999, introduced a decentralization and deregulation strategy to stimulate economic growth.[1] Falling tariffs and tariff bands were accompanied by initiatives to access export markets in the European Union (EU). Increased liquidity in the economy generated by a large rise in remittances from abroad and foreign direct investment inflows drove consumption-led energy-intensive growth (see Amjad, Din & Qayyum, pp. 13–30).

Table 1: Sectoral GDP growth, %

Sector	1986–90	1991–95	1996–2000	2001–05	2006–10
Agriculture	-5.8	1.6	1.6	-10.8	3.9
Industry	8.2	-3.9	-3.7	12.9	-5.6
Mining and quarrying	0.0	-28.6	-28.3	11.1	-16.1
Manufacturing	6.9	4.5	3.2	10.0	4.2
Construction	2.4	-14.3	-32.4	4.2	0.0
Electricity and gas distribution	21.7	-2.9	0.0	-8.8	23.8
Services	-0.4	3.1	0.6	-1.0	1.1
Transport, storage and communication	-9.1	18.6	17.7	-5.3	3.2
Wholesale and retail trade	9.0	-1.2	2.4	1.7	-0.6
Finance and insurance	-12.5	13.3	8.8	30.0	-13.7
Public administration	1.1	-7.1	-24.4	-6.7	-5.3
Others	-3.2	4.2	0.0	-4.1	11.1

Source: Pakistan Economic Survey (various years).

Pakistan's integration with EU markets quickened following the introduction of duty-free access to clothing items as countries adjusted their fiscal system in line with the termination of the Multi-Fiber Agreement (MFA) in 2004 (Rasiah, 2012). Import duties of around 12 percent had been levied on clothing imports from Pakistan in the EU until January 2005.

The government focused on small and medium enterprises (SMEs) to create jobs and raise income. The Musharraf government also launched major industrial parks in Landhi (Karachi), M3 (Faisalabad) and Sundar (Lahore). While pursuing market fundamentals, Pakistan's industrial strategy in the period 2001–05 emphasized product diversification, which stimulated growth in that sector. The share of industry in GDP increased from 22.6 percent in 2000 to 26.7 percent in 2006, growing by double digits

[1] "The economic charge-sheet." (12 August 2008). *Dawn*. Available at http://dawn.com/2008/08/12/op.htm#1.

annually. As a consequence, the national economy grew by 7 percent in this period (Pakistan Economic Survey for 2004–06).

However, both manufacturing growth as well as economic growth cooled down in the subsequent period, 2006–10. The slowdown can be attributed to the worsening security situation in the country as civil rights were undermined and terrorist attacks surged (Looney, 2008). The rising cost of gas and electricity, following the global rise in oil prices, and the global financial crisis of 2007/08 affected Pakistan's economy adversely. Devastating energy shortages and large-scale load-shedding had a serious effect on manufacturing. A few enterprises such as the Nishat Group switched to capital-intensive, but less power-intensive, production. Indeed, almost all large firms completed an energy audit and have since taken measures to reduce the use of power. Textile mills and engineering firms have, consequently, managed to save between 15 and 20 percent of power.[2] Above all, the country's leading exports, textiles and clothing, fell in 2006/07, which aggravated the trade balance.

Pakistan's patchy economic performance is a result of the absence of a dynamic industrial policy led by technological upgrading (Rasiah & Nazeer, 2015). Over time, a large cluster of potential entrepreneurs has grown in Pakistan, demonstrating the ability to expand private investment. Moreover, the public sector-driven industries of fertilizer, steel, cement, automotive equipment, petroleum refining and petrochemicals have continued to service the national economy. In addition, the government has established development finance institutions and the Corporate Industrial and Restructuring Corporation to help industry grow in spite of tough competition in the global market. A number of institutions have been set up to fulfil the needs and demands of industry.[3] SMEs play a significant role in manufacturing, which contribute 30 percent to GDP. They generate a quarter of the manufacturing sector's export earnings.[4]

Despite having established a strong science base, Pakistan has not linked this proactively to its industrial policy in order to transform the manufacturing sector from low- to high-value-added activities. Over 1947–

[2] "Industry still lagging behind." (7 December 2015). *The News*. Available at http://e.thenews.com.pk/newsmag/mag/detail_article.asp?id=4844&magId=10

[3] The National Development Finance Corporation, Industrial Development Bank of Pakistan, Pakistan Industrial Credit and Investment Corporation, Agricultural Development Bank of Pakistan, the former Bankers Equity Limited, the Small Business Finance Corporation and the Regional Development Finance Corporation.

[4] "Industrialization in Pakistan." (7 January 2002). *Dawn*. Available at http://www.dawn.com/news/13697/industrialization-in-pakistan

2010, manufacturing has enjoyed double-digit growth for short periods, but at no time has it demonstrated the potential to catch up with and leapfrog over the world's leading manufacturing firms. Indeed, Pakistan has experienced premature deindustrialization as its manufacturing share in GDP fell from 18.6 percent in 2005 to 14 percent in 2013 when it is still characterized by low-end activities. A comparison of its manufacturing performance with that of the East Asian economies can be found in Rasiah and Nazeer (in press).

4. Manufacturing Performance

The dramatic shifts in the nature of industrial policy instruments used – albeit starting with a small base, launched ad hoc and without a clear roadmap for catching up – are mirrored by the huge swings in manufacturing growth, trade balance coefficients and relative stagnation technologically. This section examines the performance of manufacturing industries in Pakistan over the period 1981–2010.

4.1 Value Added

In the key industry of textiles and clothing, value-added contracted in the periods 1981–85, 1991–95 and 2001–05 (Table 2). The focus on domestic industry in the early 1980s led to an expansion in the production of chemicals and machinery and transport equipment, which grew on average by 33.3 and 25.0 percent per annum, respectively, in 1981–85. The latter industry also grew strongly in 2001–05 as demand rose sharply due to a large inflow of remittances from abroad, following generous incentives offered by the government. Despite its small starting base, food, beverages and tobacco production either contracted or grew slowly during 1981–2010.

Table 2: Annual average manufacturing value-added growth, %

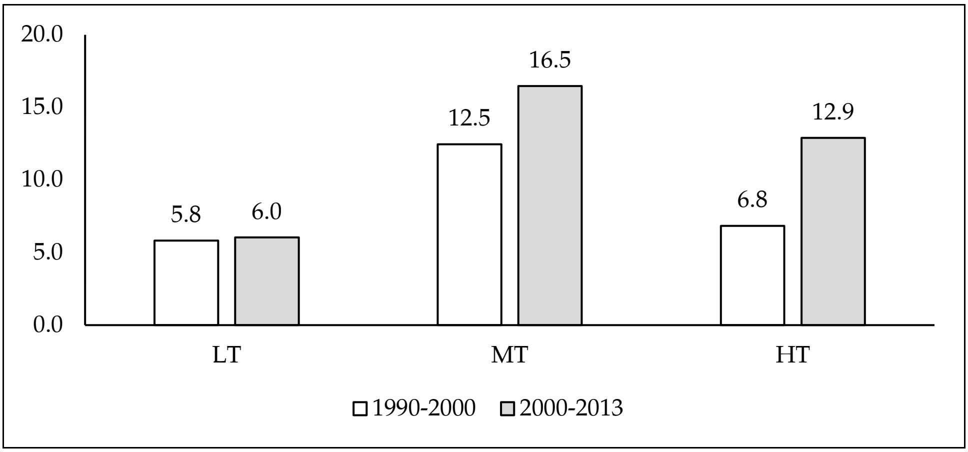
Sector	1981–85	1986–90	1991–95	1996–2000	2001–05	2006–10
Chemicals	33.3	6.3	6.7	6.3	-17.6	0.0
Food, beverages and tobacco	-8.6	-20.0	4.5	-8.7	4.8	4.5
Textiles and clothing	-9.5	28.6	-10.0	19.2	-18.2	37.5
Machinery and transport equipment	25.0	0.0	-20.0	0.0	40.0	-37.5
Total manufacturing	9.5	6.9	4.5	3.2	10.0	4.2

Source: Authors' calculations based on data from the World Development Indicators.

4.2 *Exports*

Pakistan's manufactured exports in low-tech, medium-tech and high-tech industries enjoyed higher growth in 2000–13 than in 1990–2000 (Figure 1). The medium-tech and high-tech industries experienced higher growth in exports than low-tech industries (Rasiah & Nazeer, 2015). However, this was not only a consequence of their low starting base: the industries involved are concentrated in the low-value-added segments of manufacturing. Pakistan's textiles and clothing industry remained the foundation of export manufacturing, accounting for 44.2 percent of exports in 2005 and 37.1 percent of exports in 2013.

Figure 1: Annual average manufactured export growth, 1990–2013



Note: LT = low-technology, MT = medium-technology, HT = high-technology.
Source: Compiled from UN Comtrade database.

4.3 *Trade Balance*

Pakistan's low export performance is ascribed to the structure of its exports, which is characterized by heavy specialization in traditional items, an inability to diversify and upgrade in the value chain and the lack of complementary support from knowledge-intensive services (Haque, 2014). Clothing and textiles is the only industry in which Pakistan has enjoyed a strong, positive trade balance over the period 2000–15 (Table 3). While foods had a positive trade balance over the period 2001–10 before falling into negative figures in 2011–15, all other industries experienced a negative trade balance during 2001–15. Meanwhile, foods, machinery and equipment and other manufactures experienced a trend decline in their trade balance over the period 2001–15.

Table 3: Manufacturing trade balance, 2000–15

Industry	2000–05	2006–10	2011–15
Foods	0.028	0.011	-0.020
Clothing and textiles	0.667	0.712	0.698
Petroleum	-0.908	-0.879	-0.860
Chemicals	-0.681	-0.715	-0.690
Machinery and transport equipment	-0.881	-0.909	-0.930
Other manufactures	-0.034	-0.087	-0.180

Source: State Bank of Pakistan and Pakistan Economic Survey (various years).

All in all, we can see that the use of industrial policies lacking any serious focus on technological deepening is reflected in the relative stagnation of the manufacturing sector in Pakistan. Indeed, except for the natural endowment supported clothing and textiles sector, all other manufacturing industries experienced slow growth in value-added and exports and a negative trade balance.

5. Conclusion

It appears that Pakistan enjoyed its highest manufacturing growth when (i) import substitution policies were implemented, (ii) favorable incentives were given to manufacturing establishments, (iii) the external environment (especially one that attracted a high volume of remittances) was conducive to growth or (iv) the MFA quotas were removed in 2004. The worst years appear to be when liberalization was introduced (see Haque, 2015). Unlike typical resource-rich countries, Pakistan's manufacturing sector has also been adversely affected by the Dutch disease phenomenon arising from high exchange rate valuations caused by remittances from abroad.

Despite these achievements, the pace of Pakistan's manufacturing growth, even in peak periods (the 1950s and 1960s and 2006–10), was far behind that of the Republic of Korea, Taiwan and China (Rasiah & Nazeer, in press). The manufacturing sector has not only grown slowly, but its share of GDP has also contracted prematurely since 2010, owing to industrial policies that did not emphasize technological deepening. Except for clothing and textiles, which have a strong natural support base, all other manufacturing industries have experienced slow growth in value-added and exports and a negative trade balance since 2011.

Clearly, Pakistan is facing premature deindustrialization. Its economic problems are also tied to the nature of its power relations, which has restricted institutional change. The experience of Pakistan does not contradict the conventional wisdom that political strength and stable regimes are favorable to the course of economic development in developing nations. Pakistan's tense relations with India have had a significant negative impact on the country's political, monetary and social environments. This has given the military considerable political clout, aggravated by US military aid (Hasan, Kemal & Naseem, 1997).

Rather than focusing on industrial diversification and building competitiveness internationally through the creation and diversion of rents to support technological catch-up, government policy has been shaped by clientelist interests. The solution for Pakistan is to focus on developing its technological capabilities to stimulate industrial structural change from low- to high-value-added activities.

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Public Policy, Innovation and Economic Growth: An Economic and Technological Perspective on Pakistan's Telecom Industry

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Abstract

At a time of rapid technological advancements in every field, Pakistan must develop a comprehensive strategy for harnessing science and technology to promote economic growth on a sustained basis. In recent decades, successful economies have moved away from factor accumulation models of economic growth to productivity led growth that is underpinned by technological advancements and innovations. Using the endogenous growth theory as a framework of analysis, the paper will provide a macroeconomic perspective on the importance of technology and innovation for sustainable economic growth. We argue that public policy must be geared to generate robust growth by encouraging investment in research and development (R&D) and human capital. The paper will conceptualize the role of technology in the process of economic growth and identify policy areas that can be instrumental in promoting technological modernization and innovations.

The paper will also survey some illustrations from Pakistan's telecommunication industry.

Keywords: Policy, innovation, economic growth, technology, telecom, Pakistan.

JEL classification: O14, O32.

1. Introduction

Schumpeter (1942) introduced the idea of 'innovation economics' in *Capitalism, Socialism and Democracy*, a seminal work contending that evolving

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institutions, entrepreneurs and technological change were at the heart of economic growth and not independent forces that were largely unaffected by public policy. Innovation economics is a growing area of economic theory that emphasizes entrepreneurship and innovation. It is based on two fundamental propositions: (i) the central goal of economic or public policy should be to stimulate higher productivity through greater innovation and (ii) markets relying on input resources and price signals alone will not always be as effective in generating higher productivity and thereby economic growth. This is in contrast to the conventional economic doctrine of neoclassical economics.

It is only in the last 15 years that a theory of economic growth focusing on innovation, grounded in Schumpeter's ideas, has emerged. Innovation economics attempts to resolve the fundamental puzzle of total factor productivity growth. The continual growth of output can no longer be explained only in terms of an increase in production inputs as understood in conventional industrialization. Hence, innovation economics focuses on a theory of economic creativity that affects the theory of the firm and organizational decision-making. Innovation economists believe that, in today's knowledge-based economy, economic growth is driven primarily by innovative capacity, spurred by the appropriate knowledge and technological externalities, rather than by capital accumulation as claimed by neoclassical theory.

This theory and narrative of economic growth is known by a range of terms: 'institutional economics', 'new growth economics', 'evolutionary economics', 'neo-Schumpeterian economics' or simply 'innovation economics'. This new economics reformulates the traditional economic growth model such that knowledge, technology, entrepreneurship and innovation are now positioned at the center, rather than being seen as forces that operate independently.

While the US economy has been transformed by the forces of technology, globalization and entrepreneurship, the doctrines guiding economic policymakers have not kept pace and continue to be informed by 20th century concepts, models and theories. This is in large part because the dominant economic policy models advocated by most policymakers ignore innovation and technology-led growth in favor of macroeconomic tools such as tax cuts for individuals, budget surpluses or social spending, which pale in significance to innovation as a driver of economic growth.

In this sense, innovation economics is based on the notion that it is only through the actions of workers, companies, entrepreneurs, research institutions and governments that an economy's productive and innovative power can be enhanced, in support of the building blocks of private sector growth and innovation. As a result, when examining how the economy creates wealth, innovation economics looks at a different set of questions such as:

- Are entrepreneurs taking risks to start new ventures?
- Are companies investing in technological breakthroughs and is the government supporting the country's technology base (by funding research and training scientists and engineers)?
- Are regional clusters of firms and supporting institutions fostering innovation?
- Are research institutions transferring knowledge to companies?
- Are trade policies working to ensure a level playing field for domestic companies?
- Are workers becoming more skilled and are companies organizing their production in ways that utilize these skills?
- Are policymakers avoiding barriers or protection for companies against more innovative competitors?

One of the most difficult challenges faced by governments today is to enable and channel this transformation and for individuals and companies to benefit from the self-empowering forces of technological innovation. This will not happen unless they become more open to the idea of 'creative destruction', allowing not only tools and procedures, but also attitudes to be revamped and upgraded. Such tools include well-designed public–private partnerships, especially in terms of modernizing infrastructure. This historical transformation will continue to gain momentum as it expands both in scale and scope. However, its benefits will not be fully realized unless the government takes steps to ensure that positive externalities are internalized and negative impacts are minimized.

Even when a government decides to implement policies that enable economic upgrading and adaption, it cannot do so in isolation. With technology enabling unprecedented mobility and connectivity, countries' jurisdictional power is being eroded. Furthermore, while innovation is important, what is needed even more is a concerted effort on the part of markets, institutions and policymakers and the effective use of geographical space.

The empirical evidence worldwide points to a positive link between innovation and economic performance (Fan, 2011). The surge in biotech firms in Germany, for example, is due to research and development (R&D) subsidies for joint projects. Additionally, innovation capacity explains much of the GDP growth in India and China during 1981–2004, but especially in the 1990s. By linking the sciences sector with the business sector, establishing incentives for innovative activities and balancing the import of technology and indigenous R&D, both countries have experienced rapid economic growth in recent decades.

At a time when rapid technological advancements are occurring in every field, Pakistan must develop a comprehensive strategy for harnessing science and technology (S&T) to promote sustainable economic growth. To this end, we provide a synthesis of the literature on how developed as well as developing economies have enabled the role of entrepreneurship in a capitalist society. We argue that public policy must be geared toward generating robust growth by encouraging investment in R&D and human capital. The discussion on policy focuses on entrepreneurship, competition and specific incentives for promoting technological modernization and innovations.

Section 2 provides a brief review of the literature on the determinants of economic growth, emphasizing the role of technology in sustaining long-term growth. Section 3 develops a conceptual framework for understanding the role of public policy in technological advancement and innovation. Section 4 describes the state of technology and innovation in Pakistan's industry sector in general and the telecom sector in particular to identify critical gaps in these areas. Section 5 spells out policies that would encourage technological modernization and innovation in the industry sector in general and the telecom sector in particular. Section 6 describes the state of the telecom industry in Pakistan, focusing on deregulation, the policy framework, market competition and technological modernization. Section 7 summarizes the discussion and underscores key policy implications.

