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The Magnitude of Trade Misinvoicing and Resulting Revenue Loss in Pakistan

Tehseen Ahmed Qureshi* **and Zafar Mahmood****

Abstract

This study estimates the magnitude of trade misinvoicing in Pakistan with 21 of its developed trading partners in 52 major traded commodities during 1972–2013. We find that the total volume of trade misinvoicing for this period exceeds US$92.7 billion. The gross revenue loss borne by the national exchequer due to trade misinvoicing is estimated at US$21.2 billion. Moreover, the total net revenue loss is an estimated US$11 billion in the form of evasion of customs duties and export withholding tax. The annual average net revenue loss due to trade misinvoicing is almost equivalent to 11.2 percent of the total revenue generated from customs tariffs. We also find that customs tariffs and the interest rate are positively associated with import under-invoicing, while improvements in the current account balance and political stability reduce the extent of import over-invoicing. Capital account openness is found to be insignificant in determining trade misinvoicing.

Keywords: Trade misinvoicing, revenue loss, capital flight, reverse capital flight, black money, Pakistan.

JEL classification: F13, F14, K42, H26, O17.

1. Introduction

Intuitively, when two trading partners engage in trade, the data reported by one country should be the same as that reported by the other after adjusting for c.i.f./f.o.b. However, this does not happen in many cases for various reasons. Trade misinvoicing is one reason for discrepancies in bilateral trade data. Trade misinvoicing is illegal and occurs when traders under-invoice or over-invoice their exports or imports for the purposes of tax evasion or capital flight in either direction. To estimate the volume of trade misinvoicing, we compare the exports (imports) of the reporting

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country with the imports (exports) of the partner country after adjusting for the costs of freight and insurance.

The government loses a large amount of revenue in the form of customs duties and export taxes through trade misinvoicing. The economy is deprived of domestic capital that is transferred abroad, which could otherwise be invested domestically. This results in a decline in economic growth due to lack of capital. In addition, the loss of revenue means that the government cannot use potential resources to expand social services.

Kar and Spanjers (2015) estimate that the sum of total trade misinvoicing in 2013 in developing countries was US$1.1 trillion. The total trade misinvoiced during 2004–13 is estimated to be around US$7.8 trillion for 55 developing countries. Furthermore, trade misinvoicing accounts for 83 percent of the total illicit trade in developing countries. This implies that illegal financial flows resulting from trade misinvoicing have a considerable damaging impact on developing economies (Kar, 2010).

Kar and Spanjers (2015) also point out that, in the Global South, trade misinvoicing has increased over time. Trade misinvoicing in emerging countries is increasing on average at 6.5 percent per annum. The total trade misinvoiced in Asia accounts for 38.8 percent of total trade misinvoicing in emerging countries. It also has the highest annual growth rate of trade misinvoicing at 8.6 percent. The top exporters of illegal capital are Asian countries, including Malaysia, China, India, the Philippines, Indonesia and Thailand. Russia is the main source of trade misinvoicing in Europe. Illicit flows from the West are generated primarily by Mexico and Brazil.

The first study to estimate illegal flows of capital from developing countries due to trade misinvoicing was carried out by Bhagwati (1964). He compares the bilateral trade data for Turkey with that of its trading partners. He accounts for the discrepancies between the trade figures of the partner countries by indicating that either of the two or both had exploited their trade invoices to move capital. Given that the customs administration in advanced countries is more likely to be simpler, transparent and accountable relative to developing countries, we can assume that the data for developed countries is more reliable for comparison purposes (Bhagwati & Hansen, 1973).

Historically, Pakistan has maintained very high tariff rates and relied on nontariff barriers (NTBs) to protect domestic industries from

foreign competition. Both tariffs and NTBs are seen as major reasons for import under-invoicing. Pakistan has also offered many incentives to promote export-oriented industrialization. While these incentives have helped the country maintain a reasonable rate of export growth, many exporters have also manipulated them to their advantage by engaging in unfair and illegal practices. Such practices cause not only financial losses to the exchequer, but also undermine the very objective of these policies. Consequently, exporters who do not engage in such malpractices are subject to large losses because their bargaining position in the market tends to weaken (Mahmood & Mahmood, 1993).

The rationale for conducting this study is to focus on those areas of trade misinvoicing in Pakistan that the literature does not address. For example, there has been no research on the issue of import over-invoicing and export under-invoicing in Pakistan with respect to commodities and trading partners. Moreover, there is little fresh research on the other two components of trade misinvoicing – import under-invoicing and export over- invoicing. The studies available date back to 1993 and 2001.

Mahmood and Mahmood (1993) and Mahmood and Azhar (2001) incorporate six and thirteen trading partners and limit their estimations to two and three years, respectively. This underestimates the actual size of trade misinvoicing. Our purpose, however, is to determine the key misinvoiced traded commodities for major trading partners with whom the largest extent of trade misinvoicing occurs. Moreover, we take into account the period since 1972.

No other study for Pakistan estimates the revenue loss incurred through trade misinvoicing due to evasion of customs duties and withholding tax at the export stage. This study is the first to estimate the average loss in revenue due to trade misinvoicing, using the methodology applied by Baker et al. (2014). Using a simple economic framework, we develop and estimate a robust least squares model to determine which factors affect the extent of trade misinvoicing in Pakistan.

The paper is divided into six sections. Section 2 reviews the existing literature. Section 3 discusses the methodology used to estimate misinvoicing and the resulting revenue loss. The results are interpreted and discussed in Section 4. Section 5 outlines the major determinants of trade misinvoicing. Section 6 concludes the paper and draws out policy measures that could help eradicate trade misinvoicing in Pakistan.

2. Literature Review

Bhagwati and Hansen's (1973) framework assumes that both legal and illicit trade are carried out at the same market price prevailing in the world. Illicit traders try to avoid tariffs and thus face a less favorable transformation rate because of the costs associated with misinvoicing. If the cost of misinvoicing is equal to the tariff rate, then both kinds of trade can coexist. However, if they are not equal, then each firm must trade legally or illicitly. Illegal trade reduces the revenues obtained from taxes without enhancing efficiency. The authors conclude that illicit trade does not have a positive impact on welfare.

De Boyrie, Nelson and Pak (2007) discuss trade misinvoicing from Africa to the US between 2000 and 2005. Their results suggest that misinvoicing has increased by around 60 percent because low export prices facilitate tax evasion and money laundering. Imports with higher prices enable capital flows and can be used to camouflage illicit commissions. The deviation from the average price of exports and imports is used as an indicator of capital outflows. Of the top 30 countries in Africa involved, four (Algeria, Tunisia, Morocco and Egypt) have moved around $6.7 billion via trade misinvoicing. The remaining 26 have moved approximately $13.41 billion. South Africa has moved the most capital to the US via trade misinvoicing.

Ndikumana and Boyce (2008) carry out a panel data estimation of 40 African countries to determine the magnitude of trade misinvoicing from sub-Saharan Africa during 1970–2004. They employ robust OLS, fixed effects and instrumental variables to estimate the results. The estimated value of capital flight through over-invoiced imports is $420 million. When the imputed interest is added to this, the misinvoiced stock for these 40 countries increases to $607 billion for 2004.

Berger and Nitsch (2012) study the relationship between trade misinvoicing and corruption from 2002 to 2006 for the top five importers of the world: the US, Germany, China, the UK and Japan. They analyze trade statistics at the 4-digit level using the c.i.f. and f.o.b. methodology. Based on data from UN Comtrade and the IMF Direction of Trade Statistics, they find discrepancies in the figures for recorded exports by the partner countries. They conclude that trade misinvoicing by the partner countries increases with the level of corruption.

Baker et al. (2014) study trade misinvoicing in five African countries for the period 2002 to 2011. Using UN Comtrade data, they apply Bhagwati's methodology and estimate that Tanzania experienced the highest volume of illicit flows ($1.87 billion). Kenya follows with $1.51 billion in average annual illicit trade flows while Ghana accounts for $1.44 billion annually. Uganda and Mozambique rank lower with $884 million and $585 million in annual average illicit trade flows.

The authors also estimate the loss of revenue in the form of tariff revenues and domestic taxes for each country due to trade misinvoicing. Their results indicate that, on average per year, Ghana lost $386 million, Kenya $435 million, Mozambique $187 million, Tanzania $248 million and Uganda $243 million during 2002–11. In each case, these losses represent resources the government was unable to capture and invest in development projects in education, infrastructure or healthcare. The opportunity foregone in providing these public goods is a symbol of the tangible harm caused by illicit financial flows in developing countries.

Fisman and Wei (2007) look at the export of cultural goods and antiques from Egypt to the US from 1996 to 2005. Using the c.i.f. and f.o.b. methodology, they find evidence of substantial illicit trade in cultural and antique goods between these countries. A key finding is that the level of export under-invoicing is highly correlated with the level of corruption in the exporting county.

Yalta and Demir (2010) survey Turkey's exports to its major trading partners to examine the extent of trade misinvoicing for the period 1970–2007. They find that exports are under-invoiced while imports from China are over-invoiced. They also analyze the effect of customs unions and trade liberalization policies on trade misinvoicing and conclude that liberalization policies have a negative effect on import misinvoicing at the aggregate level.

Jha and Nguyen (2014) look at India's trade with 17 major trading partners over the period 1988–2012, using Bhagwati's methodology of comparing c.i.f. and f.o.b. values after taking into account an adjustment factor of 1.1. They find that trade misinvoicing from India has increased since 2004 and peaked between 2007 and 2012. The illicit trade flow in 2008 alone was worth $40 billion and the total illicit outflow over the 14 years exceeded $186 billion.

The first study to investigate import under-invoicing in Pakistan was conducted by Sheikh (1974) for the period 1965 to 1968. Using the partner-country comparison technique, Sheikh samples 36 different products and the partner countries that supplied over 80 percent of Pakistan's imports at the time. He then divides these commodities into two broad groups – restricted and liberal – based on a careful examination of the incidence of import licensing. The results show that, for goods in the restricted category, there is a very robust tendency for Pakistani import values to fall considerably below the partner country's export figures, representing import under-invoicing for each of the four years considered. The author also institutes a relationship between under-invoicing and the categorization of a commodity as high-tariff or low-tariff, where the former is more prone to under-invoicing.

Mahmood and Mahmood (1993) estimate the volume of import under-invoicing in Pakistan from 1981 to 1988 for a sample of partner countries that include France, Germany, Italy, the UK, the Netherlands and Japan (about 40 percent of Pakistan's total imports came from these countries at the time). They find that large-scale under-invoicing occurs in chemicals, machinery, manufactured goods and transport equipment. Moreover, the commodities that are under-invoiced have significantly high duties, from 40 percent on rubber to 450 percent on automobiles.

Mahmood (1997) examines the major determinants of import under-invoicing in Pakistan for the period 1981–88 by pooling data for 96 goods and imports from six developed countries. He tests the impact of import taxes and nontariff restrictions on imports: import taxes emerge as the most significant variable with a positive correlation with import under-invoicing, while nontariff restrictions are insignificant.

Mahmood and Azhar (2001) study export over-invoicing between Pakistan and 13 major developed trading partners over the period 1984–94. At the aggregate level, exporters over-invoiced exports to the tune of US$2.4 billion over 10 years. Mahmood (2013) is the most recent work on reverse capital flight in Pakistan. He finds that the value of reverse capital flight from 1972 to 2013 is about $30 billion. The paper does not, however, estimate misinvoicing by commodity and country.

In sum, the problem of trade misinvoicing prevails mostly in developing countries. Industrialized countries have largely curtailed the problem. China and India account for the largest volume of misinvoicing in Asia, while most African and Middle Eastern countries also face this issue.

3. Empirical Model

This study uses two different methodologies to estimate trade misinvoicing and the loss of revenue, respectively. The c.i.f. and f.o.b. methodology estimates the extent of misinvoicing in exports and imports, using the UN Commodity Trade Statistics database. We use the Standard International Trade Classification (SITC) Revision 3 commodity codes to compare the exports of the reporting country with the imports of the partner country and vice versa.

The study incorporates 52 major traded commodities and 21 developed trading partners for the period 1972–2013 (see Tables A1 and A2 in the Appendix).[1] In total, more than 45,000 trade entries were reviewed to identify the volume of trade misinvoicing. The methodology for calculating revenue loss is taken from Baker et al. (2014), who have used it to estimate revenue losses from trade misinvoicing in Africa.

What is important to mention is that the UN Comtrade dataset has missing trade values for multiple goods across various years. If we were to compute the model without adjusting the data for both the reporting and partner country, this would generate statistical discrepancies that have nothing to do with misinvoicing. For example, if Pakistan reports steel exports for 2013 but its partner country, the US, does not, then the software will identify all steel exports as over-invoiced exports from Pakistan, leading to a huge discrepancy. To handle this loophole, we have explicitly deleted all such missing values on both sides to avoid any artificial discrepancies among the 45,000 trade entries reviewed.

3.1. C.i.f. and f.o.b. Methodology

Trade misinvoicing can take the form of import and export under-invoicing or over-invoicing. Naturally, the stated exports from country A to country B (after incorporating the cost of insurance and shipping or c.i.f.) should be equal to the observed imports of country B from country A. Using the IMF criteria, we adjust the c.i.f. value by a factor of 1.1, which represents the cost of insurance and shipping and makes the c.i.f. equivalent to the f.o.b.

$MI = MI_{.X} + MI_{.M}$ = misinvoicing in total trade.

[1] Pakistan's trading partners include Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, New Zealand, Portugal, the Republic of Korea, Singapore, Spain, Switzerland, Taiwan, the UK and the US.

$MI_X = M_{.icp} - X_{.pic} * ad$ = misinvoicing of exports.

$MI_X < 0$ indicates export over-invoicing in Pakistan.

$MI_X > 0$ indicates export under-invoicing in Pakistan.

$MI_M = M_{.pic} - X_{.icp} * ad$ = misinvoicing of imports.

$MI_M > 0$ indicates import over-invoicing in the country.

$MI_M < 0$ indicates import under-invoicing in the country.

where $M_{.icp}$ = imports of industrial countries from Pakistan (c.i.f.), $X_{.pic}$ = Pakistan's exports to industrial countries (f.o.b.), $M_{.pic}$ = Pakistan's imports from industrial countries (c.i.f.), $X_{.icp}$ = exports of industrial countries to Pakistan (f.o.b.) and *ad* = adjustment factor defined as c.i.f. – f.o.b. ratio.

3.2. Estimating Loss of Revenue

To estimate the loss of revenue incurred by the government in the form of potential customs tariffs and export withholding tax, the following methodology is used. The net revenue lost through import misinvoicing is:

Uim per year x (average tariff rate of commodity + average sales tax)/100 – *Oim* per year x (average tariff rate of commodity + average sales tax)/100

The net revenue lost through export misinvoicing is:

Ux per year x withholding tax on export proceeds/100 – *Ox* per year x withholding tax on export proceeds/100

where *Uim* = import under-invoicing, *Oim* = import over-invoicing, *Ux* = export under-invoicing and *Ox* = export over-invoicing.