2. Literature Review

A vast body of literature explores the determinants of economic growth, emphasizing a wide range of economic and institutional factors that underpin the process of growth. The earliest work on this was the Harrod–

Domar growth model, which underlined the role of factor accumulation in the growth process. This was followed by the influential works of Solow (1956) and Swan (1956), which stressed the role of technological progress besides factor accumulation as the main drivers of economic growth. These models, however, treated technological progress as exogenous and thus failed to explain how technological progress is shaped by economic and institutional factors, including public policy.

The question of how technological progress influences the growth process spawned a burgeoning literature under the rubric of endogenous growth theory pioneered by Romer (1986) and extended by others (see Lucas, 1988; Grossman & Helpman, 1990; Romer, 1994). This strand of the literature considers technical progress to be an endogenous process that depends on several factors, including human capital, entrepreneurship and institutions.

Economists have extensively debated the causes of wide variations in growth between different countries, arguing that disparities between growth rates are only in part explainable by different rates of increase in the use of primary factors of production: capital and labor (Easterly & Levine, 2001). In particular, studies emphasize that growth differences are also attributable to different rates of technological progress on the back of cross-country differences in returns to scale, the learning-by-doing effects of human capital and the dynamic spillover effects of export-oriented industries (Grossman & Helpman, 1990, 1994). Barro (1990) underscores the role of public spending in economic growth, emphasizing that the institutional differences implicit in public spending policies significantly explain cross-country differences in growth performance.

The more recent literature argues that factor accumulation and productivity improvements through technological change are themselves endogenous and influenced by deeper determinants of economic growth. By and large, the consensus is that the quality of political and economic institutions – the software of society – matters for economic growth (Acemoglu, Johnson & Robinson, 2005; Dollar & Kraay, 2003). The institutional framework shapes the incentives for investment, innovation, trade openness, accumulation of human capital and productivity improvements, all of which contribute to long-term growth potential (Romer, 1994; Grossman & Helpman, 1994). The role of public policy is also important in that policies can ensure better incentives for entrepreneurship, innovation and the development of new products and processes that are essential to fuel the growth momentum (King & Rebelo, 1990).

Some studies highlight weaknesses in institutional structures that prevent effective action to promote entrepreneurship and innovation. For example, despite the tremendous advancement in technology in the West, "Western political and economic structures are, in some ways, designed to resist deep and rapid change" (El-Erian, 2015). When major structural and secular challenges arise, their institutional structures can be a major obstacle to effective action. However, the system works well when economies are operating in cyclical mode.

Finally, some interesting empirical evidence is worth mentioning. Acs (2006) presents robust evidence that entrepreneurial activities vary across stages of economic development. Entrepreneurial activity has a positive effect on economic growth in highly developed countries, but a negative effect in developing nations. A related issue is how public policy varies with stages of economic development. In particular, since entrepreneurship in developing countries is likely to be low, it is useful to formulate enterprise development policies with a long-term focus. For developed countries, both labor market and financial market reforms are needed.

3. Technology, Productivity and Growth: Conceptualizing the Role of Public Policy

Economic growth depends on the level of investment, the quantity and quality of human capital and improvements in technology. The fundamental relationship between value-added in an economic activity and its productive factors is expressed as:

$$Y_t = A^{g_t}.F(e^{\alpha_t}K_t, e^{\beta_t}L_t) \quad (1)$$

$$K_t = (\delta + \sigma)K_{t-1} + I_t \quad (2)$$

where Y is the value-added in an economic activity, g is disembodied technical change, α is the embodied technical change in capital, β is the embodied technical change in labor, K is capital stock, L is labor, $\delta$is the rate of depreciation, $\sigma$is obsolescence, I is investment and t denotes time.

The productive factors in any economic activity depend on factor endowments and the incentive structure, which in turn is shaped by public policies. If the incentives are neutral, the country will specialize in accordance with its static comparative advantage. However, if there are differences in the static and comparative advantages (because certain industries may not be mature enough to compete at present, but may have the potential to develop at a later stage), neutral incentives will not be an optimal policy.

For example, in the case of an infant industry such as component manufacturing, a country may not have a static comparative advantage, but a dynamic comparative advantage instead and the government may have to protect or subsidize the industry. Similarly, if the country embarks on a program of imparting specific skills to acquire a certain competitive advantage in the long run, the government may have to intervene and change the incentive structure in favor of such an activity. Accordingly, the need to coordinate industrial S&T and R&D policies cannot be overemphasized.

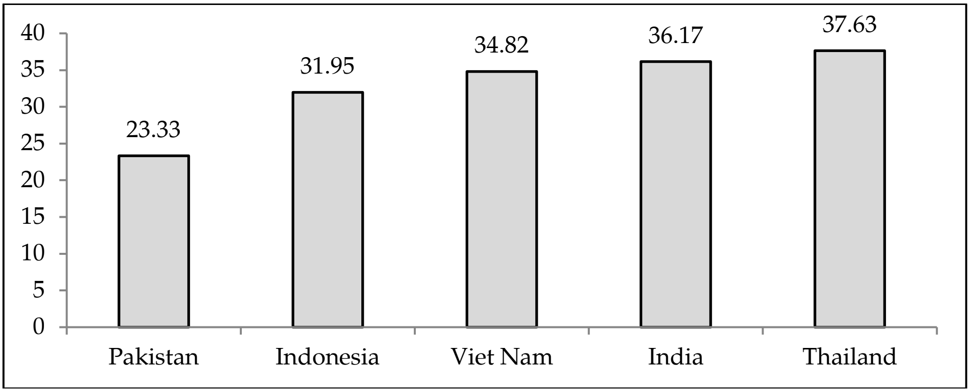
Disembodied technical change (g) arises from better management practices, learning by doing and the overall business climate. A business climate that is conducive to business development, productivity and growth is characterized by an atmosphere in which workers are motivated to contribute to the growth of the firm, better management practices and government facilitation through efficient regulatory policies.

Embodied technological improvements in physical capital (α) help the growth process in a number of ways: by improving the productivity of existing capital, through better selection and adaptation of machinery and equipment in accordance with the country's factor endowments and by stimulating private investment by improving private returns. Similarly, human capital development through higher education, upgraded skills and provision of social amenities (β) is instrumental in boosting economic growth. The government plays a pivotal role in improving education standards and initiating skills development programs to boost workers' productivity.

4. The State of Technology and Innovation in Pakistan

The state of technology and innovation is far less satisfactory in Pakistan compared with other emerging economies (Figure 1), not least because of poor incentives for technological upgrading and innovation, the weak link between industry and academia (research institutions) and the lack of resources for scientific research and technology development. A serious constraint to achieving global competitiveness is the low productivity of Pakistan's industrial sector (Mangla & Din, 2015), which is a result of myriad factors, including trade and industrial policies that provide little incentive for productivity improvements, weak human capital and the lack of a supportive business environment.

Figure 1: Global innovation ranking scores for selected countries, 2013



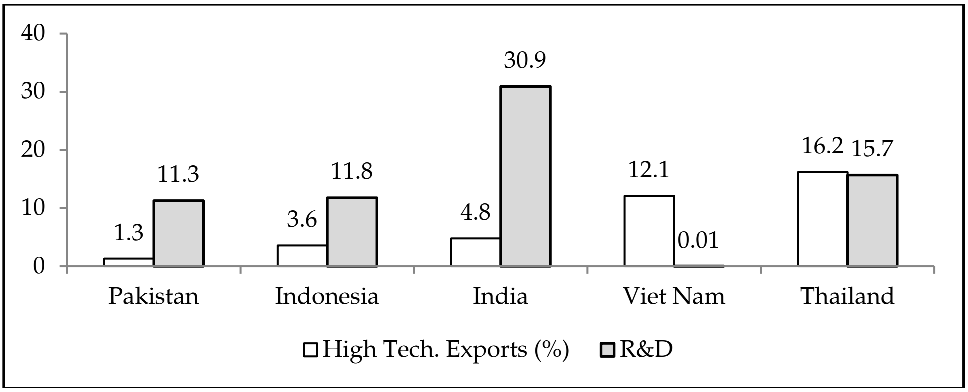
Source: Global Innovation Index.

Pakistan is deficient in skilled human resources that are vital to technological advancement. The retention of technically skilled labor is a serious problem, especially in the information technology (IT) sector where technological changes are rapid and "brain drain" widespread (Hassan, 2014). Pakistan's track record in the development of human resources is not very impressive and its efforts to improve education and skills have not contributed to any significant improvement, not least because of the poor management of public projects in these areas.

A lack of skilled workers not only adversely affects the productivity of existing industries, but also hampers the establishment of new high-tech industries. Pakistan has an acute shortage of electronics graduate engineers and technicians, especially in emerging technologies. There are only a handful of qualified professionals in the emerging areas of digital signal processing, optics, digital communications, microelectronics and microwaves. To make the situation worse, the production of graduate engineers and technicians is not demand-driven, with the result that most employers find that fresh recruits take a long time to become productive (Rahman et al., 2005).

Most Pakistani firms operate at the lower end of technology and lack the capability to adopt high-tech manufacturing processes (Rahman et al., 2005). There has been little R&D activity in the private sector and public sector institutions have not been able to deliver either, resulting in low R&D capacity (Figure 2).

Figure 2: Global scores in R&D and high-tech exports, 2013



Source: Global Innovation Ranking.

In this scenario, firms need an enabling environment to build their technological capabilities. This has three elements. The first is production capability: the operation and maintenance of existing production facilities to enable efficient operation within the parameters of the technology already employed and to adapt and improve existing technologies. The second is investment capability: expanding capacity and establishing new high-tech production facilities. The third is the capability to innovate and improve the existing technology beyond the original design parameters. While all three need to be promoted through appropriate trade and industrial policies, Pakistan should focus on the first two elements in the short to medium term. Improving its R&D capacity for developing new technology should be a long-term goal for sustainable growth.

The electronics and telecom industries are among the world's fastest growing industries. Electronics is a key enabler of growth and innovation, underpinning many important industries, including automotive as well as information and communication technology (ICT), consumer appliances, defense, biomedical appliances and other scientific equipment and devices. Despite its large growth potential, Pakistan lags behind significantly in the development of its electronics and telecom industry (Rahman et al., 2005). It is, therefore, imperative that a coherent strategy is put in place to develop these sectors with a view to increasing the country's growth potential and achieving self-sufficiency by reducing its dependence on foreign sources of electronics and telecom equipment and components.

5. Public Policies to Foster Entrepreneurship, Technology and Innovation

It is widely recognized that public policies play a critical role in fostering entrepreneurship and creating an enabling environment for technology and innovation, which are vital to long-run industrial success.[1] To prepare the country for emerging challenges, the development of S&T and its interface with industry must be brought to the forefront of industrial strategy. More specifically, there is need to put in place a multi-faceted strategy that is designed to strengthen the key ingredients of industrial success, based on the modernization of technology and innovation. Such a strategy should encompass policies that promote an entrepreneurial culture, improve the quality of human resources, develop R&D capacity, strengthen market competition and offer incentives to innovate and modernize.

At the outset, it is important to recognize that telecom is a highly innovative field in which new developments take place rapidly. In today's globally competitive environment, telecom firms are under relentless pressure to provide innovative products more quickly, more cheaply and of improved quality. The industry is driven by the demand for products that are smaller, lighter, cheaper and better than what they replace. In this scenario, countries such as Pakistan, which have yet to make their mark in the field of telecom, have a long way to go before an industry that is capable of attaining international competitiveness can be developed.

Pakistan must put in place a development strategy for the telecom sector with the following objectives: to (i) build on the existing capabilities in electronics and telecom, (ii) attract foreign direct investment (FDI) to facilitate the transfer of technology, (iii) strengthen capability in assembling and testing electronic components, (iv) develop and enhance the industry's value-added by moving into activities such as R&D and (v) support the development of indigenous supply chains.

In order to achieve the broader aim of developing and sustaining a telecom industry with the potential to emerge as a key driver of economic growth, public policies must aim to promote private sector development while emphasizing the role of the public sector as a facilitator. To begin with, an entrepreneurial culture is key to technology adoption and innovation (Acs & Audretsch, 1989; Audretsch, Keilbach & Lehmann, 2006). It is entrepreneurs who take risks, start new businesses, develop new ideas and

[1] See, for example, Acs and Szerb (2007) and the references cited therein.

products and invest in new technologies (Romer, 1994; Grossman & Helpman, 1994). Public policies to promote entrepreneurship must be geared toward creating an environment that allows entrepreneurs to take risks and unleash their creative potential.

A business-friendly regulatory and legal environment is fundamental to promoting entrepreneurship. In particular, regulatory barriers to market entry must be minimized to foster the establishment of new businesses that are most likely to lead new technology adoption and innovation. Equally important is to establish institutional mechanisms to ease firm exit, including bankruptcy laws to help businesses close down their operations. As emphasized by Acs and Szerb (2007), such policies are essential to transform an economy from conventional managerial capitalism to a more dynamic entrepreneurial capitalism powered by knowledge, technology and innovation.

Human resource development through better education and improvements in skills is a key determinant of technology adoption, innovation and productivity enhancement. In order to make the transition to a knowledge-based economy, Pakistan must prioritize human resource development. The problems of low productivity and poor product quality can only be addressed by improving the quality of human resources.

Telecommunication is a knowledge-intensive industry that requires substantial investment in human resource development. This entails supporting educational institutions through special grants to initiate and strengthen academic programs in advanced electronics (microelectronics, optics, digital signal processing and digital communications). In addition, educational institutions must emphasize entrepreneurship, commercialization and marketing studies in disciplines that lead to electronics and telecom-related careers. Moreover, the private sector should be encouraged through fiscal incentives to invest in on-the-job training to upgrade labor skills.

It is widely recognized that a competitive business environment that rewards entrepreneurship, efficiency and innovation is essential for sustained economic growth. Such an environment generates the pressure and opportunities needed for innovation and stimulates investment in technology development. It is characterized by market-driven incentives and a level playing field for investors and is supported by a transparent, predictable and consistent regulatory framework and liberal trade regime.

Besides domestic competition, external competition in the form of openness to international trade can lead to productivity gains through the international diffusion and adoption of new technologies. There is, therefore, a need to maintain competition policies both with regard to domestic commerce and openness to international trade to foster a dynamic entrepreneurial culture as the backbone of a knowledge-based economy.

The government must help deepen the country's technological base by encouraging R&D at the firm level through R&D incentives. This means allocating more funds to S&T research, which underpins an innovative culture. Attaining competitiveness requires R&D activities focused on improving the operation and maintenance of production facilities, product quality and design and process technologies. This needs a two-pronged strategy to promote R&D. First, public sector institutions need to be strengthened to provide market-driven R&D support to firms. Second, the private sector needs incentive to invest in R&D, which can include tax exemptions on expenditure incurred on R&D activities as well as matching grants for specific R&D projects.

More specifically, the expenditure incurred in training employees, product development and testing and imports of R&D equipment and supplies could be made tax deductible. In addition, well-targeted subsidies on the cost of acquiring new technology and commercializing locally developed technology would help firms achieve an efficient scale. This, in turn, would internalize the benefits of improved R&D capability.

Besides incentives for building R&D capacity, efforts are needed to propel the industry onto a higher technological plane to produce value-added goods that are competitively priced in international markets. The government could use fiscal incentives to promote the modernization of technology and innovation at the firm level. These incentives can be classified as those that (i) leave pre-tax profitability unchanged, but result in relatively higher post-tax profitability and (ii) reduce the cost of production and consequently raise pre-tax profitability. Whereas the former includes tax holidays, tax credits and accelerated depreciation allowances, the latter includes all other incentives such as concessions in the import duty on raw materials and capital goods and in the sales tax on output.

The distinction between the two types of incentives is important. The former is effective only if the activity is profitable in the first place, but post-tax profits are not high enough to attract investment, while the latter could conceivably attract investment in otherwise loss-making activities as well.

Specific fiscal incentives to enable firms to upgrade their technology may include duty-free imports of new machinery and equipment. In addition, keeping in view that not all manufacturers have the necessary resources to invest in brand new machinery and equipment, imports of second-hand machinery could be allowed. Since lack of funds for investment in new technology is seen as a major constraint to upgrading technology, a fund for this purpose needs to be created to provide long-term financial support for installing modern machinery and equipment.

Encouraging FDI can be instrumental in attracting high-tech manufacturing enterprises to locate their facilities in Pakistan. Global electronics and telecom production is controlled by multinationals that have the necessary product and process technologies. Such enterprises are pivotal in spreading modern technology through explicit technology transfer as well as through technology spillovers and learning by doing. FDI through joint ventures should be particularly encouraged as collaboration with foreign manufacturers would help bring in new technology and shorten the learning curve for local producers, especially in the telecom sector.

Recent trends indicate that technology development takes place in proximity to production and marketing operations and that multinational subsidiaries and their joint venture partners are moving toward greater localization of technology development activities. In this scenario, special incentives for foreign investors that bring high technology to the electronics and telecom sectors is important. These could include tax holidays as well as the provision of physical infrastructure and amenities.

Global experience shows that innovation takes place in clusters where high-tech companies locate to take advantage of agglomeration and network economies (Acs & Armington, 2006). Firms located in clusters develop positive feedback loops and synergy that support their research and innovation activities. The example of Silicon Valley amply illustrates how an entrepreneurial and innovative culture develops and thrives in a high-tech cluster.

While Pakistan has some industry clusters in different cities, their performance in terms of technology and innovation has not been up to the mark. There is need to promote industrial clusters of high-tech enterprises by providing amenities that would attract innovative enterprises. A key initiative would be to set up common facility centers in these clusters to facilitate the adoption of new technology and production of better quality goods. These centers should be equipped to provide advisory services, especially to small and medium enterprises.

Finally, a supportive regulatory and financial framework that enables dynamic enterprises to mediate risk, introduce new products, improve product quality and lower the cost of adopting modern technology would help raise technological capabilities. A key area that requires attention is the strengthening and strict enforcement of intellectual property rights and dispute settlement mechanisms. Strong intellectual property rights can be instrumental in encouraging domestic and foreign investment in high-tech enterprises. Similarly, there is considerable scope for promoting venture capital firms that can provide the necessary financing to promising technology-driven startups. Such entities could also support existing enterprises in new product development and innovations in production and process technologies.