4. Results and Interpretation

This section presents the results obtained for the volume of trade misinvoicing and revenue losses.

4.1. Trade Misinvoicing

The trade misinvoicing estimates are discussed in relation to policy.

4.1.1. Trade Misinvoicing, by Commodity

Table 1 provides the estimated total trade misinvoicing divided into its two main categories. The total misinvoicing for 1972–2013 is estimated at $92.7 billion. This substantial figure shows the extent to which trade misinvoicing has occurred over the last 41 years with developed economies alone. The figure does not take account of trade misinvoicing in relation to developing trading partners and minor traded commodities. Hence, to that extent, the reported figures are underestimated. The average annual trade misinvoicing that took place in Pakistan is about $2.25 billion.

Table 1: Total volume of trade misinvoicing

US$ billion

	Misinvoicing (1972–2013)		**Average annual misinvoicing**	
	Imports	**Exports**	**Imports**	**Exports**
Under-invoicing	30.20	18.04	0.73	0.40
Over-invoicing	15.60	28.90	0.38	0.70
Total	45.80	46.90	1.10	1.14

Source: Authors' estimates.

Export misinvoicing accounts for the largest share of total trade misinvoicing. The estimates show that export misinvoicing is higher than import misinvoicing, even though fewer commodities are taken into account for export misinvoicing than for import misinvoicing. This implies that tariff evasion is not traders' foremost objective: trade misinvoicing is conducted mainly for the purposes of capital flight and reverse capital flight, to earn black market premiums and to gain export subsidies.

A primary reason for this finding is that Pakistan has curtailed its tariffs significantly in the last two decades. Ad valorem rates were reduced from a peak of 350 percent in the 1970s to 90 percent in the early 1990s and then to 56 percent in 1995. The current average tariff is 9.9 percent. Thus, high import duties are not the only incentive for importers to misinvoice. On the other hand, exporters have benefited from various export subsidies, including duty drawback schemes in the 1970s and 1980s, and still enjoy the reimbursement of sales tax and federal excise duties on imported raw material and concessional export refinancing when claiming a higher volume of exports.

Due to various economic and political factors, capital flight and reverse capital flight have always been key issues in Pakistan. Trade

misinvoicing remains one of the main avenues for illegal capital flight. The highest share of import misinvoicing is that of under-invoicing in the sample period (Table 1). Import under-invoicing also has the highest share of total trade misinvoicing. Table 1 shows that the larger component of export misinvoicing is over-invoicing, which is almost twice as high as export under-invoicing. This implies that the most common reasons for export misinvoicing are reverse capital flight and availing export subsidies and tax credits from the government.

These export subsidies include export refinance schemes run by the State Bank of Pakistan in which exporters reporting a certain level of annual exports are provided credit at an interest rate that is 1–1.5 percent lower than the benchmark rate. Tax credits are availed by exporters in the form of the reimbursement of sales tax paid on imported raw materials used to produce finished goods in Pakistan. Since no export duty is currently applicable on exports from Pakistan, export over-invoicing has become lucrative for exporters.

Table 2 lists the commodities with the highest level of misinvoicing in each category. Electrical machinery ranks highest in the import under-invoicing category. The customs tariff on electrical machinery was, on average, 75 percent from the 1970s to the 1990s and dropped to 25 percent in the 2000s. Given the high customs duty levied on it earlier and as the second largest import in Pakistan after oil, importers find it beneficial to under-invoice electrical machinery.

Table 2: Highest misinvoicing, by commodity, 1972–2013

Type of misinvoicing	Commodity	Value
Highest under-invoicing in imports	Electrical machinery	US$6.10 billion
Highest over-invoicing in imports	Iron and steel	US$1.20 billion
Highest under-invoicing in exports	Linen	US$2.59 billion
Highest over-invoicing in exports	Undergarments	US$4.90 billion

Source: Authors' estimates.

Iron and steel are found to be the most over-invoiced import in the sample period. Import over-invoicing is also used widely to lower the taxable portion of profit. For example, with a current corporate tax rate of 35 percent and assuming an import duty rate of 25 percent on a specific item, it would still make sense to pay the higher import duty through import over-invoicing because the company would then pay lower taxes owing to the higher import costs that eat into its declared profit. In

Pakistan, as in most other developing countries, trade taxes have fallen with trade-based globalization while corporate taxes remain high because the government needs to make up the revenue shortfall through an increase in direct taxes. Under the circumstances, import over-invoicing continues to be a lucrative way of shifting profits.

Overall, linen is found to be the most under-invoiced export. The textiles sector contributes the largest share to Pakistan's exports. Exporters of linen fabric are less interested in availing export subsidies than in capital flight primarily because the linen industry, which dominates the textiles export sector, accounts for more than $3 billion in exports annually. In availing export subsidies tied to performance requirements, linen exporters do not over-invoice their exports to avail subsidies, but under-invoice exports instead.

Apart from the direct benefits of enabling capital flight and a lower withholding tax on exports, export under-invoicing also decreases declared export revenues. This lowers declared corporate profits and, therefore, taxable profits for the company. Thus, there are two components: the exporter benefits from a lower withholding tax at the export stage and then from a lower corporate tax on gross profits. From the national economy's point of view, the capital shifted abroad through under-invoicing is greater than the taxable portion of the amount shifted. Additionally, Pakistan incurs a foreign exchange loss when its reserves are already low.

Undergarments are the most over-invoiced export. There are no hindrances to over-invoicing these exports as exporters pay a paltry 1 percent tax on export proceeds. On the contrary, the benefits gained from export subsidies or the black market premium exceed the losses incurred in paying higher export taxes.

The top ten commodities under-invoiced and over-invoiced during the sample period are shown in Figures 1–4. The percentages show the ratio of misinvoicing to total imports or exports in that commodity, while the bar chart values depict misinvoicing in absolute terms.

Figure 1 shows that electrical machinery is the highest under-invoiced import. However, as a share of total imports, automobile parts are the highest under-invoiced commodity for this period. These are imported mainly from Japan and bear an average tariff of 50 percent. Similarly, in absolute terms, vehicles are the second most under-invoiced import mainly because the average tariff on vehicles is about 175 percent. Vehicles and

their parts remain a major source of revenue for the government in the form of a high customs tariff, which has reached up to 250 percent in the past, inducing importers to under-invoice.

Figure 1: Top ten imports under-invoiced, 1972–2013

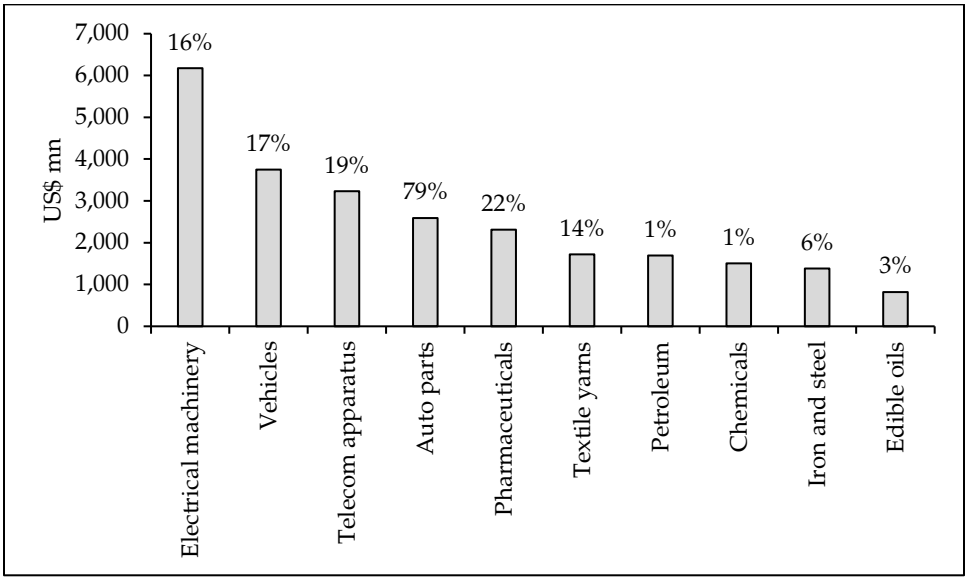


Figure 2 shows that the highest over-invoiced import as a share of total imports is motorcycles and their parts. These bear an average customs tariff of 95 percent, which makes them expensive for importers to over-invoice. Vehicles are the second most over-invoiced import in absolute terms and have very high tariff rate. These findings suggest that tariff structure is not a major deterrent to, or reason for, import over-invoicing and under-invoicing. Thus, importers under-invoice and over-invoice for other reasons such as capital flight and reverse capital flight.

Black money holders transfer their capital out of Pakistan using the services of major importers of vehicles and motorcycles in return for a service fee. Our findings show that money launderers do not mind paying high duties when over-invoicing these items because those who transfer their black money abroad pay the additional customs duties out of the black money. Such high costs are bearable so long as the aim of capital flight is achieved.

Figure 3 shows that the highest over-invoiced export as a share of total exports is bags and blankets at 450 percent over the sample period.

This extent of over-invoicing is an outlier compared to the other estimates. The total exports of bags and blankets in 2013 were $57 million.

Figure 2: Top ten imports over-invoiced, 1972–2013

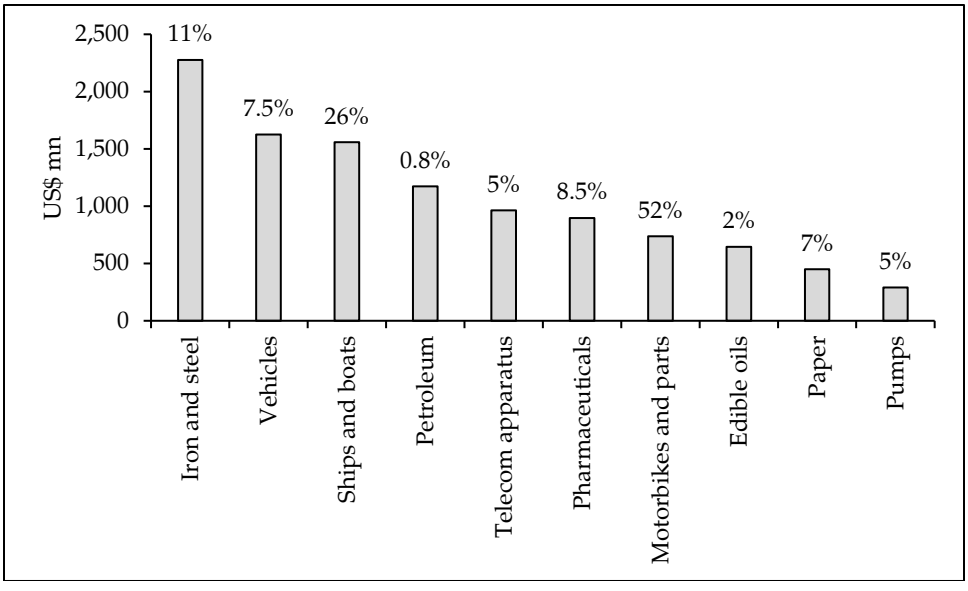
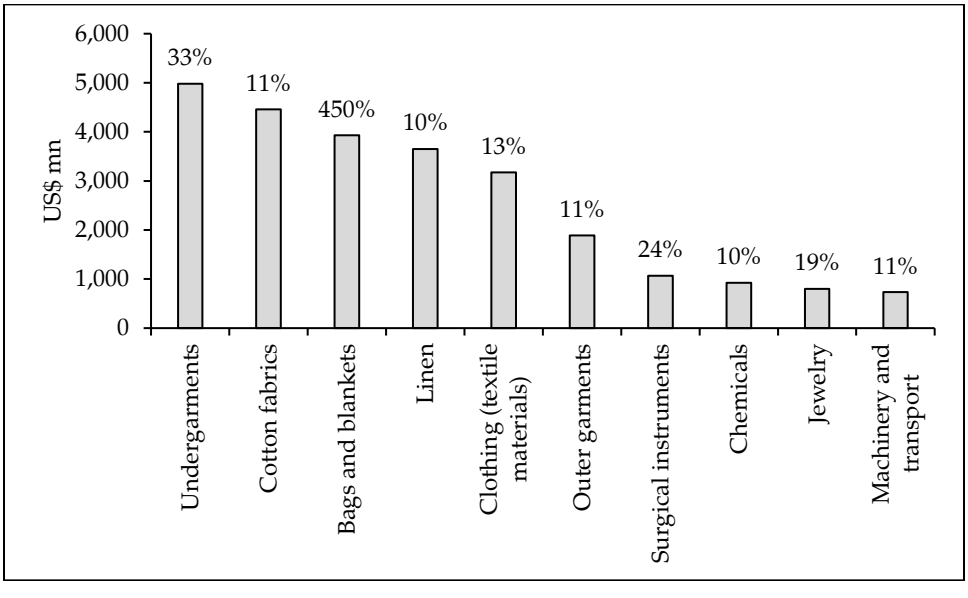


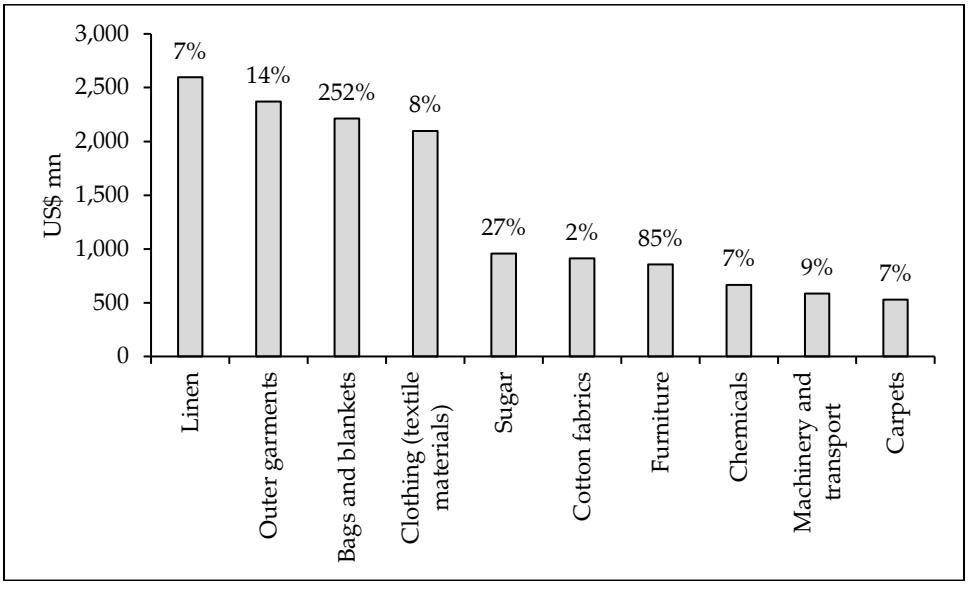
Figure 3: Top ten exports over-invoiced, 1972–2013



This implies that, to avail export subsidies such as export refinance schemes that are tied to performance, exporters of bags and blankets greatly over-invoice their exports. It could be argued that the industry's actual performance is worse than its reported performance and that it is the largest beneficiary of export subsidies in Pakistan. Reverse capital flight may be another reason for such high levels of export over-invoicing.