6. An Overview of the Telecommunications Sector in Pakistan

Telecommunication and economic growth are strongly correlated: the modernization of various sectors of the economy is associated with a good telecommunication infrastructure. The telecom sector in Pakistan has shown sharp growth over the last decade. However, despite the significant progress it has made, the sector still lags behind comparable economies in terms of fixed-line density, mobile penetration and Internet usage. Thus, policies to develop this sector rely on the active role of the private sector. The role of the government should be confined to the provision of tax and other incentives and to creating an environment conducive to private sector activity. Some necessary steps for this purpose include formulating procedures for easy access to bandwidth, expanding broadband connectivity to enhance trade and employment opportunities and reducing the tax on telecommunications.

6.1 Impact of Market Competition on Modernization in Telecom Technology

With the advent of new technologies, telecom modernization in Pakistan has been concentrated in the core network (such as switches and concentrators). Technological upgrading in the wireline access network has remained slow due to the high cost involved. In analyzing the impact of telecom policies on the modernization and indigenization of this sector, we consider two policy instruments – market competition and investment – and their role in four subsectors: fixed local loop (FLL), wireless local loop (WLL), long-distance and international (LDI) and cellular.

6.1.1 FLL Technology

Pakistan's telecom deregulation policy coincided with the shift to modern technologies (wireless, Internet protocol, fiber optics) around the world. The fixed local line network did not attract enough investment, given the availability of alternatives and the heavy capital expenditure involved. Since there was no local content development, the demand for broadband and fixed-line technology remained minimal.

The driver of fixed-line growth in this scenario is broadband; the driver of broadband growth is local content. Since local content development and availability did not keep pace with the growth pattern of other markets, FLL growth also remained subdued. Furthermore, the weak law and order situation in Pakistan and the high cost of protecting this infrastructure has deterred investment in fixed network modernization.

Maintaining the FLL infrastructure is very costly. The right-of-way issues associated with this infrastructure are also a major constraint to the growth of FLL services. Furthermore, the disparity in taxes on import equipment for FLL services vis-à-vis others is substantial. With the implementation of the 3G network, the market for FLL services is expected to shrink further: it will be used for major content downloading while mobile services are used for lighter applications.

Although market competition was introduced by the deregulation policy, the fixed-line access network could not be modernized into a fiber network because it is largely copper-based. In the absence of any large players apart from PTCL, competition in this subsector is insignificant as other wireline local loop operators constitute only 1 percent of the total fixed network of subscribers.

6.1.2 WLL Technology

The market competition created by the telecom deregulation policy has led to the adoption of the latest technologies in the modern telecom network, with the aim of providing services at competitive rates. However, contrary to expectations, the effect of market competition on the growth of WLL services remains far below its potential. While more choice is available to customers and WLL rates are affordable, its use has not increased due to restrictions on handheld terminals and limited mobility.

6.1.3 LDI Technology

While greater competition has increased bandwidth, the voice traffic business of LDIs remains weak. The entry of Trans World Associates International into the market has led to lower international bandwidth prices. In the domestic sector, Wateen, Multinet and Linkdirect have built a national long-distance infrastructure, which has decreased national bandwidth prices. Furthermore, competition among LDIs has put further downward pressure on bandwidth rates. However, their voice traffic business remains weak as national LDI traffic from the mobile network is not open to LDIs and carrier selection/pre-selection facilities are not available to mobile networks, which constitute the majority of customers.

Whereas PTCL customers (only 3 percent of the total consumer base) can select an LDI operator, mobile customers (97 percent of total consumers) have no choice as such. On the other hand, the national long-distance traffic of mobile networks is not open to LDIs through equal access provisioning. This has had a twofold impact. First, it infringes on the rights of mobile customers due to discrimination. Second, it has caused loss of revenue from national long-distance services, which could have accrued to LDIs. Moreover, the number of LDI licenses issued (a total of 15) is excessive in relation to market requirements and size. The lack of an appropriate regulatory regime for new applications and services known as over-the-top content has also hampered the LDI sector in terms of business and technology.

6.1.4 Cellular Networks

The deregulation policy has strengthened competition in the cellular market. In order to remain commercially viable and earn a reasonable return on investment, competitors have introduced new technologies. As tariffs have declined, cellular operators have focused on reducing their capital and operating expenses to stay competitive. On the other hand, the new technology deployed has enabled cellular operators to improve their operational and organizational efficiency. As profit margins and average revenue per user have declined in this market, operators have opted for diversity and new revenue streams. Some cellular operators have their own LDIs, which have been critical in strengthening their business.

With the recent introduction of 3G/4G networks, the future of the cellular telecom market in Pakistan rests with data. If competition is based on price alone, this will facilitate the consumer. However, it is equally important to balance this with investors' need to earn reasonable returns. In particular, there have been some incidents of predatory pricing, which is detrimental to new entrants and may restrict competition in the market. It is, therefore, essential to put in place an efficient regulatory mechanism to ensure healthy competition in the cellular market. This will be instrumental in boosting new investment in the latest technologies.

6.2 Impact of Liberal Investment Regime on Modernization After Deregulation

As no major investment group or foreign operator obtained a fixed license, the FLL sector did not have sufficient investment to modernize the network. The well-established PTCL was privatized and its new strategic owners did not bring in additional investment, instead recycling a portion of the revenues, thus slowing down the pace of modernization at the access level. On the other hand, a major factor inhibiting the growth of WLL is the restriction on handheld WLL terminals.

In this regard, it is pertinent to note that even wireline phones using cordless terminals have some sort of handheld facilities that have been denied to WLL customers. This has limited the opportunities for WLL growth. Limited mobility is a switch function and need not be implemented through restrictions on handheld sets. This restriction must be removed to help the WLL market and facilitate consumers. Other factors hindering WLL growth include the subsidy on fixed wireless terminals, limited mobility with associated quality-of-service problems and high import duties with an adverse effect on price setting. Thus, the cellular mobile sector, with no such limitations, has flourished to an optimum level, resulting in the rapid substitution of fixed-network services.

The WLL terminal market has been held back as local vendors consider it a risk to invest in less demanding CDMA-based WLL terminals. This has compelled service providers to supply terminals at subsidized rates to counter market pressure from the mobile networks and within the WLL sector. The provision of terminal equipment at subsidized rates has further burdened WLL operators and, consequently, affected the sector's investment potential. Another aspect is its shrinking margins. The market is highly price-sensitive and larger operators have an edge due to economies of scale and the synergy of service portfolios. Consequently, smaller operators find it hard to compete. Generally, WLL services are used by low-income customers and, as a result, the total usage volume and consumption level are very low.

In terms of policy support, removing the 10 percent withholding tax would encourage an increase in the use of WLL services and help business operators enhance their scale of operation. Under the current regime, trading practices are not allowed, which contributes to the underutilization of scarce resources. If spectrum trading were allowed, operators lacking investment could sell the allocated spectrum to another interested operator, allowing them to exit the market.

6.3 Impact of Market Competition and Liberal Investment Regime on the Indigenization of the Telecom Network

Although the telecom market was limited and manufacturing volumes low before deregulation, there was significant local assembly and manufacture of network systems and equipment. After deregulation, the market expanded, requiring high volumes of telecom network equipment. Some passive elements of the telecom network, such as cables and connectors, have high rates of wear and tear so that there is continual demand for replacement parts.

The high demand for telecom equipment and supplies led to the establishment of companies providing such elements of the ICT network. These companies helped provide material for towers and parts of the network. In addition, the cabling of the optical fiber and batteries assembly gained momentum. Market competition boosted the cellular network and services alongside an improvement in electronics and software, which led to the availability of modern switches (NGN soft switches). The improved switches and high-end handsets enabled the development and launch of innovative services.

While market competition created opportunities for local manufacturing, local investors have generally failed to take full advantage of the market growth, given their lack of capital and expertise required to produce telecom equipment that meets world standards. The decline in domestic assembly operations has been exacerbated by an import policy under which taxes and duties on finished products are far lower than on CKD equipment.

Before deregulation, investment was limited to passive network elements and the objective of indigenizing active or intelligent elements of the telecom network could not be achieved. After deregulation, market growth led to high and continual demand for telecom networks. The liberal investment regime created opportunities for local manufacturing, but the absence of local investors with sufficient capital and expertise meant that the sector could not produce telecom equipment to meet national as well as export requirements at competitive prices. Consequently, Pakistan relies heavily on imports of high-tech telecom network equipment.

Finally, the country lacks a clear policy on indigenization: whatever provisions are incorporated in various policies are not implemented in letter and spirit. There is a clear need to develop mechanisms for coping with the rapidly changing needs of the telecom industry, focusing in particular on the rationalization of tax and import tariffs and funding for R&D.

6.4 Taxation Issues in the Telecom Sector

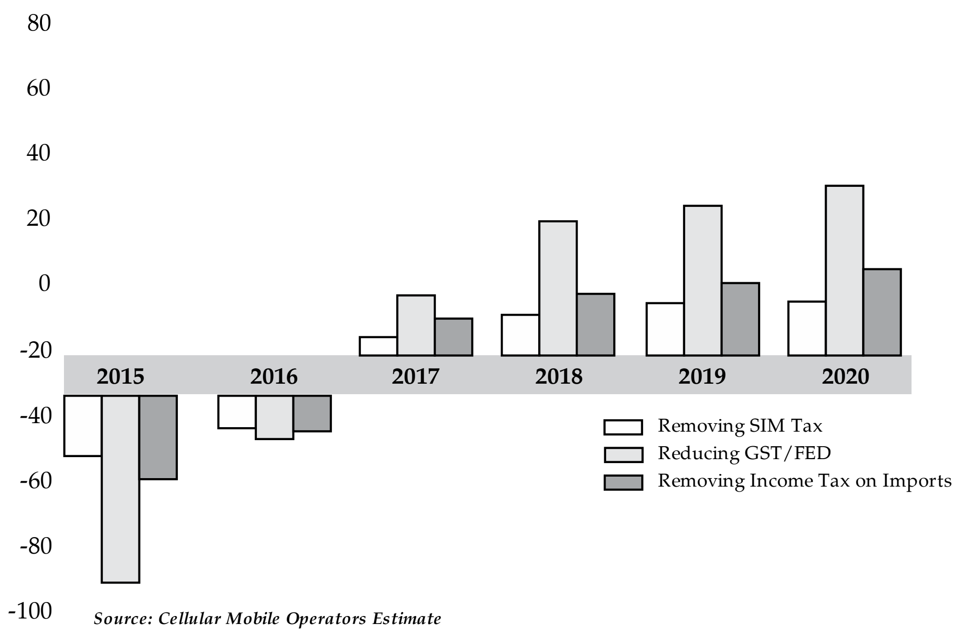
Tax policies play a significant role in market growth as well as the modernization and upgrading of the telecom sector. This makes it important to consider tax-related issues in Pakistan and the need to reform the tax policy pertaining to the sector. To begin with, the government levies a withholding tax on telecom services that is substantially higher than that charged on other segments of the economy. Most subscribers are nontax filers and cannot adjust their annual tax returns accordingly.

There are a total of 3.5 million national tax number holders in Pakistan, with an active taxpayer user base of around 0.8 million. Only 0.6 percent of mobile subscribers are actual taxpayers, which is staggeringly low. For the rest of the economy, withholding tax is usually charged at 10 percent, meaning that billions of rupees in advance income tax are not claimed. The Federal Board of Revenue should either abolish or rationalize this tax or devise a mechanism for charging only those subscribers who are otherwise taxable and liable to file a tax return.

General sales tax (GST)/federal excise duty (FED) is charged at 19.5 percent in Punjab, KP and Balochistan, 18 percent in Sindh and 18.5 percent in the rest of Pakistan. This is much higher than the average 16 percent GST charged on other sectors of the economy. This uneven treatment at a time when the telecom sector is one of the highest contributors to tax returns and has brought in significant FDI is bound to damage telecom operators and a fragile government. It is, therefore, imperative that the GST/FED on telecom services be reduced to the average GST rates in other sectors.

There are several tax proposals under consideration, but one such proposal is worth noting (Figure 3). Many in the telecom industry have, for years now, advocated a reduction in the indiscriminately high telecom taxes. It is also encouraging to have the State Bank of Pakistan discuss this issue at some length in its February 2016 report on the state of the economy, pointing out the "large untapped potential in the broadband segment" and urging the government to take measures to improve mobile and broadband use. The problems identified include "quality of services, complex price structure and high charges of devices" besides "heavy taxation" on devices, usage and SIM cards.

Figure 3: Impact of tax proposals on FBR revenue



Source: Adapted from the Business Recorder, March 2016.

7. Concluding Remarks

This paper has provided an economic and technological perspective on Pakistan's telecom sector, focusing in particular on the role of public policy in fostering innovation and economic growth. We argue that the telecom sector plays a critical role in the economy and public policy must be geared to promote its expansion while ensuring the sector is modernized and its technology upgraded. Such a policy framework must encompass measures to reward an entrepreneurial culture, promote human resource development, strengthen competition, provide incentives for technological upgrading and rationalize the tax and tariff structure.

Pakistan's discriminatory taxation structure has greatly hampered the growth of the telecom industry, indicating a need for tax reforms to ensure reasonable returns on investment in this sector. While the deregulation policy has encouraged telecom operators to modernize their technology to stay competitive, Pakistan remains heavily dependent on imported technology as the tariff structure has a built-in bias against the domestic assembly and manufacture of telecom equipment. It is thus important to rationalize the tariff structure and create a level playing field for domestic telecom producers and assemblers. A policy environment conducive to the growth of the telecom sector is expected to yield significant dividends in terms of an improvement in productivity, innovation and the modernization of technology, leading to robust economic growth.

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Innovation and Technological Upgrading in Lahore: Results From the LCCI Business Confidence Survey 2016

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Abstract

The Lahore School of Economics and the Lahore Chamber of Commerce and Industry (LCCI) conducted a unique business confidence survey of firms in March 2015. The objective of the survey was to determine industry-specific trends as well as firms' perceptions of general macroeconomic trends. In 2016, the Lahore School and LCCI conducted a second business confidence survey in which they asked a sample of firms about the same issues as well as their level of innovation and technological upgrading. In this paper, we focus on the results of the innovation and technology component of the 2016 survey. We perform an aggregate analysis across firms to see if they have innovated and upgraded their technology. Next, we focus on the impact of innovation on exports and domestic sales to gauge whether firms reporting higher exports had innovated more. Finally, we look at each sector (manufacturing, services and retail) in turn and analyze the levels of innovation and technological innovation in each.

Keywords: Innovation, technology, macroeconomic trends, business confidence survey.

JEL classification: O11, O14.

1. Introduction

In March 2015, the Lahore Chamber of Commerce and Industry (LCCI) and the Lahore School of Economics signed a memorandum of understanding that established a link between academia and the business community. As part of this collaboration, the LCCI and the Lahore School conducted a business confidence survey of firms in order to determine industry-specific trends as well as general macroeconomic trends. The first survey was conducted in 2015 with a range of firms across three sectors: manufacturing, services and retail. The results of the survey indicated a cautious optimism among the business community.

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A few key messages emerged from the 2015 survey. First, between 2014 and 2015, firms grew in terms of sales, investment and size. Second, firms across all three sectors anticipated higher growth in 2015/16 and planned to increase their investment levels, expected to have further spillover effects on growth. Third, firms were extremely concerned about sources of financing and felt that the banking sector was falling far short of meeting their needs. Fourth, firms felt there were significant shortages in the pool of skilled labor, which was a major constraint to growth. Fifth, firms pointed to energy shortages as a major constraint to growth. Sixth, firms found both provincial and federal regulations and taxes extremely cumbersome and a significant drag on growth.

In 2016, the Lahore School and LCCI conducted a second business confidence survey in which they asked a sample of firms about the same issues as well as their level of innovation and technological upgrading. The reason for including questions on innovation and technology was to see if the optimism expressed by firms in the previous year's survey was followed by investments in innovation and technology and then to see which areas firms had focused on in terms of these investments.

In this paper, we focus on the results of the innovation and technology component of the 2016 survey. First, we perform an aggregate analysis across firms to see if they innovated and upgraded their technology. Then, we focus on the impact of innovation on total exports and domestic sales to see if firms reporting higher total exports and higher domestic sales had innovated more. We look at each sector in turn (manufacturing, services and retail) and gauge the levels of innovation and technological innovation therein.

An important point is whether growth leads to innovation or if innovation is an important element for growth. Is innovation a necessary condition for growth or is it an outcome of growth? It is interesting to see which areas account for the most innovation among firms that reported higher revenues. We also look at whether innovative firms have increased investment spending and whether firms with higher investment spending have innovated. Finally, we see if there is any relationship between bank borrowing and innovation and which key areas of innovation emerge among firms that acquired larger bank loans.

2. What Was Measured in This Year's Business Confidence Survey?

The 2015 and 2016 Lahore School and LCCI business confidence surveys were administered online and asked firms to respond to questions on:

- Firm-level sales last year and expected sales the next year
- Firm-level investment undertaken last year and expected investment the next year
- Firm-level employment last year and expected employment the next year
- Firm-level bank borrowing last year and expected bank borrowing in the current year
- The impact of factors such as energy, access to finance, law and order and foreign competition
- The impact of provincial and federal regulations.

The 2016 survey asked firms the following:

- Had they innovated last year and were they planning to innovate next year?
- In what areas of business (production, marketing, finance) were firms innovating?
- Had they upgraded their technology last year and did they plan to upgrade their technology next year?
- In what areas of business (production, marketing, finance) were firms upgrading their technology?
- How do firms find out about innovations and new technologies?

An important distinction was made between innovation and technological innovation. When asking questions about innovation, the survey referred to the introduction of a new or significantly improved product, process, organizational method, technology upgrade or marketing method. These innovations would have been new to the firm, but may have been originally developed by other enterprises. The questions on technological upgrading focused purely on whether firms had invested in new *technologies*.

The reason for this distinction is that innovation is a far wider concept than merely technological innovation and it was important to capture whether firms were innovating even with their existing technologies. On the other hand, given the importance of technological upgrading when discussing firm-level productivity improvements, the survey also asked questions about technological upgrades as opposed to innovation.

3. Innovation and Technological Upgrading Across All Firms

We start by looking at the level of innovation and technology upgrading across all firms surveyed in 2016. Figure 1 shows that 72 percent of firms reported engaging in innovation last year. The breakdown of these innovations is presented in Figure 2, which shows that most innovations were carried out in production and marketing.

Figure 1: Did your firm engage in any innovation last year (all firms)?

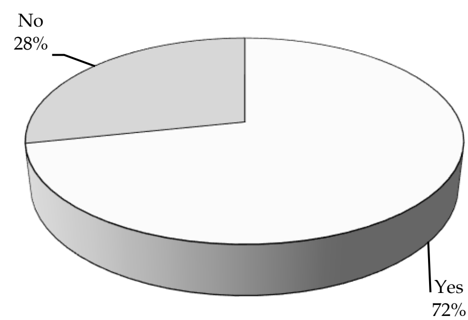


Figure 2: If so, in which areas did you innovate (all firms)?

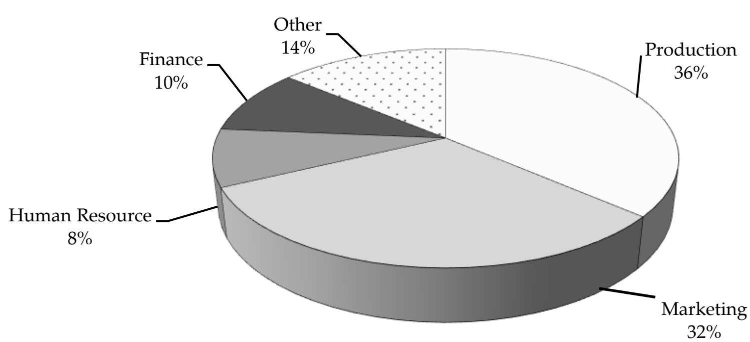


Figure 3 shows that 75 percent of firms engaged in technological upgrading last year. Figure 4 shows the breakdown of areas in which these technological innovations occurred. Again, the majority of technological innovation focused on products and marketing.

Figure 3: Did you upgrade your technology as a part of innovation (all firms)?

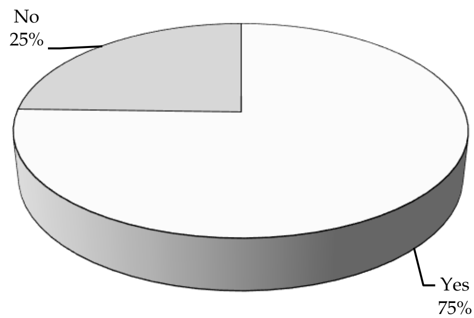
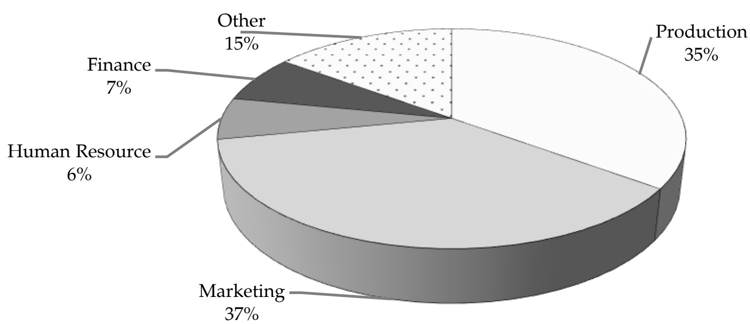


Figure 4: In which areas did you upgrade your technology (all firms)?



When asked whether they planned to upgrade their technology this year, a significant majority (85 percent) said yes (Figure 5). The responses show that more firms planned to upgrade their technology this year compared to last year.

Figure 5: Do you plan to upgrade your technology this year (all firms)?

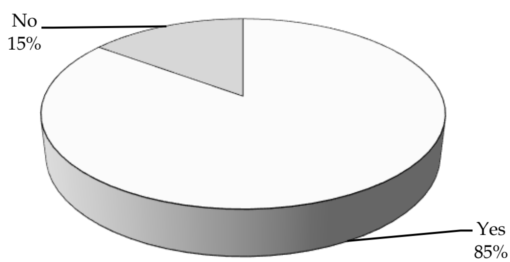
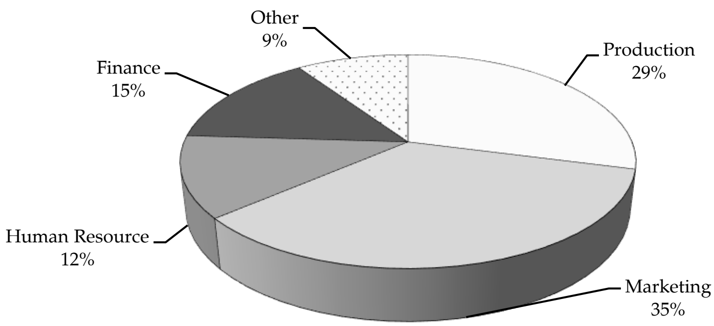


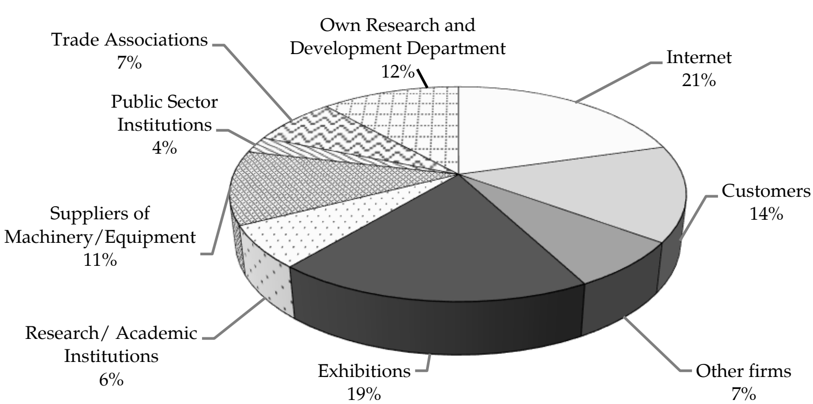
Figure 6 shows that most firms planned to improve their technologies in production and marketing, but this combined percentage is smaller than in the previous breakdown (shown in Figure 4). This implies that firms may have begun focusing on upgrading technologies in other areas, such as human resources and finance.

Figure 6: In which areas do you plan to upgrade your technology (all firms)?



Finally, firms were asked how they learned about new technologies (Figure 7). What is interesting here is that a significant number of firms say they learned about new technologies and innovations from the Internet, exhibitions and customers. A very small percentage cited research, academic and public sector institutions, which reflects the latter's failure to connect with firms. What is also interesting is that firms reported very little spillover between firms in terms of technologies and innovations, implying that there is very little cooperation among firms.

Figure 7: How do you learn about new technologies and innovations (all firms)?



On the whole, a much larger proportion of firms had innovated and upgraded their technology and planned to continue innovating this year, which seems to imply that Pakistani firms are far from stagnant in terms of innovation. What is interesting is that the bulk of technological upgrading took place in marketing, followed closely by upgrading in production; firms planned to continue focusing on these areas. Finally, firms reported finding out about innovations from the Internet, customers and exhibitions. This reflects the need to focus on creating opportunities for them to access these sources more easily. It also illustrates the failure of research, academia and the government to promote innovative ideas.

4. Innovation and Technological Upgrading in Manufacturing

Figures 8 and 10 show that a significant majority of manufacturing firms (81 percent) said they had engaged in innovation and technological upgrading last year – this number is higher than the average across firms. Figures 9 and 11 show that manufacturing firms focused almost all their innovation and technological upgrading in production and marketing.

Figure 8: Did your firm engage in any innovation last year (manufacturing firms)?

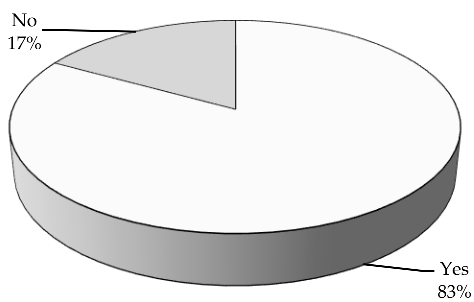


Figure 9: If so, in which areas did you innovate (manufacturing firms)?

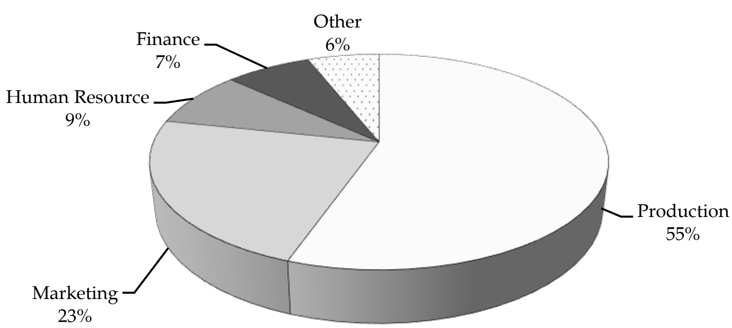


Figure 10: In which areas did you upgrade your technology (manufacturing firms)?

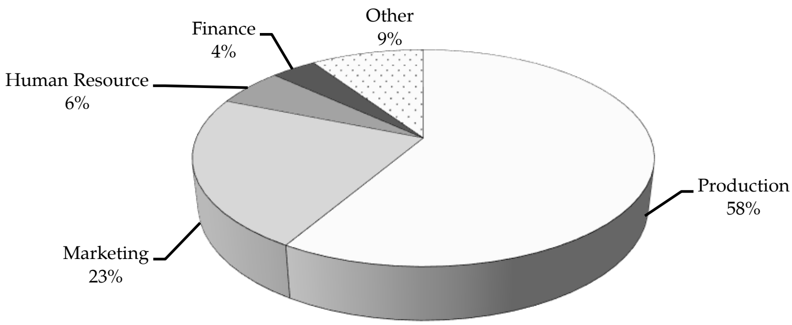
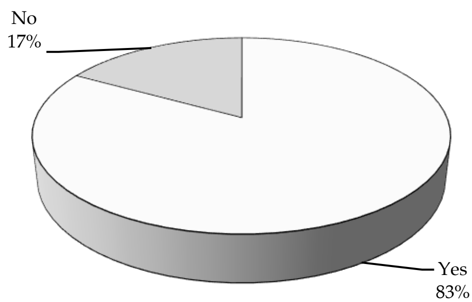


Figure 11: Did you upgrade your technology as a part of innovation (manufacturing firms)?



When asked about the current year, 88 percent of manufacturing firms said they planned to upgrade their technologies (Figure 12). Again, the vast majority planned to focus on production and marketing in this context, continuing the trend from the previous year (Figure 13).

Figure 12: Do you plan to upgrade your technology this year (manufacturing firms)?

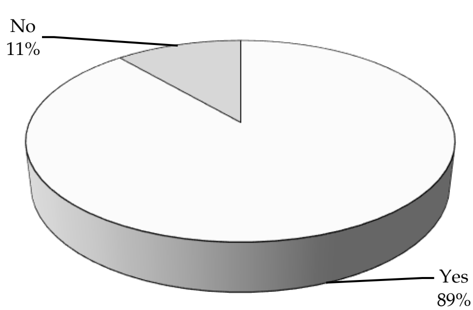


Figure 13: In which areas do you plan to upgrade your technology (manufacturing firms)?

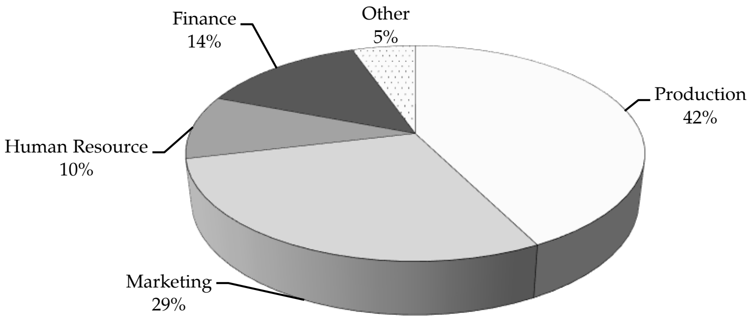
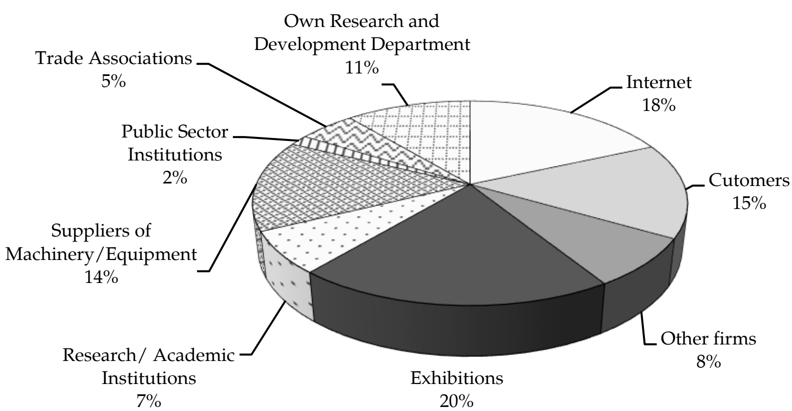


Figure 14 shows how manufacturing firms find out about innovations and new technologies. Their key sources include the Internet, customers and exhibitions as well as suppliers of machinery. This shows that the same sources of information for most firms overall are as relevant to manufacturing firms. Machinery suppliers are also a critical source of information for the latter.

Figure 14: How do you learn about new technologies and innovations (manufacturing firms)?



It is useful to point out the differences between the results for the manufacturing sector and the results for firms overall. The vast majority of manufacturing firms innovated and upgraded their technology in production and planned to continue focusing on this aspect (though they were also innovating on the marketing side). While manufacturing firms tend to rely on the Internet, exhibitions and customers for information, they also report obtaining information about technologies and innovation from their suppliers of machinery. This points to policies that allow manufacturers greater interaction with international suppliers of machinery (which could be as close as suppliers in India).

5. Innovation and Technological Upgrading in Services

While the rate of innovation in the services sector is similar to that of the manufacturing sector, the nature of innovation and technology upgrading in the former is fundamentally different. Figures 15 and 17 show that a significant number of firms in the services sector innovated and upgraded their technology (this percentage is not significantly different from firms in the manufacturing sector). At the same time, the services sector differs in the areas in which it upgraded its technology. Figure 16 shows that services sector firms focused much of their innovation on marketing, followed by production and other areas. Figure 18 shows that, in the previous year, the vast majority of technological upgrading occurred in marketing. This implies that services sector firms focus their new technologies on marketing, but remain innovative across the board.

Figure 15: Did your firm engage in any innovation last year (services firms)?

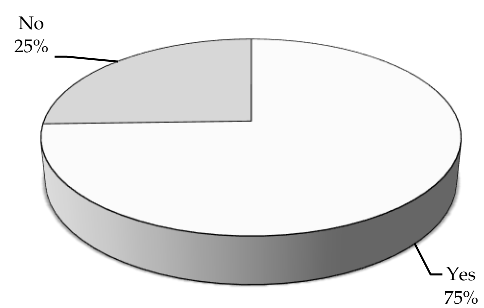


Figure 16: If so, in which areas did you innovate (services firms)?

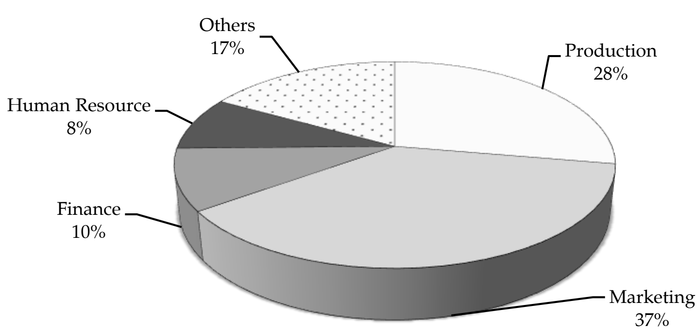


Figure 17: Did you upgrade your technology as a part of innovation (services firms)?

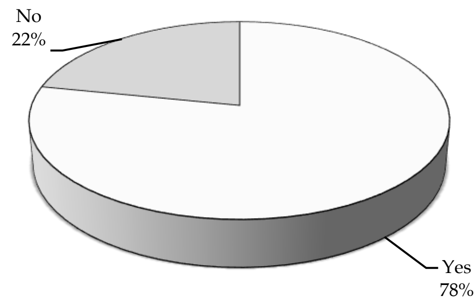
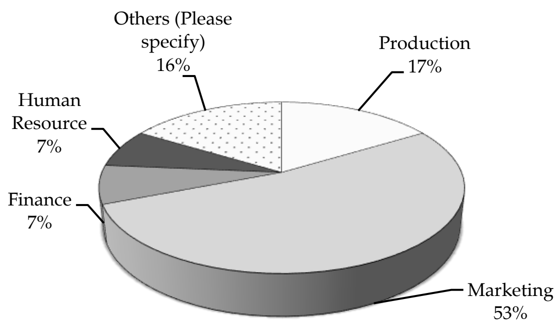


Figure 18: In which areas did you upgrade your technology (services firms)?



Figures 19 and 20 show the sector's plans for technological upgrading in the current year. What is interesting is that a very high percentage of firms plan to upgrade their technology across a group of areas as well as upgrading their technology in marketing (as in the previous year).

Figure 19: Do you plan to upgrade your technology this year (services firms)?