Figure 4 shows that bags and blankets are the most under-invoiced export, with 252 percent of total exports in this sector being under-invoiced during the sample period. Again, this leads to the earlier argument that the same industry is subject to both kinds of misinvoicing, as in the case of vehicle imports.

Figure 4: Top ten exports under-invoiced, 1972–2013



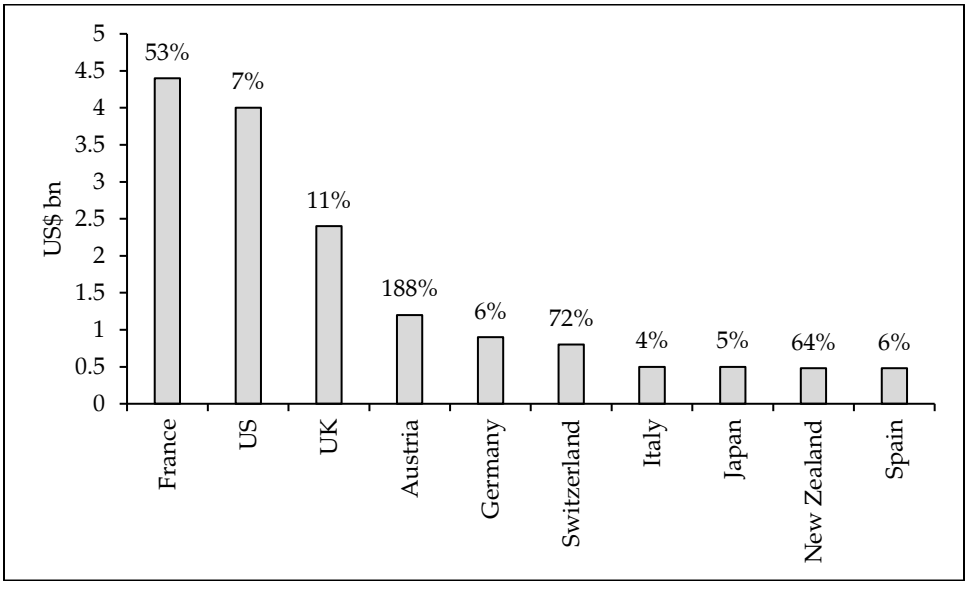
The bags and blankets industry not only enjoys export subsidies from the government through over-invoicing, but also transfers capital by severely under-invoicing its goods. Some manufacturers may be linked to those seeking to transfer their capital aboard, while others illegally avail export subsidies. The EU is the largest importer of bags and blankets from Pakistan and the analysis shows that Pakistani capital and black money holders tend to transfer their capital to Europe.

4.1.2. Trade Misinvoicing, by Trading Partner

Having estimated trade misinvoicing with respect to commodity, we repeat the analysis with respect to country. For each component of trade misinvoicing, the top ten countries associated with the highest misinvoicing in terms of absolute numbers and the ratio of total imports and exports are shown in Figures 5–8.

Figure 5 shows that France is the most popular destination for over-invoiced exports as a share of total exports as well as for the illicit transfer of funds. We can argue that, once this capital reaches France, it is transferred to tax havens such as Switzerland, where banks are well known for holding billions of dollars in illicit deposits. Moreover, France and other EU countries are major importers of Pakistani linen and garments, with 27 percent of linen imports in the EU originating in Pakistan. The large extent of over-invoicing in linen and outer garments is evidence that countries such as France, the UK, Germany and Austria are major destinations for over-invoiced textile items.

Figure 5: Top ten destinations for under-invoiced exports, 1972–2013

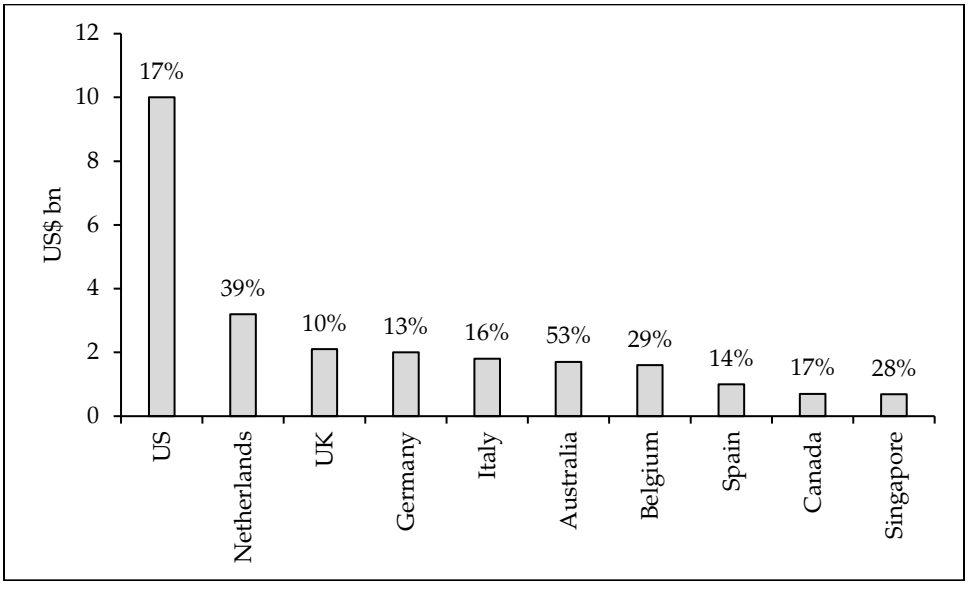


The US, on the other hand, ranks highest as a destination for under-invoiced items in absolute terms. This may be because it is a major trading partner, accounting for $3.6 billion in exports from Pakistan in 2013. Furthermore, Pakistan exports a substantial volume of linen and outer

garments to the US. This supports the estimate that shows outer garments and linen as being among the highest under-invoiced commodities.

Figure 6 shows the top destinations for under-invoiced exports for the sample period. Once again, the US ranks first in absolute terms. This finding echoes Mahmood (2013), who argues that people bring back their money to Pakistan when they deem that the sociopolitical environment is favorable. Thus, the large amount of capital that is transferred to the US in hard times is returned home in favorable times.

Figure 6: Top 10 destinations for over-invoiced exports, 1972–2013



Australia is the top destination in terms of misinvoicing as a share of total exports. Pakistan's major exports to Australia are bed linen and rice. The results show that rice is Pakistan's 17th most over-invoiced export, implying that a large volume of over-invoicing occurs in its rice exports to Australia. Cotton fabrics and outer garments, which are also among the top exports to Australia, are among the most over-invoiced commodities.

Figure 7 shows the top ten destinations for under-invoiced imports. The highest import under-invoicing as well as import over-invoicing recorded is with respect to Japan. The results show that vehicles and parts and motorcycles and parts are the most under-invoiced and over-invoiced imports, respectively (Figures 7 and 8). Japan is the largest exporter of

these goods to Pakistan, justifying its position as the top destination for misinvoicing in absolute numbers. However, Taiwan ranks first in terms of the ratio of misinvoicing to total imports at 188 percent. Textile yarn is the most under-invoiced import from Taiwan.

Figure 7: Top 10 destinations for under-invoiced imports, 1972–2013

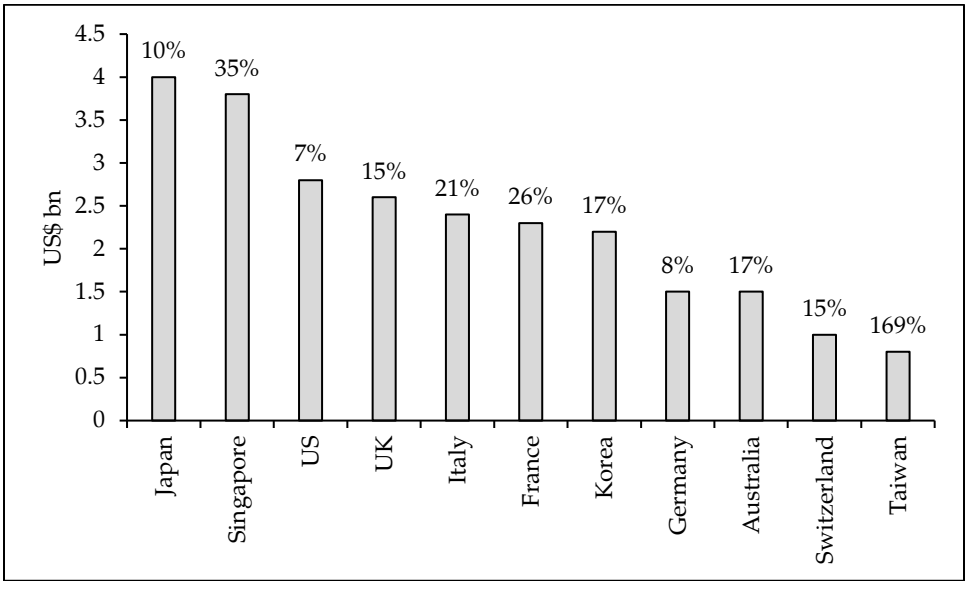
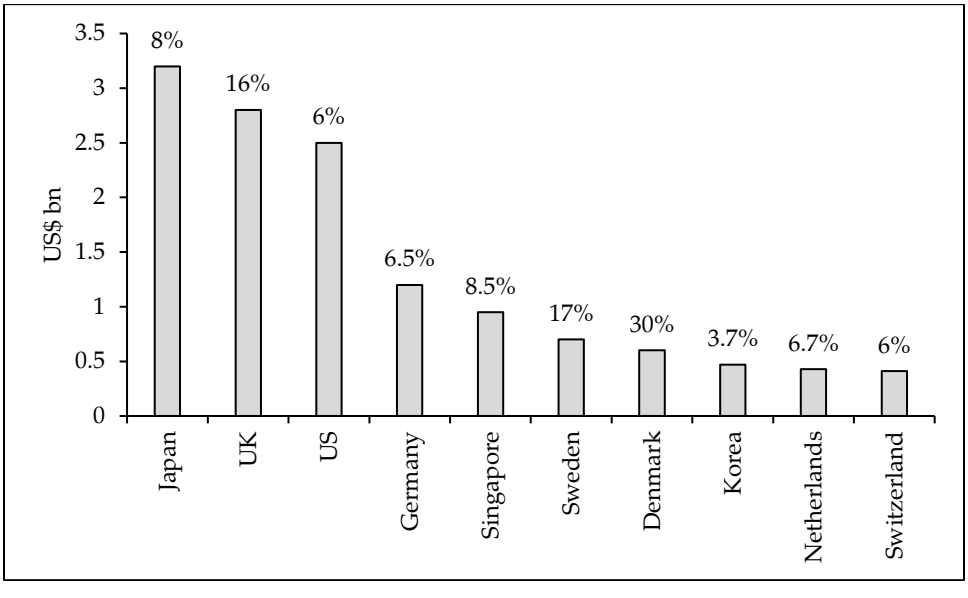


Figure 8: Top 10 destinations for over-invoiced imports, 1972–2013



4.2. Gross Revenue Losses

Table 3 reports the losses incurred by the national exchequer due to import under-invoicing in the form of lost customs duties. This amounts to an estimated $21.2 billion in revenue lost during 1972–2013 and an average annual revenue loss of $0.5 billion. The gross revenue losses due to export under-invoicing are the potential revenues that could have been obtained from withholding tax on export proceeds had those exports not been under-invoiced. The total revenue loss is estimated at $0.18 billion, with an annual average of $4.4 million.

Table 3: Gross and net revenue loss, 1972–2013

US$ billion

	Losses due to under-invoicing of		Gains due to over-invoicing of		Net revenue loss
	Imports (A)	**Exports (B)**	**Imports (C)**	**Exports (D)**	**(A + B) – (C + D)**
Total	21.2	0.1800	10.40	0.29	11.00
Average annual	0.5	0.0044	0.26	0.01	0.26

Source: Authors' estimates.

4.2.1. Gross Revenue Gains

The sum of gross revenue gains to the national exchequer due to import over-invoicing in the form of customs duties is $10.4 billion for the sample period, while the annual average gain is estimated at $0.26 billion (Table 3). The revenue gains from export over-invoicing occur in the form of the 1 percent withholding tax that is received on almost all export proceeds in Pakistan. The total revenue gain accounted was $0.29 billion in the sample period, which is very small, given the low to zero direct export taxes levied in Pakistan.

4.2.2. Net Revenue Loss

The net revenue loss is the sum obtained after subtracting gross revenue losses from gross revenue gains. The total net revenue loss to the national exchequer incurred in the form of potential customs duties and export withholding tax is estimated at $11 billion (Table 3), while the average annual net revenue loss is estimated at $0.26 billion. It is pertinent to mention here that the total tax collected by the Federal Board of Revenue through custom duties was PRs241 billion in 2013/14. The average annual net revenue loss estimated by this study is $0.26 billion or PRs27 billion,

which is about 11.2 percent of the total tax collected through customs duties. It is also important to note that we have estimated this loss by incorporating only Pakistan's developed trading partners. If the losses incurred through trade with developing trading partners were also incorporated, this would greatly inflate the net revenue loss.

5. Factors Influencing Trade Misinvoicing

Having established the prevalence of misinvoicing in Pakistan's trade sector, it is also imperative to understand which factors have, over time, deterred or induced trade misinvoicing. Taking economic theory into consideration, we generate the following four econometric models (see Table A3 in the Appendix for an explanation of variables and data sources).

The models take into account the trade conducted with the same 21 trading partners. Since this is not a commodity-specific regression analysis, the data encompasses all imports and exports for the period 1980–2013. Hence, more data is available for analysis. We apply the robust least squares method because its estimates are corrected for serial correlation and heteroskedasticity.