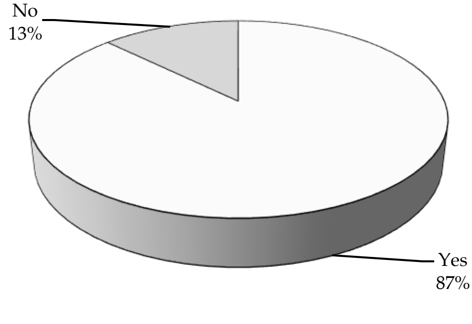


Figure 20: In which areas do you plan to upgrade your technology (services firms)?

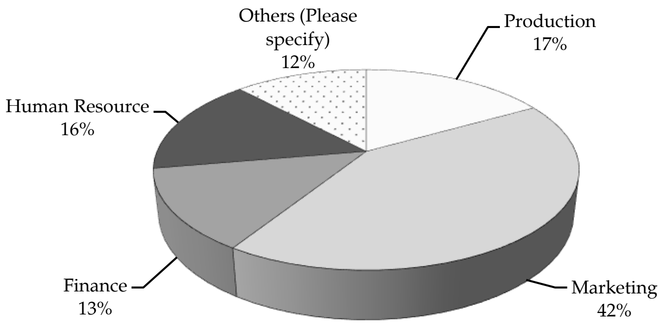
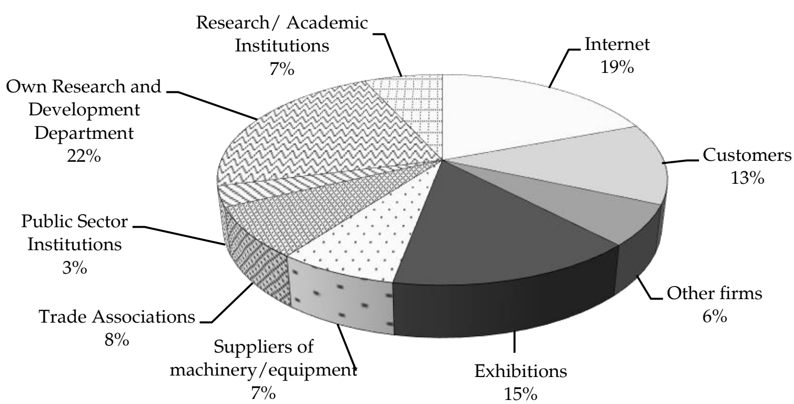


Figure 21 shows that services sector firms cite the same sources of information as manufacturing firms: the Internet, customers and exhibitions. A significant number also point to their own research, which implies that these firms engage in far more (productive) research than firms in the manufacturing sector.

Figure 21: How do you learn about new technologies and innovations (services firms)?



As expected, the bulk of innovation and technology upgrading took place on the marketing side and firms plan to increase their focus on this area in the current year. Unlike the manufacturing sector, the services sector also focuses on innovation and technology upgrading in areas such as finance and human resources. In terms of sources of information, the services sector relies on the same sources as other sectors – the Internet, customers and exhibitions – but, unlike the manufacturing sector, it also depends on its own research and development (R&D) for innovations.

6. Innovation and Technological Upgrading in Retail

The retail sector seems to be different in terms of innovation and technological innovation compared to the other sectors. Figures 22 and 24 show that, while a significant number of retail firms say they innovated and upgraded their technology last year, this percentage is lower than that of the manufacturing and services sectors.

Figures 23 and 25 show which areas the surveyed retail firms focused on when innovating and upgrading their technologies. Retail firms have a relatively even distribution of innovations across areas such as marketing, human resources and production (and this is more evenly spread than in other sectors). What is interesting is that, while retail firms improved their technologies in areas such as marketing and production, a significant proportion also focused on finance – unlike the other sectors.

Figure 22: Did your firm engage in any innovation last year (retail firms)?

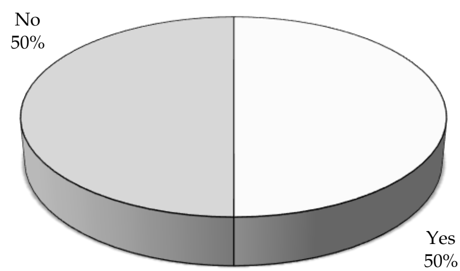


Figure 23: If so, in which areas did you innovate (retail firms)?

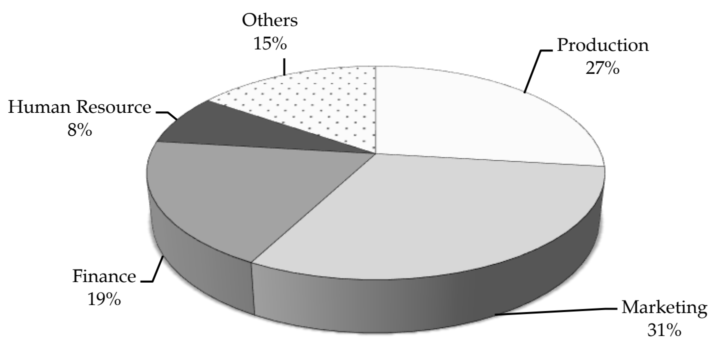


Figure 24: Did you upgrade your technology as a part of innovation (retail firms)?

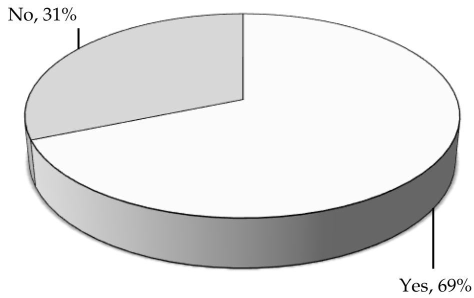
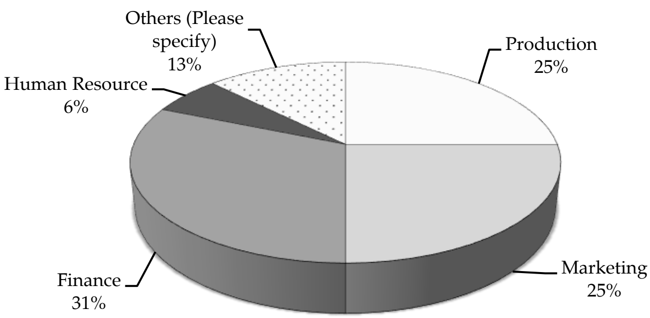


Figure 25: In which areas did you upgrade your technology (retail firms)?



Figures 26 and 27 show that all retail firms plan to improve their technologies in the current year, focusing on production, marketing and finance.

Figure 26: Do you plan to upgrade your technology this year (retail firms)?

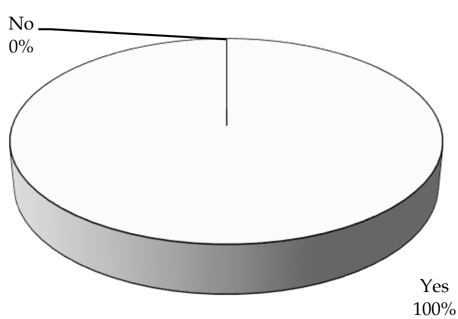


Figure 27: In which areas do you plan to upgrade your technology (retail firms)?

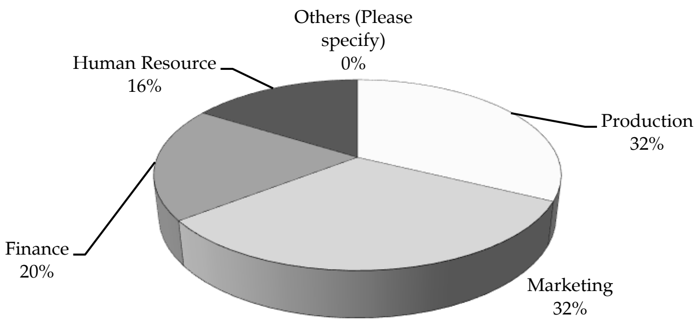
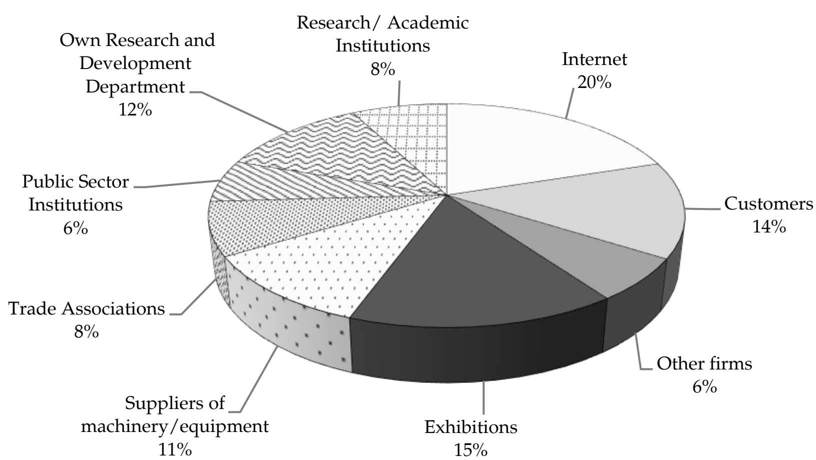


Figure 28 shows that retail firms benefit from the same sources of information as firms in other sectors, such as the Internet, customers and exhibitions. However, a significant number of firms cite suppliers of machinery and trade associations as important sources of information on technology and innovation.

Figure 28: How do you learn about new technologies and innovations? (retail firms)



Innovation and technology upgrading in the retail sector occur far more evenly across areas such as marketing, human resources and production. Retail firms plan to continue this diverse investment in the coming year. Their sources of information on new innovations and technologies follow the same general trend: most information flows come from the Internet, customers, exhibitions and suppliers of machinery.

7. Gains to Innovative Firms

One of the objectives of the survey was to determine if innovative firms had grown over the last year. Table 1 shows the benefits to firms that reported having innovated in the last year. A significant proportion of firms that innovated report higher total sales and domestic sales, but only 30 percent report higher export revenues. In terms of investment and bank borrowing, 72 percent of the firms that innovated report higher investment in the previous year, while only 22 percent report higher bank borrowing. The implication is that most gains from innovation and technological upgrading came from higher domestic revenues. Also, while innovative firms increased investment, very little of this came from bank borrowing.

Table 1: Firms that innovated last year

% of innovative firms whose total revenues increased	58
% of innovative firms whose domestic revenues increased	59
% of innovative firms whose export revenues increased	30
% of innovative firms whose investment increased	72
% of innovative firms whose bank borrowing increased	22

The results for technology upgrading are similar. Table 2 shows that, of the firms that upgraded their technology, 58 percent report higher total revenues, 56 percent report higher domestic revenues and only 32 percent report higher export revenues. While 66 percent of the firms that upgraded their technology report higher investment, only 22 percent report higher bank borrowing.

Table 2: Firms that upgraded their technology last year

% of firms that upgraded technology whose total revenues increased	58
% of firms that upgraded technology whose domestic revenues increased	56
% of firms that upgraded technology whose export revenues increased	32
% of firms that upgraded technology whose investment increased	66
% of firms that upgraded technology whose bank borrowing increased	22

Tables 3 and 4 give the results for those firms that innovated in production and marketing, respectively. While they experienced about the same increase in total revenues and domestic revenues as other firms that innovated, 30 percent of those reporting production innovations had higher export revenues and 28 percent of firms that innovated in marketing experienced higher export growth. Almost eight out of every ten firms that innovated in production report higher investment. In terms of bank borrowing, there is a stark contrast between those that innovated on the production side and those that innovated on the marketing side: 33 percent of the firms that innovated in production report higher bank borrowing (which is significantly above the average across all firms and those firms that innovate). Only 19 percent of the firms with marketing innovations report higher bank borrowing.

Table 3: Firms that innovated in production

% of innovative firms whose total revenues increased	56
% of innovative firms whose domestic revenues increased	56
% of innovative firms whose export revenues increased	30
% of innovative firms whose investment increased	76
% of innovative firms whose bank borrowing increased	33

Table 4: Firms that innovated in marketing

% of innovative firms whose total revenues increased	50
% of innovative firms whose domestic revenues increased	50
% of innovative firms whose export revenues increased	28
% of innovative firms whose investment increased	59
% of innovative firms whose bank borrowing increased	19

These results echo those for all firms that innovated. Most firms that innovated on the production side last year had higher domestic revenues and almost three quarters increased their investment. A major difference is that firms that innovated in production had a significantly higher level of bank borrowing than the average firm, implying that they either had greater access to bank borrowing or were more willing to borrow from banks than other firms. Fewer firms that innovated in marketing increased investment and the proportion of these that borrowed from banks is lower than the average.

8. Did Growing Firms Innovate?

Tables 5–7 show whether growing firms tend to innovate and in which areas they do so. We see that the vast majority of firms that experienced higher total sales, higher domestic sales and higher export sales innovated and upgraded their technology. While 82 percent of the firms reporting higher total sales and 44 percent reporting higher domestic sales innovated in production, 58 percent of the firms reporting higher export sales innovated in production. Only 45 percent of the firms that reported higher export sales innovated on the marketing side.

Table 5: Firms that reported higher total sales

% of firms with higher total sales that innovated	82
% of firms with higher total sales that upgraded technology	87
% of firms with higher total sales that innovated in production	59
% of firms with higher total sales that innovated in marketing	45

Table 6: Firms that reported higher domestic sales

% of firms with higher domestic sales that innovated	85
% of firms with higher domestic sales that upgraded technology	87
% of firms with higher domestic sales that innovated in production	44
% of firms with higher domestic sales that innovated in marketing	27

Table 7: Firms that reported higher export sales

% of firms with higher export sales that innovated	75
% of firms with higher export sales that upgraded technology	85
% of firms with higher export sales that innovated in production	58
% of firms with higher export sales that innovated in marketing	45

These tables imply that firms that experienced growth due to higher domestic sales innovated more than firms that experienced growth in export sales.

9. Did Firms That Increased Investment Innovate?

As Table 8 shows, 84 percent of the firms reporting higher investment innovated, while 83 percent upgraded their technology. Of those firms that report higher investment, 44 percent innovated in production while 32 percent innovated in marketing.

Table 8: Firms that reported higher investment

% of firms with higher investment that innovated	84
% of firms with higher investment that upgraded technology	83
% of firms with higher investment that innovated in production	44
% of firms with higher investment that innovated in marketing	32

10. Did Firms That Increased Their Bank Borrowing Innovate?

The survey reveals that, over the last two years, a very small percentage of firms reported higher bank borrowing. Of these, about 75 percent innovated and about 79 percent upgraded their technology. Moreover, 83 percent of the firms with higher bank borrowing reported innovations in production while only 42 percent reported innovations in marketing (Table 9).

Table 9: Firms that reported higher bank borrowing

% of firms with higher bank borrowing that innovated	75
% of firms with higher bank borrowing that upgraded technology	79
% of firms with higher bank borrowing that innovated in production	83
% of firms with higher bank borrowing that innovated in marketing	42

11. How did Common Constraints Affect Innovation?

The survey asked firms about the impact of major constraints to business in Pakistan, including energy shortages, access to finance, foreign competition and poor law and order. We gauge whether firms that cited these constraints innovated less or more. In the first case, such factors may have reduced their incentive to innovate, the resources devoted to innovation or the perceived benefits of innovation. In the second case, firms may have needed to innovate more to remain competitive under such constraints.

Table 10 shows that almost three quarters of the surveyed firms facing energy shortages, poor access to finance, foreign competition and weak law and order innovated over the last year. This suggests that firms innovated despite, or possibly because of, these constraints.

Table 10: Impact of common constraints on innovation

% of innovative firms that said energy was a major factor affecting their business	74
% of innovative firms that said access to finance was a major factor affecting their business	67
% of innovative firms that said foreign competition was a major factor affecting their business	52
% of innovative firms that said law and order was a major factor affecting their business	67

Interestingly, even though energy is commonly perceived as a binding business constraint, the percentage of firms that cited energy as a major constraint to innovation also felt that access to finance, followed by law and order and foreign competition, were important constraints. This means that efforts to reduce energy constraints without focusing on other issues such as access to finance, foreign competition and law and order will not result in higher innovation in the economy.

12. Sources of Innovation for Growing Firms

How do sources of innovation vary among firms that are expanding because of higher domestic sales and those that are expanding due to higher export sales? Figure 29 shows that firms whose growth is due to higher domestic sales rely on the Internet, customers, exhibitions, their own R&D departments and suppliers of machinery and equipment for innovation-related information. Figure 30 shows that firms with expanding export sales depend on customers, exhibitions, the Internet and their own R&D departments.

Here, we see that firms with higher domestic sales access the Internet, customers and exhibitions as their major sources of innovation. On the other hand, firms with higher export sales rely mainly on exhibitions, customers and the Internet, followed by their own R&D.

Figure 29: Sources of innovation for firms that reported higher domestic sales

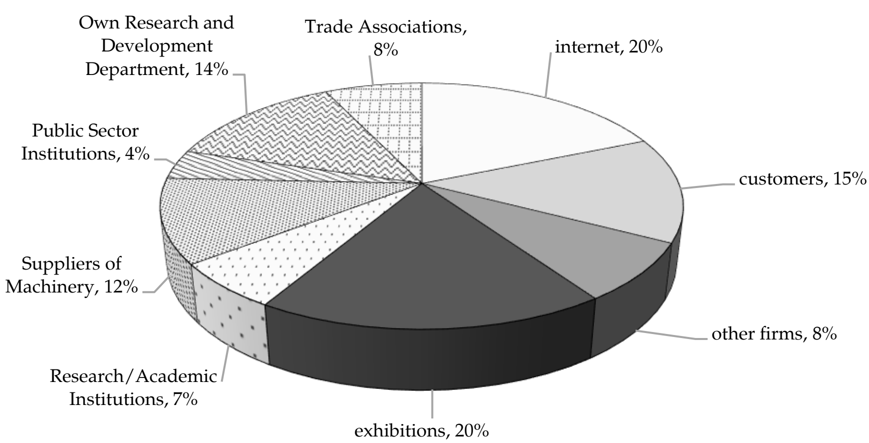
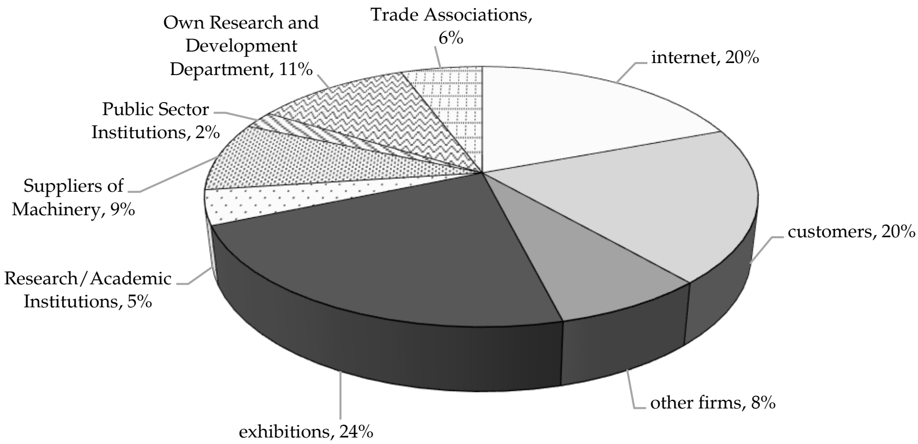


Figure 30: Sources of innovation for firms that reported higher export sales



13. Conclusion

The key results of the survey are presented in this section.

The results show that 72 percent of the responding firms engaged in innovation last year, primarily in production and marketing. Firms seem optimistic about upgrading their technology in the future, with production and marketing as their key areas of focus. Most firms plan to upgrade their technology (85 percent), primarily in production and marketing. The vast majority of manufacturing firms have focused on innovating and upgrading their technology in production and plan to continue focusing on these aspects, although they are also innovating on the marketing side.

While manufacturing firms obtain information on innovations from the Internet, exhibitions and customers, they also rely on their suppliers of machinery. In the services sector, the bulk of innovation and technology upgrading took place on the marketing side and firms plan to increase their focus on this in the current year. Unlike the manufacturing sector, the services sector is also focusing on innovation and technology upgrades in other areas such as finance and human resources. Innovation and technology upgrading in retail is far more even across areas such as marketing, human resource management and production. Retail firms plan to continue this diverse investment in the coming year.

Learning about innovation and technology upgrades from customers, the Internet and exhibitions seems to be the norm among the sample of firms, especially for the manufacturing and services sectors. However, trade associations and suppliers of machinery are also important sources of information for the retail sector. This implies that academic, research and public sector institutions have failed to form a strong connection with firms. There seems to be little technological spillover between firms. The services sector is ahead of the manufacturing and retail sectors in terms of indigenous innovation, with 22 percent of firms learning about new technology and innovation through their own R&D.

Most firms that innovated on the production side last year had higher domestic revenues and almost three quarters increased investment. At the same time, a major difference is that firms innovating in production had a significantly higher level of bank borrowing than the average firm, implying that firms that focused on upgrading their production either had greater access to bank borrowing or were more willing to borrow from banks than other firms. This differential could be attributed to the fact that obtaining a bank loan for upgrading machinery or other essential items for production may be easier than obtaining a loan to launch a new advertisement campaign. On the other hand, fewer firms that innovated on the marketing side increased investment and the proportion of these firms that borrowed from banks was lower than the average.

An interesting question is whether growth leads to innovation or if innovation leads to growth. The results indicate that 82 percent of firms reporting higher revenues innovated compared to 58 percent reporting higher sales. About 75 percent of firms reporting higher export revenues engaged in innovation compared to only 30 percent of innovative firms reporting higher export sales, while 59 percent with higher export revenues had innovated in production and 45 percent in marketing.

While energy is perceived as a key binding constraint for firms, the percentage of firms that cited energy shortages as a major constraint to innovation also mentioned access to finance as an important impediment, followed by foreign competition and law and order. This means that reducing energy constraints without focusing on issues such as access to finance, foreign competition and law and order will not result in higher innovation in the economy.

Firms with higher domestic sales cited the Internet, customers and exhibitions as their major sources of innovation, followed by their own

R&D departments. Firms with higher export sales relied on customers, exhibitions and the Internet as their major sources of innovation.

To enhance the level of innovation in the industrial sector, research and academic institutions should be given incentives to disseminate their research and help bridge the gap between academia and industry. Public sector institutions should help industry in terms of building research capacity and resolving the challenges associated with new technology. Research and public sector institutions should provide a forum for firms to cooperate and share knowledge on innovations and new technologies. While the bulk of innovation and technology adoption is concentrated in production and marketing, both industry and other institutions should work together to explore sources of innovation and technology in other spheres as well.

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Science and Technology for Raising Income: The Choice of Activities, the State and the Private Sector

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Abstract

Pakistan's lack of industrial progress over decades should be cause for concern about the future. The goods the economy produces competitively are the typical goods that yield so little income that they are only exported by economies that have low wage labour. They are much the same manufactures now as during the 1960s and have been kept competitive by keeping wages down through repeated devaluation. Income per head will rise slowly, at best, if the economy does not learn how to produce goods that yield more income, and that means acquiring the up to date technical knowledge needed to be competitive from the foreign producers who produce such goods. But that is knowledge obtained through R&D and is not provided freely, least of all to would-be competitors. Pakistani firms can try to do their own R&D, but, even with public sector collaboration, they cannot catch up with the established foreign firms, which continue to do their R&D and have more money, experienced staff and facilities. The two possibilities are to attract foreign direct investment and for Pakistani firms to insert themselves into the production processes of foreign firms. Experience shows that the first, though it has worked well in several countries, can be ruled out for the present; there has been no FDI in Pakistan for making exportable manufactures. But economies like South Korea and China acquired the technical knowledge they needed through subcontracting and joint ventures with American, European and Japanese firms and moved on from there. There is no realistic alternative and task ahead is to determine what has to be done to realize it.

Keywords: Science and technology, R & D, productivity, innovation, Pakistan.

JEL classification: O14.

1. Introduction

Awareness of the need to improve Pakistan's capabilities in the natural sciences and technology is now practically universal. This was not always so. On the contrary, there is an embarrassing history of how education and science were ignored, even looked down on, during the first

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decades after Partition and the result has been the present deficiencies in these capabilities.

This new awareness is partly the result of efforts by some economists to draw attention to the importance of science and technology (S&T), an early example being the workshop organized by the Lahore School of Economics and Dr Irfan ul Haque in 1997. Since then, there have been some extensive reports on the subject, notably that of the collaboration between the Pakistan Institute of Development Economics and the Higher Education Commission of 2003 and that of the Ministry of Science and Technology of 2013. Part of the reason for this awareness has been concern about military and security matters – this has resulted in achievements that go far beyond what has been achieved in mundane economics, but yielded little direct economic benefit.

Since S&T have been generally neglected, the two reports just mentioned are intended to be comprehensive. They try to assess the needs and possibilities of the whole country, covering a wide range of topics, including electronics, microbiology, new weaving techniques and the Large Hadron Collider. This conference's agenda is more specific: it is concerned with the S&T needed for economic progress, especially productivity. The purpose of this paper is to discuss one question: what S&T do we need to raise incomes in Pakistan? This leads to other questions: how do we get the S&T needed and what can and should the public sector do?

2. Diversifying Out of Low-Wage Goods: Why and How

First, the question of raising income. In the long run – and even in the short run – the sustained growth of income must come from manufacturing and, when possible, from technical services. However, the kind of manufacturing done here will not raise incomes. To take textiles and garments as an example, the types that are produced in Pakistan are produced here because wages are low in foreign exchange terms. High-wage countries no longer produce them and Pakistan would not produce them either if wages here were to rise. In addition, the main markets for Pakistan's textiles levy import duties on them, which lowers the prices and income received from this kind of manufacturing even more.

A good rule for manufactures is that those that are simple to make are already being made by many firms in many countries with low-wage labor and competition keeps their prices from rising. Improving productivity is of little use here. If Pakistani textiles producers are simply inefficient in the sense that they could produce more with the same labor, equipment and raw materials, there may be some gain in income from reducing that inefficiency, but this is clearly not the road to riches.

Alternatively, productivity may be improved by using more advanced production techniques, but the same can be expected of competitors in other low-wage countries. There may be a transitory gain of income, but after that the high-wage countries benefit from lower prices. Textiles, other than some special fabrics, will not become high-wage goods and the cost of capital equipment needed for the new techniques should be counted against any gain of income.

If wages and, therefore, income per head are to rise, the country must move to making other types of goods – ones that are less simple to make. This raises the question, what has prevented Pakistani firms from making these goods already? As the theme of this conference indicates, one answer is Pakistan's low level of S&T, both in the education system and in the workforce.

To formulate this more precisely, most manufactures – leaving aside the ones that are simple to make – are constantly evolving as the firms that produce them spend on research and development (R&D) to improve their designs. This can be illustrated by the example of the motor car. A few big firms spend large amounts of money to improve the many different components of their brands of cars; the result is that cars improve a little each year. The cumulative effect over time is that a car made 10 or 15 years ago is technically far behind a new car. If a car were made now using the technology of 10 or 15 years ago, consumers would not buy it unless the price was sufficiently low, in which case the price would probably be too low to cover the production costs even in a low-wage country such as Pakistan, however efficient the production. The same reasoning applies to manufactures as various as entertainment equipment, household appliances and industrial machinery. Those manufactures to which it does not apply are the simple goods, especially those bought by the poor and already being produced in low-wage countries.

The technical knowledge generated by R&D is the intellectual property or proprietary knowledge of the firms that carry out the R&D or pay for it and is protected by patents and secrecy. Since a large part of competitiveness consists of having up-to-date designs or versions of goods, the firms producing those goods do not impart their up-to-date knowledge to potential competitors. Were a Pakistani firm to start manufacturing a good in competition with established producers, the technical knowledge it would have available immediately would be out of date. It could invest in R&D, but it would not catch up with the established producers, who would continue with their R&D and maintain their lead, apart from being able to spend more.

Hence the dilemma of low-wage countries: they can invest in trying to compete with established producers of goods that evolve with R&D or they can invest in the production of low-wage goods for which R&D is unimportant. To do the former, they must have protected domestic markets since they cannot rely on exports in competition with established producers producing more advanced versions of the same good. However, countries like Pakistan that depend on foreign aid to avoid balance-of-payments crises have had to enter into agreements to reduce their trade barriers irreversibly. They do not have the option of protecting their uncompetitive industries.

The alternative that holds out the best prospects for Pakistan and which many firms in low-wage countries have discovered is to enter into the production of more complex goods – what is sometimes called entering the value chain. This is made possible by the way high-wage country firms have divided their production processes so as to assign the production of specific components of a good or stages in its manufacture to low-wage country firms, thus lowering their costs. A low-wage country firm can contract with a high-wage country firm to produce specific components or carry out processes that do not require special skills or proprietary knowledge.

This activity, which is referred to here as subcontracting, is necessarily a low-wage activity at first, but has three benefits. One is that it diversifies and increases the country's exports. A second is that it can increase the employment of more highly trained workers and engineers, depending on the type of activity – this means more income because these people are more highly paid. The most important benefit is the third: it can lead to technically more advanced activities. The experience of South Korea and China has been that, when a local firm establishes a stable relation of this sort with a high-wage country firm, the latter often increases the range of activities it assigns to the former. This usually means producing components that do require some special skills for which the high-wage country firm can send its own technical staff to give the training needed to make that component according to its own design and specifications. Step by step, this leads to taking over more of the production process because the low-wage technically qualified staff allow the partner high-wage country firm to save labor costs.

An indication of its success in other countries is that the trade caused by subcontracting has been reduced. The reason is that firms that began by doing little pieces have grown able to do more and more, which has allowed the firms for which they were subcontracting to give them a greater share of the production.[1]

Another alternative is to attract foreign direct investment. No hope should be put in this. Pakistan's authorities have been doing what they can to provide all the conditions that are supposed to please foreign investors, but the results have been modest. Since conditions in the country are difficult, foreign investment is not easily attracted. Some (much of it, perhaps) Pakistani capital that had left the country is now coming back in the guise of being foreign, but none of this investment has been in new manufactures that could be exported or compete with imports. It has all been for captive markets such as electric power, phone services and fertilizers. For that to change, Pakistan has to have some success in diversifying its exports, especially in collaboration with foreign firms that would improve its standing as a place for investing in manufacturing.

3. Education: The State and the Private Sector

Put briefly, the argument here has two parts. The first is that Pakistan can only count on being able to raise its income from production by raising wages. This can only be done by entering into activities that are not low-wage activities – activities in which the country cannot compete unless it keeps its nominal wages down in terms of foreign currencies. The economic history of Europe and America shows that industrial and technical progress was stimulated by rising wages, which induced firms to find ways of increasing output per worker and to supply new and better goods for the demand from rising income. When production is confined to low-wage goods, nominal wages must be kept down for competitiveness, which is achieved by repeated devaluation. The data on wages are poor in Pakistan,[2] but it seems that the nominal wage in constant dollar terms is lower now than it was in 1960.

The second is that activities that are not low-wage activities are necessarily ones that cannot be performed by unskilled workers alone. They require technical knowledge and it is in their nature that their specifications will change frequently. Obviously, such activities need technically trained staff who can assess their firms' abilities to undertake specific

[1] *Financial Times*, 3 March 2016, p. 3.
[2] They are surprisingly bad, especially in comparison with the data from the 1950s and 1960s.

subcontracting, notably the detailed specifications, costs and timetables, and who would organize the work. These would normally be engineers and scientists with good university degrees and some experience. The work itself has to be carried out by workers able to acquire the appropriate skills as they change, to learn unfamiliar tasks and to read instruction manuals well enough to use them and to follow translated instructions. For this, workers must have the educational basis; they must have had the schooling to give them the necessary literacy and numeracy as well as enough background in science to adapt to changes as their tasks change. Workers with little or no education who learn their work by example or with brief instruction are rarely able to acquire the skills as quickly or to adapt as well as workers with the right kind of schooling.

Since these activities are being performed in competition with other countries, the education and technical training of the workers have to be suitably good. Firms that do not have the right workers can only succeed in low-wage activities. The education system must, therefore, provide the needed education to children of manual workers because clerical workers and professionals are less likely to send their children to be prepared to work on the shop-floor in factories. In addition, vocational training should not only complement basic schooling with as much training in the specific vocation the worker chooses, but should also guide the worker's choice in response to the needs expressed by firms. Ideally, vocational training would be accompanied by on-the-job training, especially through apprenticeship, though this has proved hard to institute in the few low-wage countries that have tried it.

The general need for more and better higher education in the sciences is well understood and need not be stressed here. Pakistan's capacity for providing such education is so limited, however, that the essentials have to be stated. The subjects that should be given priority are those most needed for the kind of subcontracting discussed in these remarks. At the same time, given the need for adaptability to changing foreign demands, education has to be a continuing process. There have to be institutions for updating and broadening the knowledge of the technical staff of firms at all levels.

Often, courses can be given by Pakistani specialists who have been working in firms that have given them the experience and expertise that do not come in classrooms. This is a common practice and does a little to reverse the brain drain. For example, in the 1950s about 80 percent of the South Koreans who went to the US to study sciences or engineering stayed there.

This was an economic cost to South Korea, but some of it was recovered when the economy began to grow and to offer opportunities that attracted Koreans working abroad who could bring abilities they had acquired from their employment. Such an outcome may be a long way off for Pakistan, but attracting highly qualified people, especially retirees, for short courses is standard practice in many countries.

Pakistan has come to rely on the private sector for much of its education at all levels, mainly because the state has attached little importance to it. It may sound strange now, but in the 1950s and 1960s the government and planners, including Pakistan's foreign advisers, thought of education in Pakistan as perhaps socially desirable, but something that would have to be left to later, to a time when a 'breakthrough' in industry had occurred – rather like a dessert one got only after eating one's vegetables. Partly, it was a problem of social class: those who held power could arrange for their children to be educated in the existing schools in the country or be sent abroad, especially for higher education. The growth of private educational institutions shows how important virtually all families consider education to be and how much they sacrifice for their children to have it.

Governments show more awareness now of education's importance, but they have not yet tried to determine and state explicitly the kinds of education that are prerequisites for raising the country out of its continual poverty. The private sector cannot be expected to specify the kind of education needed for the future either, for it responds to expressed demand and not much of that demand has been directed towards S&T. There are several reasons for this. One is that many scientific and technical subjects are costly to teach because they require properly equipped laboratories and workshops and consume chemicals and raw materials. Not many families can afford such education for their children. Computer classes and IT have the advantage of having some fixed equipment that can be used by successive classes and needs little space, and that makes them affordable and popular.

Another reason is that the primary and secondary schools in Pakistan only bring a few of their pupils to the level needed to study science or engineering at a good university in Europe, Japan or the US. For the present, the only way to increase the quantity and quality of primary and secondary education in preparation for studying S&T at university level is for the state to provide the education free of charge in the public sector, with scholarships and other subsidies for pupils at private schools.

The preparation of skilled workers, scientists and engineers needed to be competitive with foreign firms has to begin in primary school and continue through secondary school. The earlier the start, the better the final training or education. More public or private sector financing for well-equipped laboratories and workshops in secondary schools is greatly needed, though it would be unrealistic to expect much. Even vocational training is poorly supplied. Greater emphasis on mathematics goes some way to filling the gap. It provides a foundation that makes it easier to enter nearly all the sciences and branches of technology and requires no expensive equipment. It also develops numerical aptitudes and some of the process of scientific thinking, especially because it requires solving problems and is incompatible with rote learning. The extent to which mathematics is an indication of scientific ability is shown by the loud criticisms and complaints of industries and educationists in Europe and America over the degree to which the children in their schools perform less well in that subject than children in Chinese, Japanese and Korean schools.

To sum up, almost everyone in Pakistan regards education as essential for improving one's prospects, but the quantity and quality of education in technical subjects provided after secondary school are inadequate. There are two reasons for this. One is inadequate preparation: the level of scientific and mathematical teaching in primary and secondary schools makes it harder for pupils to enter S&T at the level of a good foreign university. The second is a supply constraint: nontechnical subjects are easier to teach because they require little more than classrooms and teachers are easier to find. There have been remarkable successes, especially in matters of defense, and some scientific education is of high quality, but they are not designed to raise education standards in the natural sciences and related subjects in the way needed.