Model 1 is written as:

$$U_x = \alpha + \beta_1 interest_t + \beta_2 polity_t + \beta_3 CAB_{t-1} + \beta_4 CAO_t + \beta_5 TL_t + \beta_6 REER_t + \epsilon_t$$

Model 2 is written as:

$$U_{im} = \alpha + \beta_1 interest_t + \beta_2 tariff_t + \beta_3 polity_t + \beta_4 CAB_{t-1} + \beta_5 CAO_t + \beta_6 TL_t + \beta_7 REER_t + \epsilon_t$$

UN Comtrade lacks data for the year 1994 for Pakistan and so, is not included in the regression. Trade data for Taiwan is available only from 1989 onwards, for Germany from 1991 onwards and for Belgium from 1999 and onwards.

Model 3 is written as:

$$O_x = \alpha + \beta_1 interest_t + \beta_2 polity_t + \beta_3 CAB_{t-1} + \beta_4 CAO_t + \beta_5 TL_t + \beta_6 REER_t + \epsilon_t$$

Model 4 is written as:

$$O_{im} = \alpha + \beta_1 interest_t + \beta_2 tariff_t + \beta_3 polity_t + \beta_4 CAB_{t-1} + \beta_5 CAO_t + \beta_6 TL_t + \beta_7 REER_t + \epsilon_t$$

All the variables are taken in period t except for the current account balance (CAB), the lagged value of which is added as a regressor. The CAB suffers from the problem of endogeneity in the form of reverse causality. Although it is a determinant of misinvoicing, a large enough figure for over-invoiced exports will inflate the CAB while a high value for import over-invoicing will enhance the current account deficit. To deal with the issue of reverse causality, we take the lagged value of the CAB – $CAB(-1)$ – as an explanatory variable because trade misinvoicing in period t cannot inflate or deflate the CAB in period $t - 1$ However, the CAB in period $t - 1$ can affect the extent of misinvoicing in period t.

The first and third models do not include the tariff rate because it bears no direct relation to exports. In the model for export under-invoicing, the two main aims of the agent are assumed to be either flight of capital or to pay less withholding tax and corporate tax liable on the profits of the company (by under-invoicing exports, the value of total revenue and net profit declines). Table 4 gives the results for all four models.

Table 4: Robust least squares estimates

	Dependent variables (in US$ mn)			
Independent variables	**Under-invoicing of exports**	**Over-invoicing of imports**	**Over-invoicing of exports**	**Under-invoicing of imports**
Tariff	–	-8.29	–	69.34
		(-2.32)***		(5.54)***
Interest	0.84	16.72	-25.50	126.67
	(0.83)	(1.75)*	(1.59)	(3.80)***
Polity	-0.54	-13.60	1.54	-24.96
	(-0.20)	(-3.20)***	(0.22)	(-1.71)*
CAB (–1)	15.04	-26.89	-18.76	34.96
	(2.66)***	(-3.08)***	(-1.27)	(1.14)
CAO	12.89	-126.50	13.85	462.43
	(0.11)	(-0.73)	(0.04)	(0.70)
TL	6.74	15.50	-28.00	-47.14
	(1.30)	(2.11)**	(-2.20)**	(1.83)*
REER	-0.30	0.48	2.70	-17.69
	(-0.81)	(0.30)	(2.48)***	(-3.57)***

Note: z-stats in parentheses. * = significant at 10%, ** = significant at 5%, *** = significant at 1%.
Source: Authors' estimates.

In the case of import over-invoicing, agents' primary aim is to enable capital flight or claim higher-than-actual duty drawbacks. Exports are over-invoiced to retrieve capital from abroad or to claim higher benefits from export finance schemes. Finally, import under-invoicing occurs mainly to pay smaller customs tariffs on imports and is also a tool enabling reverse capital flight.

The tariff rate variable is highly significant and positively associated with import under-invoicing. As shown in Table 4, a 1 percent increase in the tariff increases import under-invoicing by $69 million on average. This result bolsters the argument that higher customs duties are the primary reason for import under-invoicing. This result is in line with Mahmood (1997) and Patnaik, Gupta and Shah (2010), who also find the tariff rate to be highly and positively associated with import under-invoicing in Pakistan and other developing countries.

The coefficient of import over-invoicing is negative and significant, suggesting that a 1 percent increase in the customs tariff decreases import over-invoicing by $8.29 million on average. This shows that customs tariffs can deter agents from sending their capital abroad. Agents will pay the higher duty so long as the benefit accruing from capital flight outweighs the associated cost (Bhagwati, 1973).

The interest rate is insignificant with respect to exports, showing that exporters are less concerned about the domestic interest rate even though Pakistan has sustained higher interest rates than the international market, averaging 10.7 percent over the last three decades. The interest rate has a positive and significant coefficient with respect to import over-invoicing and under-invoicing. The positive sign associated with import under-invoicing suggests that, when the domestic interest rate increases, agents retrieve their capital from abroad and deposit it in the domestic economy for higher gains. The positive sign associated with import over-invoicing suggests that a higher interest rate is a sign of high inflation, which leads to the depreciation of the local currency. In fear of expected depreciation, agents may opt to send their capital abroad, losing the opportunity to earn higher returns on their capital in Pakistan.

The coefficient of political stability is significant and negative with respect to import over-invoicing and under-invoicing. This suggests that import misinvoicing falls in periods of political stability. The proxy for political stability used in this model is the existence of a democratic regime in the country. We can argue that, under a democratic government,

customs laws are strictly enforced, leading to a decline in import misinvoicing. The negative sign of the import over-invoicing variable reflects Mahmood (2013) and Jha and Nguyen (2014), who argue that political instability causes capital flight.

The lagged CAB is significant with respect to export under-invoicing and import over-invoicing. An increase in the CAB of 1 percent of GDP in the previous year leads import over-invoicing to fall by $26 million in the current year. Improvements in the current account reduce the flight of capital as expectations of currency devaluation fade with the rising CAB.

A key finding is that capital account openness (CAO) is insignificant in all four models. This does not, however, imply that the capital account balance has no influence in the model. This result is very important as it rejects the intuition that, in a large and open financial sector, agents have the choice of moving their capital through the financial market (see Patnaik et al., 2010; Mahmood, 2013; Berger & Nitsch, 2012). In the case of Pakistan, our results suggest that agents may feel that capital flight is more easily managed through misinvoicing than through the financial market. This may be because regulatory authorities such as the Securities and Exchange Commission of Pakistan conduct checks and balances or because the country's financial sector is not as open as that of other developing countries such as China, India or Turkey.

The literature has two theories as to what happens to misinvoicing when trade is liberalized. Either misinvoicing will increase because a larger tradeable sector offers more opportunities for misinvoicing or it will decrease due to trade-friendly government policies (Kar, 2010). In the case of Pakistan, our results show that both have occurred over time. Trade liberalization is significant and negative in the models for export over-invoicing and import under-invoicing. The government has continued to liberalize the trade sector in Pakistan: tariffs and para-tariffs have fallen significantly over time, quotas are now almost nonexistent and export-oriented policies have been adopted (Mahmood, 2013). As a result, import under-invoicing and export over-invoicing have witnessed a significant decline under liberal trade regimes. The coefficient of import over-invoicing is positively and significantly associated with trade liberalization. This result supports the first notion that a large importable sector, once liberalized, increases opportunities for import over-invoicing.

The real effective exchange rate (REER) is a measure of currency overvaluation or undervaluation. With an increase in REER, an overvalued exchange rate creates expectations of currency devaluation and should induce capital flight. However, the coefficient on REER is insignificant for export under-invoicing and import over-invoicing. In our model of import under-invoicing, the negative and significant sign (less returning capital) can be interpreted to mean that, with a high REER, imports become cheaper for local consumers as their purchasing power is increased. This increases the demand for imports. The corresponding larger volume of imports is linearly associated with higher under-invoicing.

Similarly, the significant and positive sign of export over-invoicing can be explained thus: a higher REER causes the currency to be overvalued and decreases the volume of exports. This leads to a decline in chances to avail export subsidies (the main incentive for over-invoicing exports), which are tied to reported total exports. Therefore, exporters will over-invoice their exports under a high REER so that they can continue to avail export subsidies from the government.

6. Conclusion and Policy Implications

This study shows that Pakistan's trade sector is prone to a high level of misreporting. At the same time, the government incurs large losses in terms of potential customs duties and withholding tax on exports. Trade misinvoicing is not only a major source of capital flight and reverse capital flight, but it also deprives the national exchequer of an amount equal to 11 percent of the total revenue generated through customs duties and export tax. Consequently, trade policies devised in the presence of misinvoicing are bound to be less potent. To make trade policies effective and for the CAB to reflect the true picture, it is imperative that trade misinvoicing be reduced.

To this end, we recommend the following policy measures:

- Discourage export over-invoicing by devising a policy under which all exporters are awarded concessional credit without any discrimination.
- Pakistani customs should require the submission of a verified invoice from the customs of the partner country.
- High tariffs and NTBs encourage misreporting. Therefore, a policy of meaningful trade liberalization needs to be pursued.

- Export rebates should be granted only to achieve export performance targets in nontraditional products. They should not be given under threat or pressure from the industry.
- Introduce proper scrutiny of products subject to the reimbursement of general sales tax and federal excise duty with an updated input–output coefficients system.
- Take punitive action against leading misinvoicers and scrutinize top exports and imports such as linen and undergarments. Scrutinize and enforce strict monitoring for all goods exported to or imported from countries identified as major sources of misinvoicing.

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Appendix

Table A1: List of commodities used to estimate import misinvoicing and average tariffs (percentage)

SITC Rev 3 code	Commodity description	Average tariff
112	Alcoholic beverages	100
111	Non-alcoholic beverages	30
512	Chemicals	30
02	Dairy and eggs	45
411	Animal fats and oils	20
95	Firearms and ammunition	60
7328	Auto parts	50
72	Electrical machinery	30
7118	Engines	25
7329	Motorbikes and parts	95
7192	Pumps	35
735	Ships and boats	25
724	Telecom apparatus	50
732	Vehicles	175
684	Aluminum	50
682	Copper	35
67	Iron and steel	50
664	Glass	40
621	Materials of rubber	25
641	Paper	60
65	Textile yarns, fabric and thread	50
6291	Tyres	40
84	Clothing	75
82	Furniture	75
864	Watches and clocks	50
33	Petroleum products	40
54	Pharmaceuticals goods	25
12	Tobacco	100

Note: A 15 percent sales tax was added to all the commodities for all periods to calculate the loss or gain. Edible oils are not incorporated in the revenue loss methodology because the tariff on edible oils is specific and not ad valorem. Hence, an average tariff based on the invoices of goods cannot be estimated.

Table A2: List of commodities used to estimate export misinvoicing

SITC Rev 3 code	Commodity description
1	Beverages
5	Chemicals
8411	Clothing of textile materials
84144	Outer-garments
84143	Undergarments
03	Fish
05	Fruits and vegetables
01	Rice
075	Spices
06	Sugar
85	Footwear
82	Furniture
897	Jewelry
611	Leather
7	Machinery and transport
54	Pharmaceutical goods
2631	Raw cotton
8944	Sports goods
8617	Surgical goods
656	Bags and blankets
657	Carpets and rugs
652	Cotton fabric
6537	Knitted fabrics
65691	Linen

Table A3: Data sources and justification of variables

Variable	Justification	Source
Import and export misinvoicing	C.i.f. and f.o.b. values used to estimate the difference between reported trade by the partner and the reporting country.	UN Comtrade
Trade liberalization (TL)	A larger tradeable sector offers greater opportunities for agents to misinvoice imports and exports with the aim of moving capital outside the country. Imports + exports/GDP * 100	World Development Indicators
Current account balance (% of GDP) (CAB)	A larger current account deficit increases the chances of local currency devaluation and reduces the incentive to invest in local assets, encouraging investors to acquire assets abroad.	State Bank of Pakistan
Political stability (polity)	High political instability implies that investors prefer to move their capital out of the country, as the government may implement actions that decrease the value of their holdings.	Polity IV dataset. The variable is obtained by taking the difference between the democracy and dictatorship indices. The democratic and politically stable characteristics of a country = 10 points and the authoritarian and less stable characteristics = –10.
Interest rate	A lower domestic interest rate and higher international interest rate induces flight of capital, as investors seek to invest where the interest rate is higher.	State Bank of Pakistan
Customs tariff	Agents seek to under-invoice imports to pay lower customs duties.	Average aggregated annual customs tariff Federal Board of Revenue Annual reviews, Government of Pakistan
Real effective exchange rate (REER)	Ratio of domestic to international prices. An overvalued exchange rate creates expectations of currency devaluation and induces capital flight.	World Development Indicators

Variable	Justification	Source
Capital account openness (CAO)	When countries liberalize their financial markets, local investors can invest in foreign assets legally. The incentive to move capital outside illegally, therefore, diminishes.	Dataset obtained from Chinn and Ito (2006). The Chinn–Ito index ranges from –2.54 to 2.54, where higher values indicate greater financial openness.

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Is the Value Addition in Services and Manufacturing Complementary? Empirical Evidence from SAARC

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Abstract

Most empirical studies on sectoral change provide evidence in favor of the complementarities between manufacturing and services, claiming that both sectors generally grow in parallel. This study investigates the complementarities hypothesis for the SAARC countries, which have dominant services sectors but have not graduated to industrial status. We ask whether the rapid growth and value addition of services presents an opportunity or threat for value addition in manufacturing, when the latter sector is still at a premature stage. Our findings do not validate the complementarities between manufacturing and services overall in the case of the SAARC countries. However, there appear to be potential complementarities once services is interacted with trade variables.

Keywords: Manufacturing sector, services sector, economic growth, SAARC.

JEL classification: N65, O14, O47.

1. Introduction

Rostow's (1960) last stage of economic growth[1] is characterized by high mass consumption and a dominant services sector. However, most developing countries feature a dominant services sector despite being far removed from the high mass consumption stage. The literature on structural change tends to explain this phenomenon in terms of the

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[1] The first stage indicates a traditional society and agricultural economy. In the second stage, the economy moves toward infrastructure development and specialization. In the third stage, industrialization increases with workers switching from agriculture to manufacturing. The fourth stage enables maturity and diversification: technological innovations provide diverse investment opportunities, the economy produces a wide range of goods and services, and there is less reliance on imports. In the fifth stage, the economy is geared toward mass consumption: consumer durable industries flourish and the services sector becomes increasingly dominant.

complementary role of services in manufacturing value addition and growth, implying that the efficiency of both sectors moves in the same direction. These studies take into account the forward and backward linkages between the sectors. For instance, Blyde and Sinyavskaya (2007) argue that an increase in export manufacturing is strongly linked to the efficiency of the services sector, such that a 10 percent increase in services trading will create a 6 percent increase in commodities trading.

Similarly, Zott and Amit (2010) show that a larger services sector improves value addition in manufacturing: it enables manufacturing firms engaged with the services sector to provide information to producers on market needs. This enlarges the scope of production, resulting in value addition and increasing sales and revenues in manufacturing. Agrawal, Ferguson, Toktay and Thomas (2012) argue that the integration of manufacturing and services strengthens value addition in the production chain. Miroudot, Sauvage and Shepherd (2013) hold that a well-equipped, advanced services sector can fuel growth in other sectors through input and output linkages.