This is not to advocate an intellectual monoculture. On the contrary, if living standards can be raised for the mass of the population, cultural demands will increase and it is unlikely that the intellectual and artistic exuberance that has been manifest in recent times will fade because of better science teaching. The criterion for improving the teaching of technical subjects and the sciences is whether or not it allows Pakistan to diversify into collaborating with foreign firms so as to produce goods that will yield more income than do the low-wage goods produced here now.

4. A Final Comment

Two conclusions can be left tactfully to the end. One is that increasing productivity does not help. Greater productivity with low-wage goods ends up lowering prices and is all to the benefit of the high-wage countries. This has been much discussed with agricultural products such as coffee and cocoa, of which the prices have been a diminishing part of the prices of the final goods made from them. There is no reason it should be different with textiles or garments. Second, innovation is neither possible nor necessary. It is unlikely that a firm or individual in Pakistan can invent some good or method that becomes exportable and has not been discovered by firms in high-wage countries, even if it cannot be logically excluded. So, Pakistan's firms are not going to spend much money on R&D to innovate and the state's budget is too small for any serious effort outside defense.

At best, innovation would consist of adapting goods or production methods to Pakistani conditions. What matters at this stage is that firms be able to adapt to the innovations of producers of other countries and the changes these innovations require of the products that Pakistani firms make as subcontractors. At a later stage, when some firms have reached the point of supplying components for foreign firms on a large scale, it may be worthwhile for these firms to invest in R&D in collaboration with their foreign partner firms.

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Productivity Growth and Entrepreneurship in Pakistan: The Role of Public Policy in Promoting Technology Management

Shaukat Hameed Khan *

Abstract

Numerous public announcements are made regularly in Pakistan about moving towards a knowledge economy. These appear to be wishful thinking in the absence of any coherent understanding of the role of technology and its spillovers as major drivers of development and growth as well as lack of clarity about the manner in which science and technology are organized in Pakistan. Pakistan has not really been able to manage the major organizational changes brought about by the techno-information revolution of the 21st century. Its competitiveness is falling, organizational changes are slow and workforce skill levels are inadequate – all of which have stalled productivity and innovation. Pakistan faces a serious risk of deindustrialization unless the dynamics and disruptive nature of modern technology are better understood and embedded as a key pillar of public policy in order to enhance productivity and innovation. This article attempts to define the nexus between technology and entrepreneurship and show how it differs from scientific research. It also examines the role of public policy in promoting productivity growth and entrepreneurship through better policies in technology management.

Keywords: Productivity, growth, entrepreneurship, public policy, technology, Pakistan.

JEL classification: O39.

1. Introduction

Economic advancement is an extremely complex process. Science and technology (S&T) alone is not a magic wand. Lessons from numerous growth studies show that it is not possible for a country to replicate exactly those that have gone before; latecomers must dance to their own music. This, however, needs some good orchestration.

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In order to identify public policies that promote better management and acquisition of technology in Pakistan, it is necessary first to understand the emerging morphology of the global economy. Its distinctive feature is the transnational/vertical division of labor and diffusion of work, technology and ownership, which requires matching transnational skills. From the 1970s to the 1990s, it was shown that manufacturing could be done anywhere. Now, designing, too, can be undertaken anywhere and this shift appears to be irrevocable. Other intrinsic factors remain the development of institutional excellence and fast-moving human resources, coupled with strategic alliances for complementary resources. The key drivers of growth are, and will remain, people, innovation and capital. These, however, require a strong congruence between social and technological capabilities.

Almost all developed economies are now identified as 'knowledge economies' to some extent or the other and they are taking further steps to consolidate this position by becoming even more knowledge-intensive and competitive (Romer, 1994). Even when their productivity growth has slowed down, the rate of increase in the skill bias in technology has not. In some newly industrialized Asian countries, such activities have already enabled small and medium enterprises (SMEs) to evolve into major global players and conglomerates, which now offer complete end-to-end services in the supply chain, whether as manufacturers of piece parts and systems or providers of services, design and research. Developing countries, too, have witnessed a sharp reduction in the relative demand for unskilled labor since the end of the 1970s.

1.1 Playing Catch Up

Historically, there have been several major attempts at playing 'catch up' during the last 150 years and the dynamics of the process have been studied extensively. These include German attempts to emulate the earlier industrial revolution in Britain (Gerschenkron, 1962) and the forced modernization of Meiji Japanese society (Morishima, 1982), both of which took place in the 19th century. More recent studies have focused on the postwar boom in Europe, the sudden rise of newly industrialized countries in East Asia and, of course, China.

The basic lesson from growth studies is that it is not possible to replicate the policies of countries that took the route earlier because of that moment in history, such as empires, captive economies, colonies and division of labor. Today, it is about the digital disruption, automation and the death of distance brought about by the information revolution, with totally different dynamics for adoption. Further, while economic integration, larger and more homogeneous markets and large-scale production technologies have driven growth and development, the process of sustained growth experienced by several countries and regions would not have been possible without a general increase in education levels and human capital (Barro & Lee, 2000).

Recently, the emergence of a congruence has been observed in the modern sectors of the economy, which show a "robust tendency toward convergence in labor productivity in such manufacturing activities … regardless of geography, policies or other country-level influences" (Rodrik, 2013). This is caused by extremely rapid changes in the technology innovation cycle and its absorption by countries that are ready for this disruption. The basic requirement, however, remains the congruence of technological and social capabilities and infrastructure (Abramovitz, 1994), which in turn require the institutional evolution of domestic knowledge systems.

Innovation activities in firms are ascribed as the driving force behind economic growth, brought about by new combinations of science and engineering, market research and organizational experience, all of which promote more qualitative than quantitative activities (the "creative destruction" proposed by Schumpeter in 1976). Lundvall (1992, 2005), meanwhile, emphasizes learning as the source of technological growth (learning by doing) while Romer (1994) focuses on innovation and research and development (R&D) with its externalities and spillovers to improve the capacity for future innovation.

1.2 Technology Management and Entrepreneurship

While there is a considerable body of literature available in economics and development or in entrepreneurship and management, the field of technology entrepreneurship is still in its infancy and detailed studies are few and far between. The result is that entrepreneurship, especially technology entrepreneurship, can be as difficult to teach as public morality (Socrates having asked, "Can morality be taught?"). Moreover, most literature on technology management relates to large enterprises that have dedicated resources for managing assets and achieving productivity gains. Technology management operations in SMEs are generally very patchy and informal.

Bailetti (2012) examines all articles published in 62 major journals between 1970 and 2011 across eight related themes and notices a rapid increase in the volume and breadth of research on technology entrepreneurship. Two thirds of the articles were published in the last 12 years, of which 84 percent deal with four topics only. The majority (45 percent) examine the external factors that influence the formation of technology firms; 15 percent discuss how, why and when technology entrepreneurship affects the socioeconomic development of a region; 13 percent cover the approaches used by small technology firms to generate revenues, reduce costs, manage operations and business transformation; and 11 percent deal with the internal practices used to operate and transform small technology firms. Since 1970, a mere four articles, or 4 percent of all the articles, have dealt with an overview of technology entrepreneurship, of which two were published in 2000–09 and one in 2011.

1.3 Science, Technology and Productivity

A recent report by Manyika et al. (2013) identifies 12 technology areas with a potentially huge impact on how people live and work and how industries and economies will evolve by 2025, based on extensive interaction with experts and respected leaders in industry and academia. While such changes have always been disruptive, the speed of change and their scope have accelerated. Their potential impact needs to be carefully examined and leveraged in state policies. The report also points out that, unlike previous innovations, "the benefits of technological change are not being widely shared – real median wages have fallen behind growth in productivity and inequality has increased."

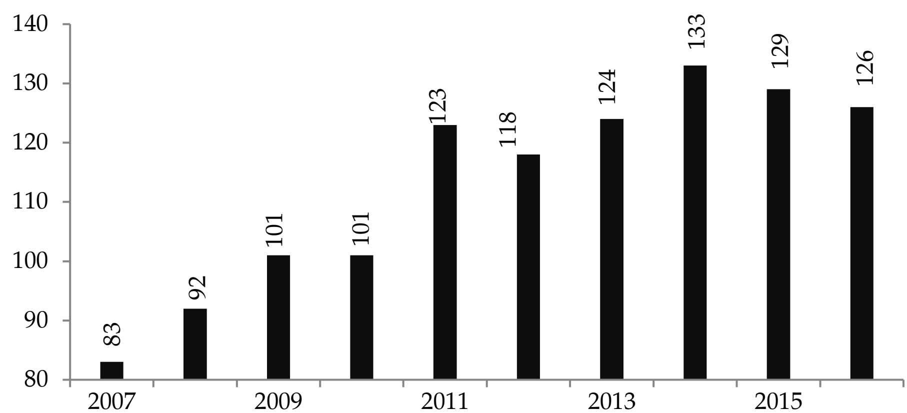
A further disruption is caused by the blurring of boundaries between scientific research and technology application, especially in the realms of molecular biology and computers and information ('big data' and IT). The two communities of researchers and technologists and their activities do not differ as much in their methods of enquiry and pursuit of knowledge as in their reward structures and approach to the disclosure of knowledge (Dasgupta & David, 1994). The fundamental difference between the two strains is the division between public and private knowledge systems, science being supposedly free – the philosophy of the 'Republic of Science' (Polanyi, 1962) – while technology is driven by secrecy, profits and the production of industrial goods and services or military hardware.

Moreover, the knowledge worker does not necessarily hold a PhD. For productivity gains, the skilled worker may be more important than the research scientist and covers the entire spectrum of new skills required, whether it is the telephone operator or the fisherman and farmer, the worker on a building site or the people who maintain and operate essential infrastructure.

2. The State of Productivity and Competitiveness in Pakistan

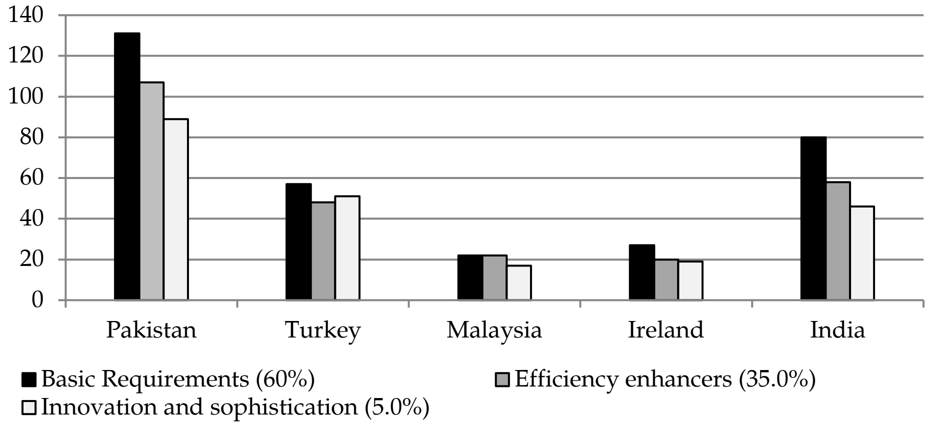
Pakistan's overall competitiveness is quite low and its ranking on the global competitiveness index (GCI) fell from 83 in 2007 to 126 in 2016 (Figures 1–3). The Global Competitiveness Report for 2015/16 (prepared by the World Economic Forum for 144 countries) identifies 12 'pillars' that contribute to productivity and competitiveness. Four of these are directly linked to skills: primary education, higher education and training, business sophistication and innovation. The indirect pillars include technological readiness (which measures how a country implements existing technologies to improve productivity) in addition to labor market efficiency. The primary cause of Pakistan's poor performance is poor performance against the basic requirements (see Figure 3), which carry a weight of 60 percent in the evaluation.

Figure 1: Pakistan's competitiveness ranking, 2007–16



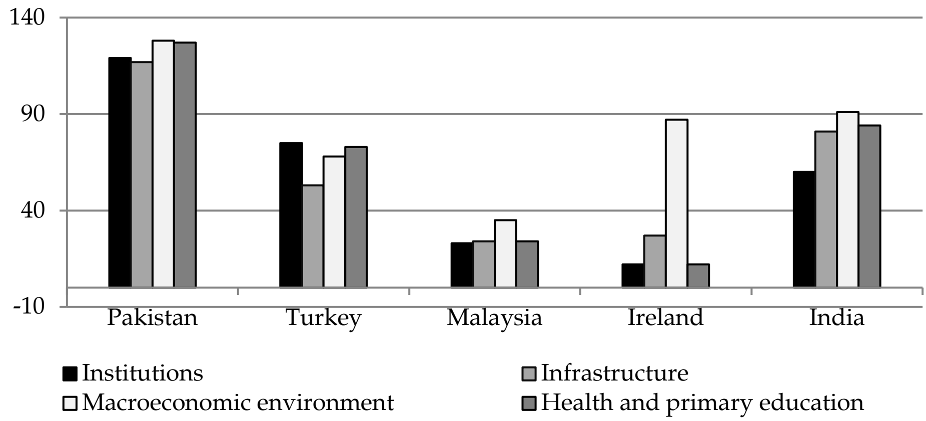
Source: World Economic Forum (2016).

Figure 2: Overall GCI ranking out of 140 countries



Source: World Economic Forum (2016).

Figure 3: GCI ranking, basic requirements



Source: World Economic Forum (2016).

When it comes to technological readiness or the capacity for innovation (Table 1), Pakistan fares badly overall, being ranked the lowest among the five selected countries in nine out of seven sub-indicators. Surprisingly, Pakistan fares better than India in the availability of the latest technology and firm-level technology absorption as well as foreign direct investment (FDI) and technology transfer.[1] This is surprising, given its much lower ranking in the basic requirements group (see Figure 3). Ireland leads in FDI and technology transfer, followed by Malaysia and Turkey.

[1] R&D readiness is discussed extensively by Berteletti, Morel and Teulieres (2016).

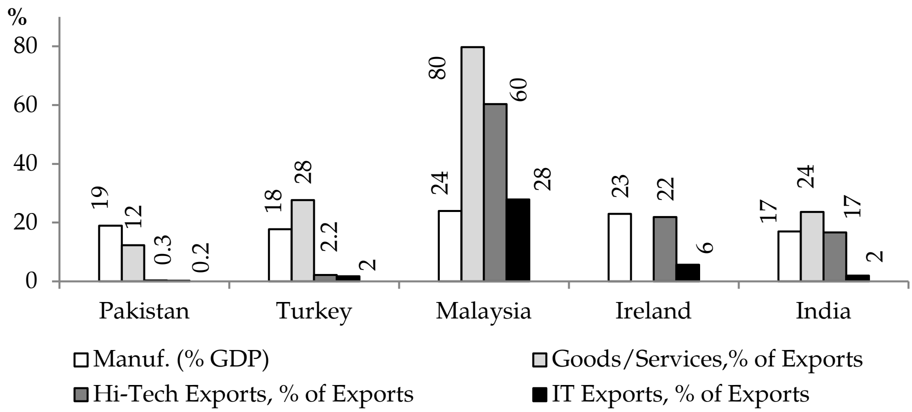
An important indicator of productivity and innovation within the global economic environment is the share of manufacturing in GDP and exports. The ratio of Pakistan's exports to GDP is quite small (12.5 percent). The worrying feature is that its biggest components are cotton and agricultural products. Exports of high-technology goods and services – such as computers and office machinery, communications semiconductors, aerospace, pharmaceuticals and scientific and measuring equipment – have a low share (Pakistan Bureau of Statistics, 2015; World Bank, 2015). This is shown for five selected countries in Figure 4.

Table 1: Technological readiness and innovation in selected countries

9th pillar: technological readiness	**Pakistan**	**Turkey**	**Malaysia**	**Ireland**	**India**
Availability of latest technology	79	55	30	17	108
Firm-level technology absorption	82	36	23	24	102
FDI and technology transfer	77	52	5	1	95
Individuals using the Internet, %	119	67	45	28	117
Fixed BB Internet subscribers, %	107	61	68	29	104
Int. Internet bandwidth, kb/s per user	115	62	77	16	116
12th pillar: innovation					
Capacity for innovation	95	83	7	17	50
Quality of scientific research institutions	104	82	20	15	45
Company R&D	88	79	8	19	31
University/industry R&D collaboration	98	61	12	13	50
Government procurement (advanced technological products)	52	39	3	51	26
Availability of scientists and engineers	44	50	5	8	49
Patents application/million	109	42	33	20	61

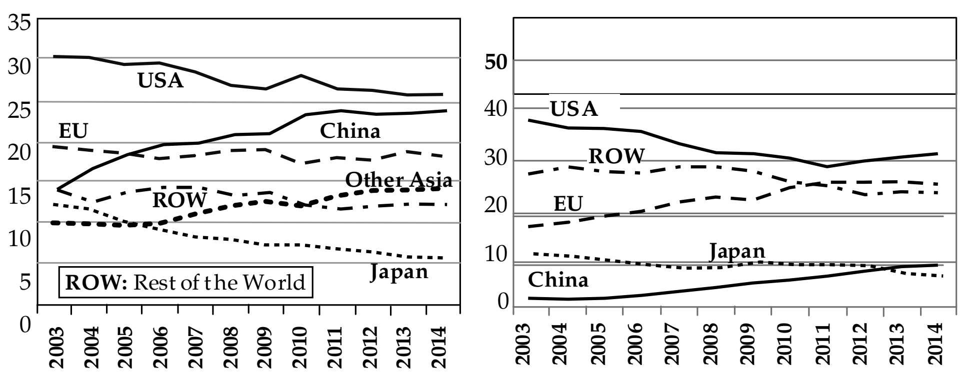
= worst = best

Figure 4: Manufacturing and export profiles for selected countries, 2015



Cotton and its derivatives, or the goods produced by the Sialkot export group, have low growth rates and demand, while technology-based items, especially electronics, have larger global turnovers and growth. These sectors are also highly competitive. China and East Asia are growing the fastest in the high-technology merchandise exports category, but the US and EU are still the biggest providers of knowledge-intensive services (Figure 5).