Numerous other studies have looked at sectoral interdependencies in explaining the complementarity between growth and value addition in services and manufacturing.[2] Their central argument is that integration between the two sectors enhances knowledge creation and, therefore, product development and engineering, thereby adding value to the manufacturing sector. However, this study questions whether the same interdependency applies in the case of the South Asian Association for Regional Cooperation (SAARC) bloc, where the services sector has grown rapidly and before the manufacturing sector could mature. We ask if this presents an opportunity or a threat to value addition in manufacturing.

The SAARC countries are very similar with respect to their age as independent economies. They have a common history and social structures, and many of the same economic fundamentals. In recent decades, indicators have pointed to the services sector as the driver of economic growth in most SAARC countries, accounting for about 55 percent of their GDP on average (World Bank, 2012). The employment share of the services sector increased from 20 percent in the 1970s to 45 percent in 2002 (World Bank, 2012). This is also associated with the region's weak industrial base: in the two major SAARC economies, India and

[2] See, for example, Dasgupta and Singh (2005); Cassiman and Veugelers (2006); Pradhan (2003); Porter and Siggelkow (2008); Fink and Molinuevo (2008); Novak and Stern (2009); Arnold, Hoeller, Morgan and Wörgötter (2009).

Pakistan, the contribution of the industrial sector to GDP and employment is still below the world average.

The rapid growth of services long before the manufacturing sector has had a chance to mature has created economic growth pitfalls for the SAARC economies. We test the hypothesis that, in this region, value addition in the services sector has crowded out value addition in manufacturing. The rest of the study is organized as follows. Sections 2 and 3 present our empirical model, datasets, sample and estimation technique. Section 4 examines the empirical findings and carries out robustness checks. Section 5 concludes the study.

2. Empirical Model

We estimate the following baseline model, which draws on Chang, Kaltani and Loayza (2009); Musonera (2007); and Borensztein, De Gregorio and Lee (1998):

$$VAM_{it} = \beta_0 + \beta_1 VAS_{it} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

where VAM_{it} is the dependent variable, manufacturing value-added. On the right-hand side, VAS_{it} denotes services value-added, the variable of interest. Manufacturing value-added is the net output of the sector (the sum of all outputs less intermediate inputs) and comprises the value added in mining, large-scale construction, electricity, water and gas. Similarly, services value-added is the sum of all outputs less intermediate inputs. This incorporates the value added in wholesale and retail (including hotels and restaurants), transport, government services, financial and professional services, and personal services (education, healthcare and real estate).

Both manufacturing value-added and services value-added are measured as a percentage of GDP (see World Intellectual Property Organization, 2000; Bosworth & Collins, 2008; Ilyas, Ahmad, Afzal & Mahmood, 2010). X_{it} is a vector of control variables. This includes physical capital $PhyC_{it}$ – measured by gross fixed capital formation as a percentage of GDP – and human capital HC_{it} – measured by Barro and Lee's (2013) average years of schooling, adjusted for the average Mincerian rate of return. The human capital stock is constructed as the exponentially compounded product of the average years of schooling for the working-age population (15 years and older), adjusted for the global average Mincerian rate of return (9.5 percent) (see Haq & Luqman, 2014). Trade openness TON_{it} is measured as exports plus imports as a percentage of GDP and ε_{it} is the error term.

3. Dataset, Sample Selection and Estimation

We have used longitudinal panel data on five SAARC countries – Bangladesh, India, Nepal, Pakistan and Sri Lanka – for 1980 to 2012. The data is taken from the World Bank's World Development Indicators database, the Penn World Table 7.1, Barro and Lee's (2013) schooling dataset and UN Comtrade (see Table A1 in the Appendix).

As Haq and Luqman (2014) explain, there are several reasons for limiting this analysis to a regional bloc. First, it reduces the possibility of a heterogeneous level of initial technology across countries: Temple (1999) suggests that initial levels of technology are more likely to be similar within a region, but vary between regions. Second, the socioeconomic similarities of the SAARC countries help to avoid the problem of assuming a common intercept in the cross-country regression. Third, these countries have comparable patterns of structural transformation in terms of employment and sectoral shares of GDP (see Figures A1 to A5 in the Appendix). For example, from the 1950s to the 1970s, all five sample countries relied heavily on agriculture, moved toward manufacturing-led growth in the 1980s and shifted rapidly to advanced services in the 1990s. Following the literature on dynamic panel models, we employ the generalized method of moments (GMM) estimation technique developed by Arellano and Bond (1991).

4. Empirical Findings and Interpretation

As mentioned above, the key objective is to investigate the impact of services on value addition in manufacturing. We focus on the value addition of services in the sample countries and the interacting terms.

4.1. Results of Empirical Model

Table 1 gives the results of the empirical model: VAM_{it} is regressed on VAS_{it}[3] along with the control variables. The model is dynamic, with the lagged dependent variable VAM_{t-1} introduced as an explanatory variable. The coefficient of VAM_{t-1} is positive and highly significant in all the specifications of model 1. These lagged values capture the cumulative industrialization process. A number of empirical studies maintain that the existing level of technology can affect the potential gains of new technology and, therefore, a certain level of technology is required to tap into international knowledge and technology.[4]

[3] The data was taken from http://data.worldbank.org/indicator/NV.IND.TOTL.ZS and http://data.worldbank.org/indicator/NV.SRV.TETC.ZS, respectively.

[4] See, for instance, Baumol, Nelson and Wolff (1994); Forbes and Wield (2000); Griffith, Redding and Van Reenen (2003); Keller (2004).

Table 1: Empirical results of baseline model

Variable	Model_1	Model_2	Model_3	Model_4	Model_5	Model_6	Model_7	Model_8	Model_9
VAM_{t-1}	0.579***	0.770***	0.867***	0.045***	0.853***	0.857***	0.810***	0.321**	0.852***
	(0.000)	(0.000)	(0.000)	(0.040)	(0.000)	(0.000)	(0.000)	(0.010)	(0.000)
VAS_{it}	-0.091***	-0.110***	-0.103***	-0.318***	-0.08**	-0.092**	-0.118***	-0.563***	-0.083***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	0.002)	(0.000)	(0.000)	(0.002)
$PhyC_{it}$	0.016**	0.092**	0.068**	0.271***	0.031	0.021**	0.057**	0.359***	0.047**
	(0.031)	(0.003)	(0.031)	(0.002)	(0.387)	(0.049)	(0.057)	(0.000)	(0.013)
HC_{it}	0.009***	0.007**	0.010***	0.422***	0.410***	0.360	0.005**	0.246***	1.950**
	(0.000)	(0.002)	(0.000)	(0.000)	(0.001)	(0.003)	(0.027)	(0.000)	(0.037)
TON_{it}	0.011**								
	(0.013)								
MEM_{it}		0.027***							
		(0.000)							
MIM_{it}			0.012						
			(0.251)						
$IMPC_{it}$				0.982***					
				(0.000)					
$(VAS * TON)_{it}$					(0.080)				
					(0.923)				
$(VAS * MIM)_{it}$						.0001*			
						(0.093)			
$(VAS * MEM)_{it}$							0.0713**		
							(0.001)		
$(VAS * MEM)_{it}$							0.0713**		
							(0.001)		

Table 1: Empirical results of baseline model Continued…

Variable	Model_1	Model_2	Model_3	Model_4	Model_5	Model_6	Model_7	Model_8	Model_9
$(VAS * IMPC)_{it}$								0.009***	
								(0.000)	
$(HC * IMPC)_{it}$									0.006
									(0.237)
Observations	155	155	155	155	155	155	155	155	155
Countries	5	5	5	5	5	5	5	5	5
Instruments	62	60	62	60	60	60	62	62	62
Sargan test p-values	0.148	0.173	0.141	0.131	0.112	0.152	0.146	0.122	0.141
Arellano–Bond test for autocorrelation	-1.94 (0.240)	-1.98 (0.151)	-1.87 (0.712)	-2.393 (0.113)	-1.85 (0.172)	-1.887 (0.14)	-1.88 (0.12)	-2.013 (0.082)	-1.91 (0.140)

Note: p-values given in parentheses; * significant at 10%, ** significant at 5%, * significant at 1%.
The equations have been corrected for heteroskedasticity where needed. The Sargan test determines the validity of instrumental variables in GMM estimation. In all the models, the null hypothesis of the Sargan test (over-identifying restrictions are valid) is not rejected, which shows that the instrumental variables are valid.
Source: Authors' calculations.

Column 2 shows that the variable of interest VAS_{it} has a negative sign (–0.091) and is statistically significant at 1 percent. This implies that the value addition in services and manufacturing moves in opposite directions for this sample. The following reasons may explain why. First, as Kiley (2001) and Bresnahan (2003) argue, new technology in services requires the production process to be reorganized. The replacement of technology, therefore, becomes costly for services companies, especially at the initial stage. The second factor is the speed of shock adjustment in sectoral income, which may be far higher in the manufacturing sector compared to the services sector. Third, the negative sign of own-industry services investment may be due to the "business stealing" effect, whereby firms that find new and more efficient applications of services will have a negative effect on the productivity of their competitors in manufacturing (Bloom, Schankerman & Van Reenen, 2013). Overall, in the case of the selected SAARC countries, we cannot accept the hypothesis that value addition in services and manufacturing moves in the same direction. This implies a lack of complementarity between the two sectors and indicates that value addition in services may present a threat, rather than an opportunity, for value addition in manufacturing in SAARC.

All the control variables in the baseline specification have the expected signs and are statistically significant. Physical capital $PhyC_{it}$ (model 1) has a positive sign and is statistically significant. This result is in line with Bigsten et al. (2000), Dasgupta and Singh (2006) and Rajni (2013), supporting the claim that an increase in the stock of physical capital enhances the production capacity of individual firms, in turn increasing overall sectoral growth. The coefficient of human capital HC_{it} also has a positive sign and is statistically significant, indicating that an increase in workers' human capital enhances their production capacity, in turn increasing firms' productivity. This result is consistent with Romer (1989), Becker (1993), Bakare (2011) and Olayemi (2012).

Trade openness TON_{it} has a positive sign (0.011), denoting its positive impact on value addition in manufacturing. This finding is supported by Ellahi, Mehmood, Ahmad and Khattak (2011), who show that trade openness and manufacturing value-added have a sustained and positive relationship. By extension, the result is also in line with Guisan and Exposito (2004), who find that the liberalization of imports has a positive impact on manufacturing growth.

Columns 3 to 10 give the results of the sensitivity analysis. It is important to clarify that VAM_{t-1}, VAS_{it}, $PhyC_{it}$ and HC_{it} are common to all

the specifications. In model 2 (column 3), all the variables, including VAS_{it}, yield the same results as for model 1. In this specification, we replace TON_{it} with MEM_{it}, denoting export manufactures[5] as a percentage of merchandise exports.[6] MEM_{it} affects manufacturing value-added through two channels. First, an increase in the export of manufactured goods creates competition among domestic producers, in turn improving the quantity and quality of manufactures. Second, an increase in export manufactures creates fiscal space for producers to expand their research and development (R&D) capacity. This raises the sector's level of invention and innovation (Boggio, 1988; Rivera-Batiz & Romer, 1991a, 1991b; Lucas, 1993).

MEM_{it} is significant and positive (0.027), implying that the value addition in manufacturing rises in tandem with an increase in the sector's share of total exports. This is because (i) any modification of technology associated with higher exports increases the profits of production units, in turn stimulating firms' investment in new technology and R&D; and (ii) access to export markets provides an opportunity for learning, which improves the quantity and quality of production.

In model 3 (column 4), we replace MEM_{it} with MIM_{it}, denoting import manufactures as a percentage of merchandise imports. The variable has a positive sign, but is not significant. This may be associated with the nascent structure of the manufacturing sector in the selected SAARC countries. Model 4 (column 5) follows Blyde and Sinyavskaya (2007) and Mayer (2001) and incorporates the impact of the type of manufactured goods being imported. The import of machinery and transport equipment play a significant role in manufacturing value-added (Mayer, 2001). In specification 4, we replace MIM_{it} with $IMPC_{it}$, denoting imports of machinery and transport equipment as a percentage of merchandise imports. $IMPC_{it}$ has a positive and relatively strong coefficient (0.982) that is significant at 1 percent. This reveals that, instead of overall imports, imports of machinery and transport equipment play an important role in manufacturing value-added.

Specifications 5–8 (columns 6–9) give the regression results for complementary reforms, incorporating the interaction between services value-added and different trade variables. Model 5 examines the complementarity between services value-added and trade openness, using the interaction term $(VAS * TON)_{it}$. The coefficient of this interaction is

[5] According to UN Comtrade, export and import manufactures comprise commodities, chemicals, basic manufactures, machinery and transport equipment, and miscellaneous manufactured goods.
[6] Merchandise exports and imports are a country's exports and imports of tangible goods.

positive, but not statistically significant. Next, we add the interaction between services value-added and import manufactures $(VAS * MIM)_{it}$, which has a positive sign and is significant at 1 percent. This indicates that the value-added effect of an increase in services on manufacturing value-added depends positively on import manufactures. That is, any value addition in services leads to a large increase in manufacturing value-added when countries are more open to importing manufactures.

Model 7 (column 8) presents the results of a third interactive term, $(VAS * MEM)_{it}$, which is positive and significant. This signifies that sectoral structures should change in favor of adding value to manufacturing by liberalizing the export of manufactured goods. Similarly, model 8 (column 9) measures the impact of the interaction between services value-added and imports of machinery and transport equipment $(VAS * IMPC)_{it}$. The coefficient of this interaction term is statistically significant and has a positive sign. This shows that the value addition effect of an increase in services value-added on manufacturing depends positively on the increase in imports of machinery and transport equipment (enhanced through complementary trade reforms).[7]

Three arguments support the claim that greater openness in the import and export of manufactures increases the value added to the manufacturing sector. First, adapting advanced technology – given that the sample countries rely on imported technology – is associated with the liberalization of import manufactures. This enables the importing country to enhance its technological capacity and shift from being a producer and exporter of primary products to a producer and exporter of value-added (manufactured) products. Second, the liberalization of export manufactures increases the fiscal space of production firms and stimulates their investment in new technology and R&D. Third, access to international markets provides an opportunity for learning, which improves the quantity and quality of production units.

The extent to which a country's manufacturing value-added will gain from imported technology is also sensitive to the country's capacity for absorbing this technology into its production process. To evaluate the impact of the absorption capacity on manufacturing value-added, we employ the interaction between human capital and imports of machinery and transport equipment $(HC * IMPC)_{it}$. The last column (specification 9)

[7] Chang et al. (2009), Fiori, Nicoletti, Scarpetta and Schiantarelli (2007), and Stieglitz and Heine (2007) use interaction terms, defining complementarity and substitutability based on the variable's sign.

presents the results of this interaction: the term is statistically significant and has the expected positive sign. This implies that the value addition effect of an increase in imported capital depends positively on the progress made in human capital. This result is in line with Keller (1998), who argues that developing countries utilize international technology more efficiently if local firms are carrying out R&D. Moreover, as Mayer (2001) points out, differences in human capital and machinery imports can also explain productivity differences across developing countries.

4.2. Robustness Checks

Instead of conventional cross-sectional regressions, we have used a dynamic panel model and GMM estimator. This provides consistent and asymptotically normal estimates as it eliminates the biases caused by omitted variables, endogenous right-hand-side variables, the omission of initial efficiency and the presence of measurement errors. It is important to note that, to control the problem of endogeneity, we use a GMM estimator with the lagged values of the dependent variables as instruments. To avoid upward biased coefficients, we limit the number of lags to two.

To verify the validity of the empirical estimates, we apply the following diagnostic tests. The Wald test measures the joint hypothesis of coefficients, where the null hypothesis is that all the regressor coefficients are 0 simultaneously. In this case, the probability of obtaining the given values of F or above are almost 0 in most of the specifications. This shows that the explanatory variables account for a significant proportion of the variability of the dependent variable in each specification (Table 2).

Table 2: Wald test for joint significance

	Model_1	**Model_2**	**Model_3**	**Model_4**	**Model_5**
F-value	3.720	4.820	27.010	26.710	3.430
P-value	(0.031)	(0.078)	(0.000)	(0.000)	(0.013)

Note: H0 = all the regressor coefficients are 0 simultaneously.
Source: Authors' calculations.

The Pesaran (2004) test gauges the cross-sectional dependence of the residuals across countries, where the null hypothesis is that the residuals are not correlated. In all the specifications, the null hypothesis is not rejected (Table 3). Finally, the Sargan (1958) test is used to verify the validity of the instrumental variables in the GMM estimation. The null

hypothesis – that over-identifying restrictions are valid – is not rejected, which indicates that the instruments are correctly specified.

Table 3: Pesaran test for cross-sectional dependence

	Model_1	Model_2	Model_3	Model_4	Model_5	Model_6
F-value	4.200	-2.700	27.010	-1.568	-0.717	-0.717
P-value	(0.126)	(0.472)	(0.618)	(0.116)	(0.473)	(0.381)

Note: H0 = residuals are not correlated ($p > 5\%$).
Source: Authors' calculations.

Tables A2 and A3 in the Appendix provide the correlation matrix results and panel unit root test results. Tables A4 and A5 present the study's results for the OLS regression model and time fixed-effects model.

5. Conclusion

Although much of the empirical literature on sectoral shifts supports the notion of complementarities between manufacturing and services – arguing that both sectors move in the same direction – we contend that this hypothesis warrants further investigation in countries that have a dominant services sector, but have not graduated to industrial status. Accordingly, this study tests the hypothesis that value addition in the services sector crowds out value addition in manufacturing. Our sample of five SAARC countries all have a dominant services sector, but have not achieved industrial status. The empirical evidence shows that any value addition in services is significantly and inversely associated with value addition in the manufacturing sector. Hence, our findings do not support the idea of complementarities between manufacturing and services overall in the case of the selected SAARC countries.

However, when the services regressor interacts with different trade variables, we find some evidence of complementarity. For instance, unlike the individual term, the interaction term for trade openness and services value-added has a positive sign. We also find that the interaction terms for services value-added and export manufactures, and for services value-added and import manufactures are positive and statistically significant. These findings imply that, the more open an economy is to international trade, the more the services sector is likely to support value addition in the manufacturing sector.

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Appendix

Table A1: Variables and data sources

Variable	Description	Source	Measurement
VAM_{it}	Value added in manufacturing	WDI	Percent of GDP
VAS_{it}	Value added in services	WDI	Percent of GDP
$PhyC_{it}$	Gross fixed capital formation	WDI	Percent of GDP
HC_{it}	Average years of schooling	Barro and Lee (2013)	Unit
TON_{it}	Trade openness	WDI	Total trade percent of GDP
MEM_{it}	Export manufactures	WDI	Percent of merchandise exports
MIM_{it}	Import manufactures	WDI	Percent of merchandise imports
$IMPC_{it}$	Imports of machinery and transport equipment	UN Comtrade	Percent of merchandise imports

Note: WDI = World Development Indicators dataset.

Table A2: Correlation matrix results

Variable	VAS_{it}	VAM_{it}	GFC_{it}	AYS_{it}	MEM_{it}	MIM_{it}	TON_{it}
VAS_{it}	1.0000						
VAM_{it}	0.6714	1.0000					
GFC_{it}	0.2907	0.5722	1.0000				
AYS_{it}	0.5939	0.6271	0.5242	1.0000			
MEM_{it}	0.3521	0.1299	-0.1621	-0.0788	1.0000		
MIM_{it}	-0.0342	-0.0589	0.0436	0.3895	0.0415	1.0000	
TON_{it}	0.2436	0.3250	0.5171	0.7754	-0.1810	0.3990	1.0000

Source: Authors' calculations.

Table A3: Panel unit root test results

	VAM_{it}	VAS_{it}	$PhyC_{it}$	HC_{it}	TON_{it}	MEM_{it}	MIM_{it}	$IMPC_{it}$
PP-Fisher chi-sq.	18.065	16.860	12.771	16.318	10.232	22.254	20.18	20.402
Prob.	(0.0724)	(0.088)	(0.237)	(0.091)	(0.423)	(0.013)	(0.027)	(0.0257)

Note: H_0 = presence of a unit root.
Source: Authors' calculations.

Table A4: Pooled OLS results

Dependent variable = value added in manufacturing as a percentage of GDP

Variable	Model_1	Model_2	Model_3	Model_4	Model_5	Model_6
VAM_{t-1}	0.991***	1.003***	0.980***	0.931***	1.002***	1.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
VAS_{it}	-0.201*	-0.298**	-0.183**	-0.214*	-0.297*	-0.302**
	(0.092)	(0.024)	(0.034)	(0.061)	(0.071)	(0.029)
$PhyC_{it}$	0.152**	0.196**	0.222***	0.173***	0.192***	0.193**
	(0.014)	(0.036)	(0.000)	(0.000)	(0.001)	(0.034)
HC_{it}	0.612***	0.488*	0.235***	0.326**	0.002	0.557
	(0.000)	(0.079)	(0.000)	(0.042)	(0.731)	(0.115)
TON_{it}	0.042**					
	(0.022)					
MEM_{it}		0.014*				
		(0.093)				
MIM_{it}			0.980***			
			(0.000)			
$(VAS * TO)_{it}$				0.582		
				(0.742)		
$(VAS * MIM)_{it}$					0.001**	
					(0.023)	
$(VAS * MEM)_{it}$						0.004***
						(0.000)
R^2	0.96	0.96	0.91	0.94	0.95	0.95
Adj. R^2	0.95	0.95	0.90	0.93	0.94	0.94
SE of reg.	0.86	0.87	1.28	0.92	0.88	0.88
Durbin–Watson stat	1.99	1.85	1.09	1.93	1.85	1.83

Note: p-values in parentheses. *, **, *** = significant at 10, 5 and 1%, respectively.
Source: Authors' calculations.

Table A5: Time fixed-effects results

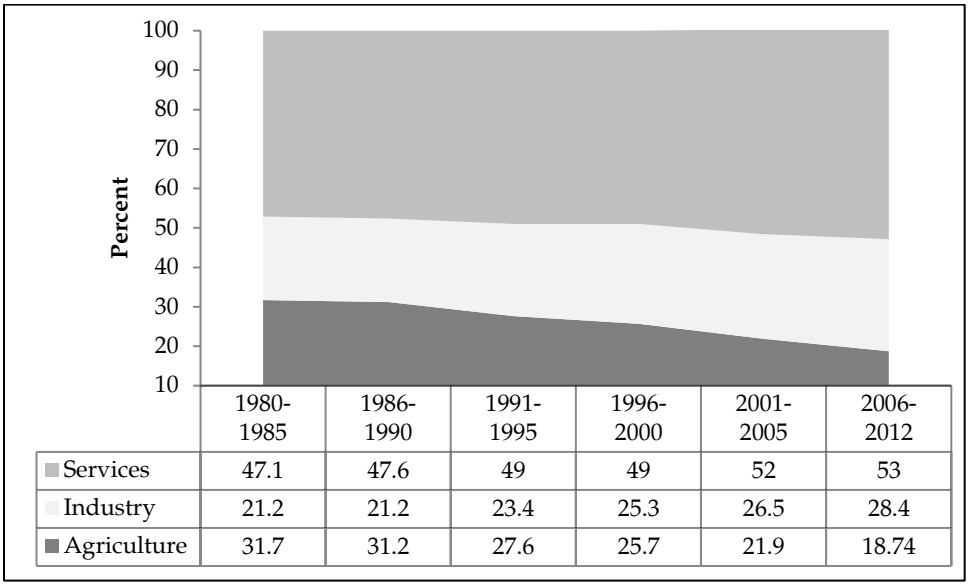
Dependent variable = value added in manufacturing as a percentage of GDP

Variable	Model_1	Model_2	Model_3	Model_4	Model_5	Model_6
VAM_{t-1}	0.927**	0.928**	0.0832***	0.931***	0.955***	0.936***
	(0.033)	(0.027)	(0.000)	(0.000)	(0.000)	(0.001)
VAS_{it}	-0.013**	-0.012**	-0.002***	-0.004*	-0.006	-0.067***
	(0.021)	(0.011)	(0.000)	(0.084)	(0.851)	(0.000)
$PhyC_{it}$	0.028**	0.046**	0.009	0.034**	0.011*	0.043**
	(0.009)	(0.022)	(0.462)	(0.051)	(0.081)	(0.025)
HC_{it}	0.171*	0.115**	0.017*	0.119***	0.351*	0.122*
	(0.049)	(0.041)	(0.091)	(0.001)	(0.071)	(0.093)
TON_{it}	0.037**					
	(0.007)					
MEM_{it}		0.036***				
		(0.011)				
MIM_{it}			0.009			
			(0.831)			
$(VAS * TO)_{it}$				0.375*		
				(0.067)		
$(VAS * MIM)_{it}$					0.205*	
					(0.084)	
$(VAS * MEM)_{it}$						0.074***
						(0.000)
R^2	0.96	0.96	0.96	0.96	0.95	0.96
Adj. R^2	0.95	0.94	0.94	0.95	0.94	0.94
SE of reg.	0.94	0.92	0.96	0.95	0.95	0.92
Durbin–Watson stat	1.86	1.98	1.89	1.86	1.85	1.96

Note: p-values in parentheses. *, **, *** = significant at 10, 5 and 1%, respectively.
Source: Authors' calculations.

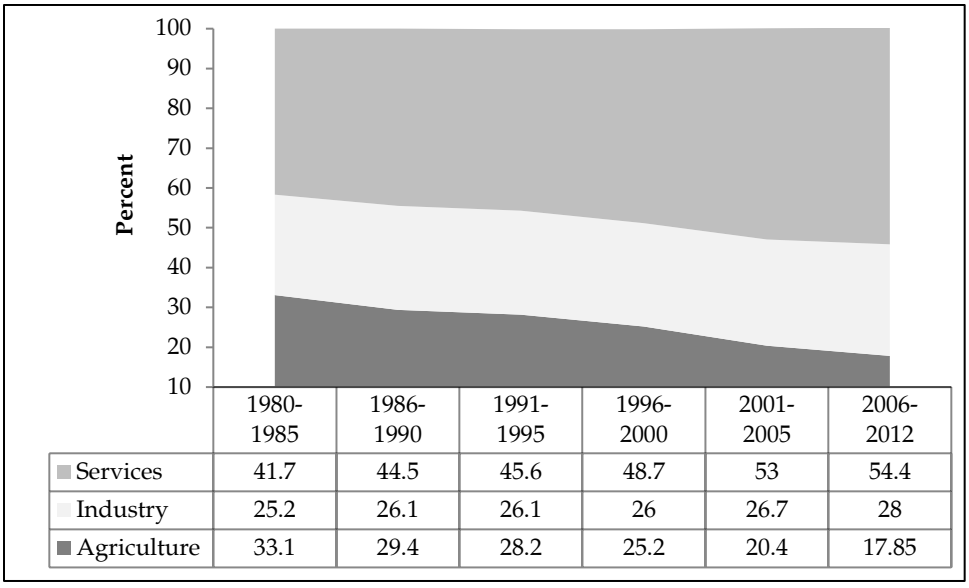
Sectoral composition of SAARC countries

Figure A6: Bangladesh



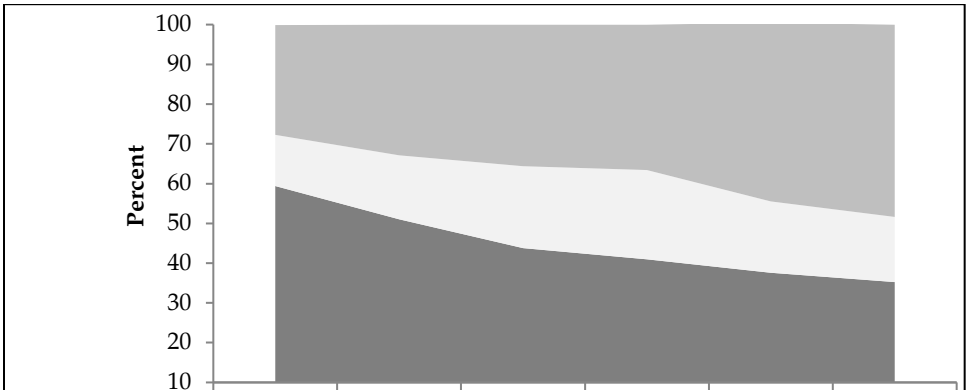
	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2012
Services	47.1	47.6	49	49	52	53
Industry	21.2	21.2	23.4	25.3	26.5	28.4
Agriculture	31.7	31.2	27.6	25.7	21.9	18.74