Figure 5: High-technology exports and commercial knowledge-intensive services as % of global exports, 2014

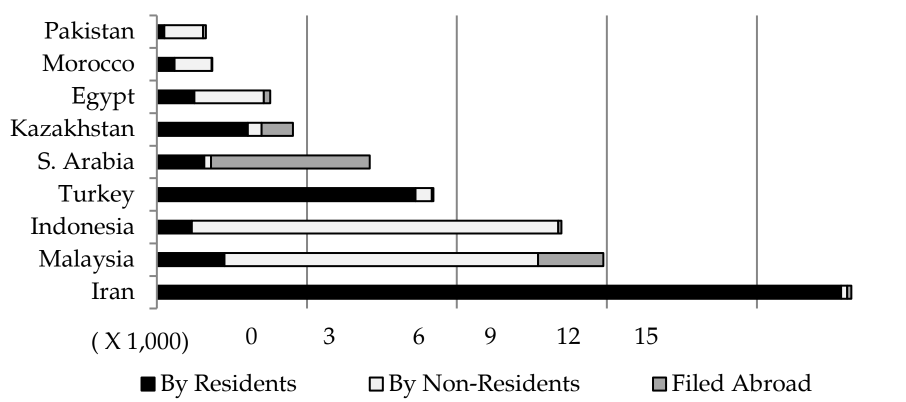


3. Patents as a Proxy for Innovation, FDI and Terms of Trade

Patent applications are an important proxy for industrialization, entrepreneurship and research. The share of OIC member states in the 2.7 million global patent applications filed in 2014 was only about 50,000 or 1.9 percent (World Intellectual Property Organization, 2015). The share of 'residents' in patent applications was also very small, except for Turkey and Iran, indicating weaknesses in local systems. In comparison, just five countries accounted for 89 percent of global patent applications, with China leading with 965,000 (36 percent), followed by the US (803,000 or 30 percent), South Korea (277,000 or 10 percent), Germany (197,000 or 7 percent), India (147,000 or 5 percent) and France (74,000 or 3 percent). These numbers reflect the state of investment and activities in the modern sectors of their economies.

Pakistan fares badly even among the OIC countries (Figure 6), with just 978 applications or about 2 percent of the total number filed by OIC countries in 2014 (World Intellectual Property Organization, 2015). Of these, 146 were filed by residents, 776 by nonresidents and 56 filed abroad. Globally, Pakistan's share was a negligible 0.04 percent, which reflects not only its low innovative capability, but also lack of investment and intellectual property protection. It also implies the absence of the diffusion of innovations and best practices from leading global firms, especially 'frontier firms', which have higher productivity levels than nonfrontier or large firms (OECD, 2015).

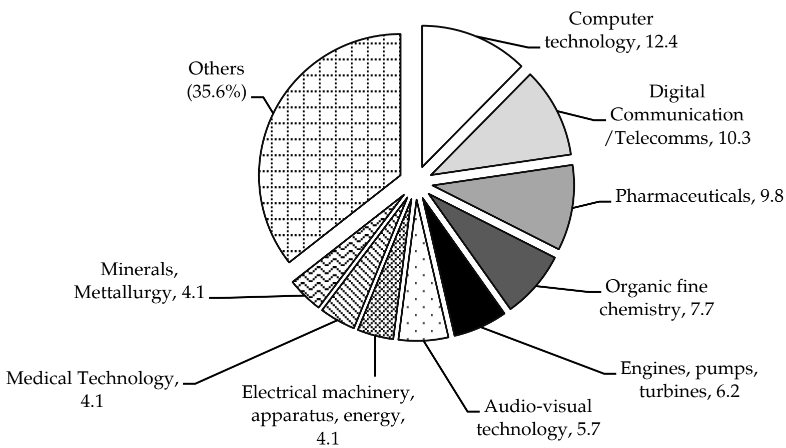
Figure 6: Patent applications, top nine OIC countries



Source: World Intellectual Property Organization (2015).

The categories in which patents are created in Pakistan are given in Figure 7, with computers and digital communication, telecoms and pharmaceuticals being the top four categories.

Figure 7: Pakistani patents, by field



Source: World Intellectual Property Organization (2015).

Incidentally, the IT and software sector is not adequately reflected in patents or exports because of innumerable 'virtual' services and transactions

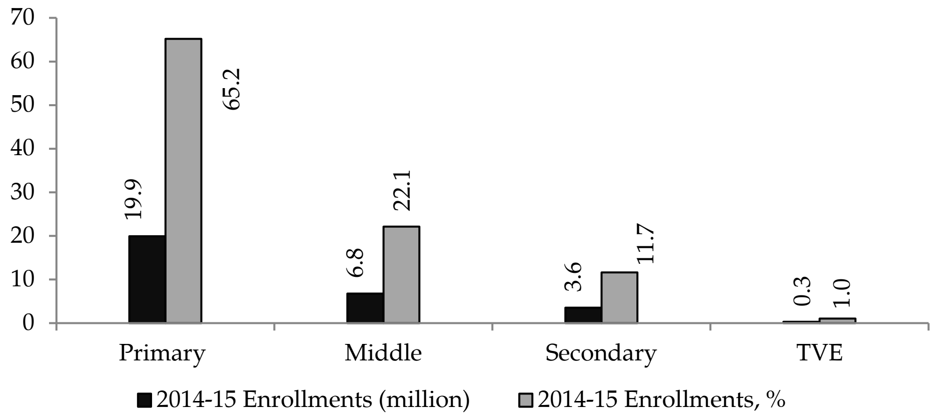
4. The Causes of Low Productivity in Pakistan

This section looks at the relationship between productivity and education.

4.1 The Education Crisis

Low productivity in Pakistan can be attributed to one key factor: the crisis in its education system. Of the 30.6 million children enrolled in school in 2014, the share of secondary schooling is 3.6 million (11.7 percent) while that of technical and vocational education is only 0.32 million (1.04 percent). This reflects a major problem in education as regards to completion and skills development. The Pakistan Labor Force Survey for 2009 gives even more startling numbers for education levels among the workforce: nearly three quarters had less than eight years of schooling and a third had attended school for only one year (see Figure 8).

Figure 8: Education profile of Pakistan, 2016



Source: Pakistan Bureau of Statistics (2016).

When it comes to the allocation of resources, education and skills are badly neglected. University enrolment is just over 1.8 million while only 0.3 million are enrolled in any formal technical education. This figure compares unfavorably with both developed and developing countries and affects productivity. Turkish enrolment in technical skills is around 35 percent of the relevant age cohort.

Machin and Van Reenen (2007) regard higher skills as an important factor in the production process, whereby higher-educated workers are more able to respond to new technologies such as ICT than less educated workers. They are also better able to react to organizational changes in modern firms such as the decentralization of decision making and control, collective work, job rotation and skills segregation and homogenization. This nonneutral technological change makes higher-skilled workers much more attractive to employers and rising worker skills could perhaps create their own demand.

An example of skewed priorities in Pakistan is the Islamabad–Rawalpindi metro bus infrastructure, which cost about Rs 45 billion over 15 months (nearly 11 times the annual school budget of Rawalpindi). The quality of teachers, education delivery and the books and subjects taught need a drastic overhaul.

4.2 *Social and Economic Returns on Skills Development*

There is inadequate recognition of the economic and social returns of secondary, technical and vocational education in Pakistan. It has been estimated from OECD panel data that the productivity premium at the firm level for a trained worker is about 23 percent, with a wage premium of training of about 12 percent (Konings & Vanormelingen, 2010). This supplements the international data, which points out that countries with a large proportion of students enrolled in upper secondary vocational programs have significantly higher rates of school attendance and completion at the higher upper secondary level. In the US, 90 percent of students attending a comprehensive high school take at least one occupation-specific course (Bishop & Mane, 2005).

Ireland is an excellent example of a country that has changed its educational attainment and skills profile. In 1972, half the workforce had only primary education; by 2002, 63 percent had higher secondary and tertiary education. With a highly creative and talented workforce, an open economy and a competitive corporate tax environment, Ireland is now the second largest exporter of computer and IT services in the world, hosting eight of the ten leading companies with exports of over US$55 billion in 2014.

The development of higher and different skills will affect the growth of new startups, but these will need to be regularly updated. This is where the state comes in. SMEs need venture capital and angel finding. However, funding for SMEs is less of a bottleneck than technology intelligence and help with change management. The policy framework required for SMEs in Pakistan would be to enhance technical skills and the organizational capacity of the client, provide training in financial and business models, provide ‘change’ intelligence and facilitate venture capital and angel funds, especially for new technology-based firms (NTBFs).

5. The New Technology-Based Firm

Becoming an entrepreneur involves changing the external environment from one state (that without the venture) to another (one with the venture). This causes a basic discontinuity in the competitive structure of the industry and can result in the creation of an altogether new industry. New technology enterprises and startups have different dynamics of evolving into mature businesses and involve activity, technology levels and business processes, and of course early death. The process must be viewed as a complete system, from the product concept to an acceptable finished product in the context of market share and the stage of the organization in the firm's lifecycle.

NTBFs are also quite vulnerable in the initial stages (the initiation, survival and growth phases) and face rapidly changing technology management activities and matters of sustainable supply chains, which include not just hardware and software, but also people with the right skills and their sudden exit to potential competitors and further new startups. The state can help by providing 'changing technology' intelligence.

It has been suggested that NTBFs are more likely to be initiated by employees working in small companies, which foster new startups because they are exposed to entrepreneurial working conditions and the learning opportunities are greater than in bigger firms (Werner & Moog, 2009; Parker, 2009). Normally, NTBFs do not evolve in a linear fashion from stage to stage and certain stages can be bypassed when required in a rapidly changing situation (Savioz, Luggen & Tschirky, 2003). This is also where the state comes in, as occurred in East Asia, Korea, China and Brazil, which have unorthodox policies to encourage such startups.

In the US, the impact of the Bayh-Dole Act on the entrepreneurship of scientists was measured by their propensity for starting a new firm. Audretsch et al. (2011) show that scientists who are on the board of a company or scientific advisory board and publish frequently with scientists employed in industry have a greater propensity for engaging in entrepreneurial activity.

5.1 Change Agents

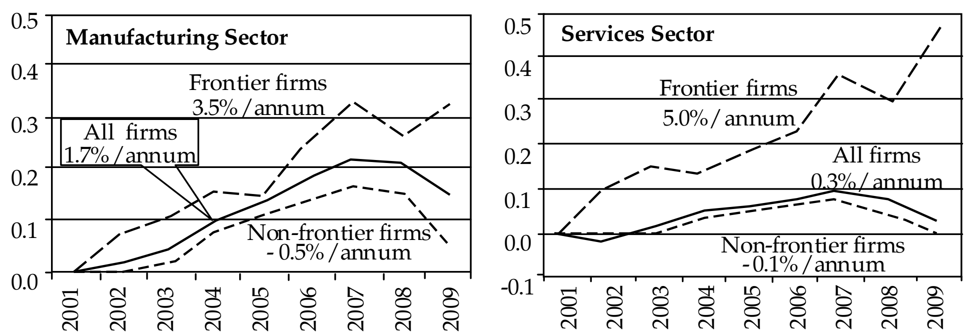
Three types of agents can promote productivity and competition in a firm. First, there are the companies in the region (including their customers and suppliers) that represent the production component of the regional innovation system (Khan, 2016). Second, these need to be backed up by innovation support from universities, technical colleges, vocational training organizations and R&D institutes as well as business associations and financial institutions. Finally, there is need for technology transfer agencies such as KISTEP in Korea. With these in place, it will be possible to develop a soft infrastructure and social capital.

5.2 *Productivity and Frontier Firms*

At a general level, productivity drivers may be identified either at the level of the firm or across firms and countries.[2] In the former, the firm culture, incentive structure and quality of human and physical capital will dominate. Across firms and countries, the spillovers from geographical proximity and even outside the region will be determined by regulation, trade and being part of supply chains. Product innovation in products and technology adoption are common drivers of productivity in all firms.

Firms operating at the frontiers of technology generally show higher productivity and productivity growth than larger, older firms (Figure 9) or those operating in nonfrontier areas (Andrews, Criscuolo & Gal, 2015). They are younger, more flexible and more likely to file patents. The authors attribute this gap to a "highly uneven process of technological diffusion, which is consistent with a model whereby global frontier technologies only diffuse to laggards once they are adapted to country-specific circumstances by the most productive firms within each country." Further, a proper policy framework can promote productivity diffusion by sharpening firms' incentives to adopt technology and promoting a market environment.

Figure 9: Productivity lag between frontier firms and older firms



Source: Andrews et al. (2015).

This would require reallocating resources to the most productive firms in addition to R&D tax incentives, industry–university R&D collaboration and patent protection. Greater industry–academia R&D collaboration would facilitate technology diffusion to smaller and less productive firms by providing new avenues of knowledge such as advanced

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[2] See: http://www.kauffman.org/microsites/state-of-the-field/topics/firm-and-industry-dynamics/productivity-growth

machinery and instruments and skilled scientists. Trading with frontier firms and participation in global value chains, coupled with better e-governance and major reallocations for skills enhancement, are key drivers of productivity and innovation gains.

5.3 Policies, Foresight and Internal Transfer of Technology

The efficacy and impact of state policies or advice to policymakers will depend on three factors: relevance, stakeholder interests and the jurisdiction of those who will fund, implement and monitor these programs. It will also depend on the nature of the work that must follow, which is distinct from making buildings. An important role for the government will be to provide foresight and map trends: this could help pick potential winners, enable better matchmaking with stakeholders, redraw existing and future allocations and develop better skills and standards.

Conducting regular foresight exercises is now common in many countries. While the impact of such exercises is still being examined, they do have a significant effect on designing and shaping national innovation policies and the necessary innovation systems and structures, including change management. Mu and Ren (2009) study this impact on the scientific community, on making S&T policy decisions and on the public understanding of S&T in China, while Yi, Kim and Yu (2016) conduct a similar study for Korea. Both give insight into coherent policymaking and implementation through foresight exercises.

Currently, a major revolution is underway in the energy sector: efficiency in the generation and use of electricity and the grid integration of renewable energy are major drivers of the new energy scenario. This sector needs urgent attention, as the window of opportunity is small, with many new players appearing on the scene.

Pakistan has developed major technological capabilities in its national government laboratories, especially those in the strategic sector. These cover modules for power plants, computers and controls, agriculture and water management, seed development, biotechnology and medicine. It is time to transfer these to local industry. Such an internal technology transfer could be extremely beneficial, especially for small businesses. The latter are more efficient innovators and state assistance would reduce the cost of negotiating technology agreements.

The allocation of resources for basic scientific research has always been controversial because its economic payoffs are uncertain and likely to be delayed, whereas technology is expected to generate 'rents' or profits much sooner. For a country such as Pakistan, another issue is the protection and enforcement of intellectual property rights and patents, which is crucial in the modern part of the economy based on medium-tech and high-tech enterprises.

6. Conclusion

With the China–Pakistan Economic Corridor in the news, generating employment and matching skills with demand in the changing workplace will be central to success in poverty reduction, economic growth and social mobility. The national education and training system is, unfortunately, not in sync with these objectives and is due for a major overhaul.

Low literacy in Pakistan is a natural outcome of the system's lack of responsiveness to the economic needs of students and explains to a great extent the high dropout rate after five years of schooling. Recent studies suggest that extreme convictions on either side of the public–private divide are no longer supported and an intermediate position exists between pure market forces and rigid state planning. This "rare historic opportunity for planning industrial policies" (Rodrik, 2004) allows the state to be responsible for basic strategic and coordinating roles in the productive sectors, irrespective of the intensity of globalization.

Education and training are the most successful policy instruments for state intervention. This has happened in every newly industrialized country of the last few decades and is also actively pursued by the OECD countries. Education with skills is now viewed as a right for young people and a core responsibility of the state. My extensive interaction with industry and business suggests that the private sector in Pakistan is willing and able to participate with the public sector if its stake is duly recognized. This is in line with Maclean (2005), who argues that, "in many countries, secondary education has become the weakest link in the education chain." It is now receiving more attention and policy priority because it is seen not just as a bridge between primary and tertiary education, but also as an active instrument for preparing young people to enter the workforce of a fast-changing global economy.

General education will not be displaced. It will be supplemented to the extent of, say, 15–20 percent with economically relevant courses related to the productive sectors of the economy (services, industry and agriculture). This needs to be augmented with 'soft' skills such as communications, interpersonal skills and team-based approaches. For both streams, teachers are the long pole that holds up the reformed structure. All programs must therefore be built around well-trained and well-paid teachers. At the institutional level, the capacity for data collection and analysis of the labor market needs to be strengthened while maintaining a balance between institutional autonomy and the public accountability of financing instruments and the monitoring of outcomes.

It is argued that internal technology transfer can and should be facilitated between the best in the country and not-as-good technical institutions. This could take the form of 'mother institutions' where the national laboratories in particular could help to steer quality matters and benchmarking. These could include major institutions and industries in sectors such as power, chemicals and pharmaceuticals, IT, agribusiness, mining and the relevant departments in academia.

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6. Detailed derivations of any main mathematical results reported in the text should be submitted separately along with the articles.

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8. The graphic format for each mathematical formula, diagram, figure or chart should be in text mode for further editing.

9. Tables for the main text and each of its appendices should be numbered sequentially and separately. The title of each table should clearly describe the contents. The source of the table should be given in a footnote immediately below the line at the bottom of the table.

10. Footnotes should be numbered sequentially.

11. All references used in the text should be listed in alphabetical order of the authors' surnames at the end of the text. References in the text should include the name(s) of author(s) with the year of publication in parentheses, and all references should conform to the style of the Journal. Further information on questions of style may be obtained from the Associate Editor, *The Lahore Journal of Economics*, Lahore – Pakistan.

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