Figure A7: India



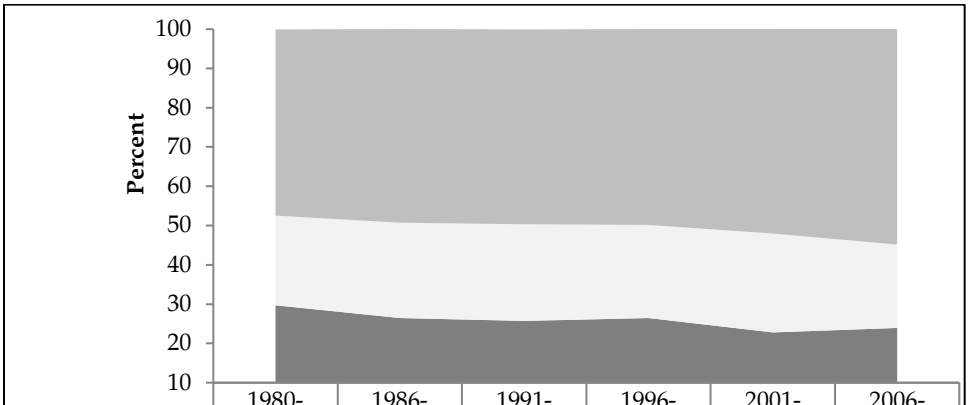
	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2012
Services	41.7	44.5	45.6	48.7	53	54.4
Industry	25.2	26.1	26.1	26	26.7	28
Agriculture	33.1	29.4	28.2	25.2	20.4	17.85

Figure A8: Nepal



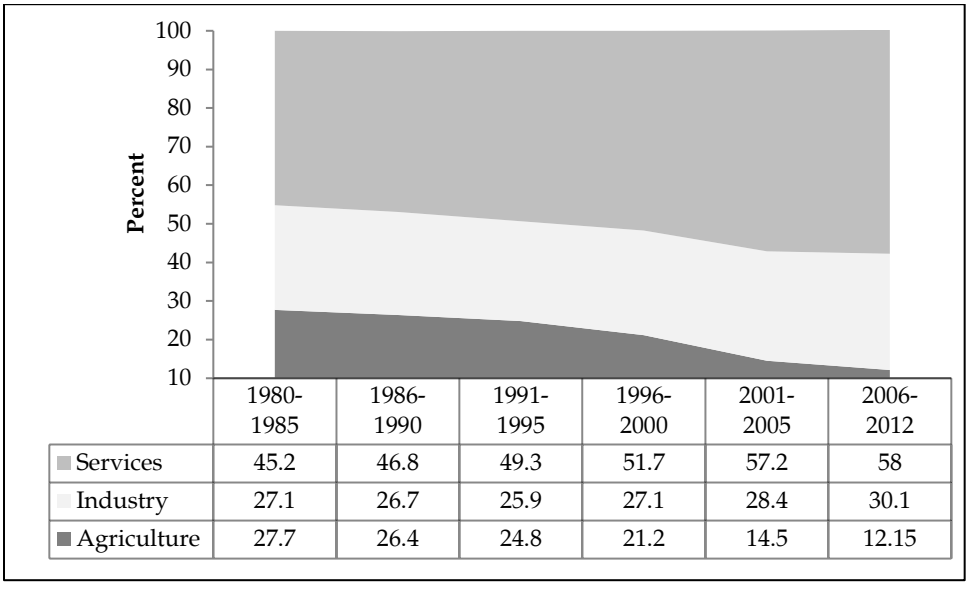
	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2012
Services	27.6	32.9	35.6	36.6	45	48.3
Industry	12.9	16.1	20.6	22.4	17.9	16.4
Agriculture	59.4	51	43.8	41	37.6	35.23

Figure A9: Pakistan



	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2012
Services	47.4	49.3	49.6	49.8	52	55
Industry	22.8	24.2	24.6	23.7	25.2	21.2
Agriculture	29.7	26.5	25.7	26.5	22.8	23.97

Figure A10: Sri Lanka



	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2012
Services	45.2	46.8	49.3	51.7	57.2	58
Industry	27.1	26.7	25.9	27.1	28.4	30.1
Agriculture	27.7	26.4	24.8	21.2	14.5	12.15

Source: World Development Indicators.

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Assessing the Effects of Fiscal Decentralization on the Education Sector: A Cross-Country Analysis

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Abstract

This paper examines the effects of fiscal decentralization on the education sector for a sample of 62 countries. The results suggest that different sources of fiscal decentralization have distinct effects on education expenditure and quality. While subnational governments that are financed through own-tax revenues are more likely to increase the funds allocated to education, they also seem less concerned with maintaining teaching quality. This study provides evidence that decentralized structures cater better to local social needs. Fiscal decentralization is, therefore, an important policy instrument for achieving social goals.

Keywords: Fiscal decentralization, education expenditure, teaching quality, panel data.

JEL classification: H75, H71, H40, H52, I21.

1. Introduction

The Millennium Development Goals reflect the need for improved education and health, both of which have a vital impact on the quality of life. Better health and education services ensure greater economic opportunities for individuals while the state benefits simultaneously from better-quality human capital. Given market imperfections and the externalities associated with social spending, public sector involvement is considered mandatory for the provision of basic public goods. However, as human needs increase and public sector resources become more scarce, it becomes important to evaluate the effectiveness of social spending. Higher public spending on health and education by itself is not an effective instrument to remedy imbalances. It is necessary to set proper goals, target the right areas and use scarce resources efficiently to increase the effectiveness of public resource use. In developing countries, poorly managed public spending is a key reason for suboptimal outcomes (World Bank, 2003).

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In striving for growth and development, human capital is widely acknowledged as the engine of economic growth. To improve human capital, governments must invest in education and health. Policymakers can do this in two possible ways: either invest more money or look to improve policies. When constrained by resources, policymakers aim to optimize the use of scarce resources. Among the competing social sectors, government spending on health and education is by far the most important. Spending on health and education is argued to enhance economic growth, improve human capital, reduce poverty and achieve better income equality (see Romer, 1986; Lucas, 1988; Barro, 1991; Chu et al., 1995; Tanzi & Chu, 1998; Baldacci et al., 2008).

In this context, decentralization is critical, given its potential to influence service provision and resource use. Advocates of decentralization argue that it is based on efficient allocation due to better awareness of local needs and preferences. Decentralization is increasingly relevant to the education sector as the demand for learning rises in economies now based predominantly on knowledge and innovation. This has made education the center of attention for decentralization reforms. With the drive toward greater decentralization, policymakers try to ensure better targeting and greater transparency. Local authorities are, therefore, increasingly entrusted with various decentralized tasks, including provision of education services.

The aim of this study is to estimate the effects of fiscal decentralization[1] on different indicators of education. The literature suggests that taking policymaking closer to the public helps identify and execute what people need most. Galiani, Gertler and Schargrodsky (2008) review the literature on the education decentralization and show a positive association between decentralization and education preferences. Faguet (2004) argues that local governments have more accurate information on people's preferences in education, which leads to positive results. Behrman and King (2001) also note a level of harmonization between household decisions and steps taken in a decentralized structure.

In a study on Argentina, Eskeland and Filmer (2007) find a positive association between school autonomy and student performance. Jimenez and Sawada (1999) show that decentralization has led to greater parental participation in schools' decision making in El Salvador. Similarly, Galiani

[1] Fiscal decentralization is currently the most viable form to empirically measure and compare the outcomes of decentralization across countries.

and Schargrodsky (2002) find that decentralization improves overall school performance. In a study using panel data for Swiss cantons, Barankay and Lockwood (2007) show that greater decentralization results in higher educational attainment. Del Granado, Martinez-Vazquez and McNab (2005) find a positive association between fiscal decentralization and education expenditures. Falch and Fischer (2012) conclude that decentralized government spending results in higher test scores. Looking at Chile, Parry (1997) reports that the decentralization of education has enabled the central and local governments to balance their responsibilities better.

Nevertheless, no policy comes without preconditions and thus cannot bear fruit without an enabling environment. Galiani et al. (2008) point out that the positive effects of decentralization depend on preconditions such as the ability to bridge information asymmetries and heterogeneous preferences, increased local participation and greater accountability of service providers to their clients. Therefore, there is the chance that decentralization may not improve social indicators, or even cause them to deteriorate, if local communities have no voice and face elite capture (Bardhan & Mookherjee, 2005) or if local governments lack the capacity to administer public services efficiently (Smith, 1985). These risks can limit the positive effects of fiscal decentralization and, therefore, rigorous empirical evidence is essential to determine the extent to which it might contribute to the education sector. Appendix 1 summarizes the literature on education indicators and their determinants.

Despite the available literature in this area, there is need for further empirical evidence to quantify the effects of fiscal decentralization on education outcomes (Hanushek, 2002). The available empirical evidence is based largely on country-specific studies that use primary survey or national secondary data sources. Few studies have looked at cross-sectional and panel data for different countries in this context. One reason cited for the limited research is the absence of comparable data across countries. Nevertheless, as better, more consistent datasets are published, it becomes easier to assess the effects of fiscal decentralization on basic education indicators using cross-country data.

Recognizing the need for updated research in this area, using cross-country evidence, this study seeks to analyze the impact of fiscal decentralization on the education sector, using a rich panel dataset for 62 countries in different regions of the world. It focuses on indicators such as education expenditure, the enrollment rate and the quality of education (with the teacher–pupil ratio as a proxy). The study also disaggregates the

effects of different sources of subnational revenue to investigate how these influence the effectiveness of local structures.

The paper is organized as follows. Section 2 presents the data and methodology used and discusses the theoretical linkages between education indicators and their determinants, especially the nexus with fiscal decentralization. Section 3 presents the empirical results, followed by a discussion in Section 4. Section 5 concludes the study.

2. Dataset and Methodology

This section describes the study's hypotheses, empirical model, dataset and properties and the estimation techniques used.

2.1. Background

Governments invest in education because of its long-run social and economic returns. As O'Connor (1973, cited in Devine, 1985) notes, the government bears the cost of education and health to increase productivity in the economy with a better-skilled, more productive labor force. Baldacci et al. (2008) analyze the effects of education on economic growth, showing that the positive association between the two is now well established (see also Barro, 1996a, 1996b; Barro & Sala-i-Martin, 1995; Levine & Renelt, 1992; Mankiw, Romer & Weil, 1992; Sala-i-Martin, 1997). Coulombe, Tremblay and Marchand (2004) report that a literacy score that is 1 percent higher than average is associated with a 1.5 percentage point increase in per capita GDP growth.

There are also social implications attached to this spending. Certain goods and services are allocated through the public sector because they are nondivisible and/or consumed collectively (Musgrave & Musgrave, 1973). Moreover, the free market does not necessarily lead to an equitable distribution of public and merit goods, given their associated externalities. As a merit good, education shares these properties, making the role of the government very important. From this perspective, fiscal decentralization can play an important role in improving service provision. A decentralized administrative structure makes it easier to accommodate diverse local demands as compared with centralized allocation, which may be based on insufficient information. Decentralization, therefore, results in better allocation of scarce resources.

Decentralization affects development outcomes through a country's political, fiscal and economic systems (Kalirajan & Otsuka, 2012). Fiscal decentralization makes policymakers accountable through local elections, which improves transparency. This makes it reasonable to assume that it will have a positive effect on education as well as other social sectors.[2] Although there is some empirical support for this argument, further research is always desirable. Accordingly, we test the hypothesis that fiscal decentralization improves education indicators. The study's cross-country panel data analysis will help distinguish between the effects of different decentralization policies.

2.2. Hypotheses

The study's main hypotheses are discussed below:

- Fiscal decentralization has a positive effect on the education sector. Increased fiscal decentralization helps allocate resources more efficiently and presumably translates public demand into the actions required. The coefficients of the fiscal decentralization measures show whether this effect is significant.
- Different decentralization policies result in distinct outcomes. We analyze the cross-country evidence to gauge whether it is only local resources that matter or if different sources of local revenue result in different outcomes. We examine two measures of fiscal decentralization – subnational tax revenues and federal transfers to subnational governments – to determine if they produce similar results or affect the education sector differently. This comparison will shed light on the effectiveness of different sources of subnational revenue.

These hypotheses not only help examine the effects of fiscal decentralization on education, but also make a clear distinction among the available fiscal decentralization policies, if any. A comparison of the effects of local tax revenues and federal transfers at the subnational level will help compare the impact of local autonomy with that of partial fiscal decentralization (Brueckner, 2009).

[2] Provided issues such as regional inequalities, elite capture, leviathan governments and capacity issues are taken care of.

2.3. Empirical Model

Unlike the health sector, which has easily comparable outcomes such as infant/child mortality and immunization, the education sector does not have necessarily equivalent measures. There are significant differences across countries in terms of the starting age for school, the duration of primary and secondary schooling and, above all, the quality of education. Nevertheless, by examining the most obvious indicators, it is possible to analyze the link between fiscal decentralization and education.

An obvious choice of indicator is education spending. As a direct input to the sector, it reflects the response of the local government to education in the short run. However, evidence from an input indicator alone is not enough and it is important to analyze how policy affects the output or outcome variable. While school enrollment is a good proxy for output, the data available limits its use. The study sample is dominated by countries that are members of the Organisation for Economic Co-operation and Development (OECD) and are characterized by compulsory education policies. In addition, OECD countries have better social protection schemes that have enabled them to achieve almost universal enrollment, with little variation left for empirical analysis. Accordingly, we use the teacher–student ratio as a proxy for the quality of education.[3] Both indicators – public education expenditure per student and the teacher–student ratio – are measured at primary school level, which provides a basis for further education and offers the highest social rate of return (Psacharopoulos, 1994; World Bank, 1995).

Following the literature on education-related macro-studies, we employ the following control variables: per capita income, government spending, demographics and access to infrastructure. In addition, we include the fiscal decentralization measures to identify their impact on education and investigate whether the effect differs across decentralization policies.

[3] It is important to mention here that 'test scores' are regarded as the most obvious measure of the education sector's performance, making the PISA test scores a good indicator of the effects of fiscal decentralization on education outcomes. However, consistent data is available primarily for the OECD countries only and with three-year gaps. For this reason, we do not use this indicator here, where the emphasis is on the effects of fiscal decentralization on education in both OECD and non-OECD countries (OECD, 2013).

To estimate the given relationship, we use the following equations:

$$(EE/St)_{it} = \alpha_{1i} + \beta_{11}Y_{it} + \beta_{12}FD_{jit} + \beta_{13}GE_{it} + \beta_{14}Pop(5\ to\ 14)_{it} + \beta_{15}Pop(65+)_{it} + \beta_{16}Urb_{it} + \varepsilon_{it} \quad (1)$$

$$(T/St)_{it} = \alpha_{2i} + \beta_{21}FD_{jit} + \beta_{22}\left(\frac{EE}{St}\right)/Y_{it} + \beta_{23}Pop(5\ to\ 14)_{it} + \beta_{24}Dep_{it} + \beta_{25}Urb_{it} + \varepsilon_{it} \quad (2)$$

for country *i* in period *t* where *j* represents the three fiscal decentralization measures. In equation (1), *EE/St* is public education expenditure per student (at primary level)[4] while in equation (2), the teacher–student ratio is denoted by *T/St*.

Although the World Bank provides a more elaborate, internationally comparable measure of education expenditure, that is, the ratio of public education expenditure to GDP per capita *(EE/St)/Y*, we factor out the latter in equation (1) because GDP per capita is a determinant of education spending itself.[5] Equation (2), however, employs education expenditure per student as a share of GDP per capita to explain the teacher–student ratio in a cross-country setting. Education quality depends on factors that simultaneously affect education expenditure, thus yielding a recursive model for the second equation.[6] Table 1 defines the variables used and specifies the sources of data. The rationale for including the explanatory variables is given below.

[4] The choice of a fixed or random effects model depends on the equation $E(FD_{jit}\eta_i) = 0$.

[5] However, the results presented here remain mostly consistent, even for the ratio of education spending per student to GDP per capita. We exclude GDP per capita from the set of explanatory variables to avoid endogeneity problems: any shock affecting per capita GDP will also affect the dependent variable, which contains the same denominator. This would cause confusion and raise specification issues.

[6] Where expenditure per student/GDP per capita (primary) is instrumented with the same set of explanatory variables as given in equation (1), except GDP per capita.

Table 1: Variables and sources of data

Variable		Definition
Expenditure per student, primary (in real US$)	EE/St	Public education expenditure (current) per student at primary level, in real US dollars, base year 2000
Expenditure per student, primary (% of GDP per capita)	$\left(\frac{EE}{St}\right)/Y$	Public education expenditure (current) per student at primary level, as percentage of GDP per capita
Teacher–student ratio, primary	T/St	Number of teachers available relative to number of students enrolled (at primary level)
GDP per capita	Y	GDP per capita, in constant US dollars
Government spending	Ge	General government expenditures, as percentage of GDP
Urbanization	Urb	Percentage of total population living in urban areas
Dependency ratio	Dep	Ratio of dependents (people younger than 15 or older than 64) to the working-age population (aged 15–64), as proportion of dependents per 100 people of working age
Population aged 65 and above	Pop (65+)	Percentage of total population aged 65 and above
Population aged 5–14	Pop (5–14)	Percentage of total population aged 5–14
Subnational govt. share of tax revenue	Fdtax	Subnational tax revenues as percentage of total government tax revenues: (tax rev_SG + tax rev_LG) divided by (tax rev_CG + tax rev_SG + tax rev_LG)
Subnational govt. share of revenue	Fdtpr	Total subnational revenues as percentage of total government revenues: (total rev_SG + total rev_LG – grants from SG to LG) divided by (total rev_CG + total rev_SG + total rev_LG)
Vertical grants as share of subnational govt. revenue	Fdtrans	Total subnational transfers as percentage of subnational total revenues: (grants_SG + grants_LG – grants from SG to LG) divided by (total rev_SG + total rev_LG)

Note: CG = central government, SG = state government, LG = local government.
The data for these indicators is from the World Development Indicators database, except for the demographic indicators, which were sourced from the Health, Nutrition and Population Statistics database.

- GDP per capita (Y) is used to capture the level of development in a country and is expected to have a positive and significant effect on education expenditure.
- Fiscal decentralization (*FD*) is the main variable of interest. We expect informed policymaking to result in better resource allocation, with a

positive effect on education. Three measures are used to proxy fiscal decentralization:[7] the share of subnational tax revenue, the share of subnational total revenues and vertical grants (see Appendix 2 for a note on the construction of the fiscal decentralization measures and descriptive statistics). These measures will help identify the effect of different sources of subnational government revenues on the performance of the education sector. Different revenue sources are assumed to carry distinct incentives for the local government. We ask whether it is the resources available or the level of empowerment that enhances local government efficiency.

- Government expenditure as a percentage of GDP (*GE*) also explains current education expenditure per student and captures the effect of the government's spending behavior and preferences on the education sector.
- *Pop (5–14)* denotes the percentage of the population aged 5–14 and is a proxy for the school-age population. This measure reflects the educational needs of the country, which, if not accurately assessed, put pressure on existing resources. *Pop (5–14)* is expected to have either an insignificant or negative effect on education spending per student and quality.
- *Pop (65+)* denotes the percentage of the population aged 65 and above, characterizing the interest group hypothesis proposed by Miller (1996). A higher proportion of the elderly is assumed to divert public spending toward other sectors such as health. Hence, this variable is expected to have a negative effect on education spending.
- *Urb* represents the level of urbanization, where urban areas are assumed to have access to better infrastructure than rural areas. This is expected to have a positive effect on teaching quality (the teacher–student ratio). However, the variable's sign with respect to public education spending depends on the facilities available in urban areas. While urbanization can improve enrollment through greater access and higher demand for funding, economies of scale can also result in lower per capita expenditure.
- The dependency ratio (*Dep*) is used as a proxy for the household's ability to afford schooling for its children. A larger dependent population can result in lower demand for schooling if people cannot afford the cost of education. It can also result in increased dependence

[7] This is in line with Stegarescu (2004) and Busemeyer (2007).

on the public sector: households that cannot afford private schooling will rely on public schooling, which can increase the demand for the latter. This variable has important implications for education quality.

2.4. Data

Using cross-country panel data is associated with several concerns. Countries tend to vary widely in terms of economic and local government structures as well as response to policy. This can make combining data series problematic. In this case, education indicators and the level and implementation of decentralization vary across the sample. Nevertheless, these concerns are overshadowed by the advantages of panel data, including the greater number of observations, the variation in the data both between countries and within them across time, and the ability to generalize results. Country-specific data makes the results more difficult to generalize. Improved econometric techniques help incorporate cross-country heterogeneity and obtain reasonable results.

2.4.1. Data Characteristics and Availability Across Countries

While many studies have assessed the effect of fiscal decentralization on service provision in the health and education sectors, most of them are country-specific or focus on developed/OECD countries for which better data is available. This plays an important role in sample selection. Generalizing the results obtained is not always straightforward. The World Bank's (2012) fiscal decentralization indicators offer better (although not universal) coverage for the period 1972–2010.[8] This provides an opportunity to extend the research in this area and re-examine the evidence.

2.4.2. Descriptive Statistics

The new fiscal decentralization dataset provides information for 96 countries, while the data for Pakistan was obtained from national sources. However, given the limited data available on education indicators, the sample was reduced to 78 countries (including Pakistan). This yields an unbalanced dataset, with missing values within the series, primarily for the education indicators (the dependent variable), but also for fiscal decentralization (the variable of interest). Table 2 gives descriptive statistics for the variables used in this study.

[8] It is important to note that data availability differs among countries. Even within countries, missing observations are in some cases an issue.

Table 2: Descriptive statistics

Variable		Mean	SD	Min	Max	Observations
Subnational govt. share of tax revenue	Overall	18.03	13.86	0.16	58.74	N = 824
	Between		14.36	0.18	54.84	n = 69
	Within		2.82	1.00	33.36	T-bar = 11.94
Vertical grants as share of subnational govt. revenue	Overall	44.39	20.11	1.39	92.72	N = 811
	Between		20.73	4.04	87.51	n = 72
	Within		7.96	16.76	75.96	T-bar = 11.26
Subnational govt. share of revenue	Overall	25.68	13.91	0.82	98.27	N = 746
	Between		15.07	0.82	68.79	n = 66
	Within		4.15	-13.19	55.16	T-bar = 11.30
Expenditure per student, primary (% of GDP per capita)	Overall	18.63	8.20	0.60	61.64	N = 864
	Between		8.29	3.51	58.48	n = 78
	Within		4.75	-12.09	44.89	T-bar = 11.08
Expenditure per student, primary (constant 2000 US$)	Overall	29.88	27.87	0.19	136.66	N = 862
	Between		23.84	0.25	88.90	n = 77
	Within		10.90	-44.35	86.85	T-bar = 11.19
Pupil–teacher ratio, primary [a]	Overall	19.70	8.71	8.68	82.80	N = 630
	Between		12.18	8.68	69.50	n = 70
	Within		2.61	6.41	33.00	T-bar = 9
GDP per capita	Overall	14,171.7	11,002.8	292.09	55,807.4	N = 864
	Between		10,038.7	340.02	40,100.6	n = 78
	Within		4,239.7	1,591.2	40,493.9	T-bar = 11.08
Government spending (% of GDP)	Overall	18.72	5.49	4.71	43.41	N = 862
	Between		5.28	4.71	36.34	n = 78
	Within		2.18	10.10	30.32	T-bar = 11.05
Population aged 5–14	Overall	15.55	4.68	8.77	29.63	N = 864
	Between		5.91	9.23	29.23	n = 78
	Within		1.83	8.05	21.12	T-bar = 11.08
Population aged 65+	Overall	11.88	4.37	2.51	22.69	N = 864
	Between		5.07	2.52	21.06	n = 78
	Within		1.08	7.31	15.62	T-bar = 11.08
Urbanization (%)	Overall	69.01	17.12	13.01	97.39	N = 864
	Between		18.73	14.06	96.27	n = 78
	Within		2.65	56.97	79.63	T-bar = 11.08
Dependency ratio (%)	Overall	54.57	10.88	37.53	105.52	N = 864
	Between		15.44	38.90	104.79	n = 78
	Within		4.70	34.66	81.55	T-bar = 11.08

Note: a = represented in reverse order for a better understanding of the term.
Source: Author's calculations.

On average, subnational governments generate 18 percent of the total tax revenues, but this varies across countries, as indicated by the standard deviation and the range of values (from 0.16 to 58.74 percent). Similarly, within-country variations are given in the third row for each variable (2.82 percent in the case of the subnational share of taxes). These differences are smaller than for the cross-country data. Countries that have implemented deeper reforms register values ranging from 1 to 33.36 percent for the subnational share of taxes variable.

The low share of taxes generated means that subnational units remain dependent on vertical transfers from the central government (44 percent, on average). The ratio of expenditure per primary student to GDP stands at 18.6 percent, on average, with large variations (0.60 to 61.64 percent) across countries. The pupil–teacher ratio indicates that, on average, there is one teacher for every 19 students at primary level, but with large disparities across the sample. This applies to the other variables as well, but the differences in data availability imply that the two dependent variables will not correspond to the same observations.

3. Empirical Quantification

While such a wide-ranging dataset provides better coverage across countries and time, allowing more accurate comparisons between different economic blocs, it can also yield unbalanced panels, missing observations, nonstationarity in long panels and persistent differences in countries' level of development, governance, endowments, infrastructure and public preferences. Nonetheless, panel data is valuable when carrying out policy analyses because it accounts for unobserved individual country effects, which a cross-sectional analysis cannot do (Islam, 1995). Moreover, the results of country-specific studies cannot be generalized, making panel studies preferable.

Panels containing long data are more likely to exhibit serial correlation within the error term. Most researchers use a five-year average to resolve this issue and avoid short-run fluctuations in the data, but this is not suited to unbalanced panel data characterized by incomplete coverage. Since our results confirm the existence of serial correlation within the error terms and the panel heteroskedasticity test reveals that the errors do not have a constant variance, we need an estimation technique that takes both autocorrelation as well as heteroskedasticity into account.

The Hausman specification test is applied to both equations to determine whether to use a fixed effects (FE) or random effects (RE) model for estimation. The evidence suggests that an RE model will generate more efficient and consistent results. We need an estimation technique capable of handling serial correction and RE for heterogeneous countries as well as yielding better results with unbalanced panel data containing missing observations. The most appropriate panel data method in this case is that of Baltagi and Wu (1999), programmed in Stata as *xtregar*. This method is suited to panel data models in which the disturbance term is first-order autoregressive. It also provides results for both FE within the estimator and the generalized least squares (GLS) estimator for an RE model.

As a robustness check, we use the GLS estimator (programmed as *xtgls* in Stata), which also accounts for panel heteroskedasticity and panel-specific error autocorrelation. The only issue *xtgls* does not resolve is that of missing observations when calculating the error autocorrelation. We therefore estimate[9] equation (1) following Baltagi and Wu (1999) and report both the FE and RE results along with those for *xtgls*. However, as equation (2) contains an endogenous variable (education expenditure), we apply two instrumental variable (IV) methods instead.

The first is the two-stage least squares (2SLS) estimation technique in which the endogenous variable is instrumented with the same set of explanatory variables as in equation (1), except for GDP per capita. Second, to solve the endogeneity problem inherent in panel data, we instrument education expenditure with its own lagged value, which is assumed to be independent of contemporaneous errors. Finally, countries with only one observation are dropped such that the number of data points ranges from 2 to 36 for different countries. All the variables used in the estimation are expressed in log form so that their coefficients represent elasticities.

4. Results and Discussion

The empirical results of the analysis are presented in Tables 3 to 9. Overall, our results are as expected. In addition to the evidence from the Hausman test, the FE and RE estimates lie close together and justify the use of an RE model. The Baltagi and Wu (1999) and 2SLS results are discussed in more detail as the baseline estimates, while the GLS estimates provide a robustness check for both equations. The results

[9] Since the public spending equation is dynamic, the GMM technique was also considered for carrying out the estimations. However, the unequally spaced unbalanced panel data with gaps barred the analysis.

remain generally consistent across different estimation techniques, which suggest they are robust.

4.1. Education Expenditure Outcomes

Tables 3 to 5 report the empirical results for education expenditure across the overall sample as well as for its decomposition into OECD and non-OECD countries. The effects of fiscal decentralization are captured by three measures: subnational tax revenues, subnational total revenues and federal transfers to the provinces. The empirical evidence confirms that different fiscal decentralization structures have different implications. Table 3 shows that a rise in subnational tax revenues increases education spending per student, with a positive and significant impact. We obtain comparable and consistent results across different estimation techniques. This finding holds for the overall sample as well as for the OECD countries.

The baseline regression suggests that a 1 percent increase in subnational tax revenues increases per pupil education spending by 0.08 percent for the overall sample (62 countries). This coefficient is almost double in the case of the OECD countries where a 1 percent increase in subnational tax revenues leads to a 0.16 percent increase in per pupil government spending. However, the subnational tax revenues variable is not significant for the non-OECD countries, despite its positive sign.

The second measure of fiscal decentralization, subnational total revenues, generates similar results (Table 3), which suggest that an increase in total resources at the local level has a positive effect on education expenditure per pupil. The baseline regression results show that a 1 percentage point increase in total revenues at the subnational level leads to a 0.08 percent increase in per pupil education spending for the overall sample. The corresponding change for the OECD countries is 0.22 percent.

Despite their positive signs, there is no evidence that the coefficients are significantly different from 0 in the case of the non-OECD countries. This suggests that local governments in non-OECD countries lack either the capacity or funds to make effective decisions concerning education spending. This also relates to effective governance, although we have no empirical evidence (due to data limitations) to prove it. Once again, the results suggest that any increase in local revenues does not translate into higher education spending per student in non-OECD countries.

The third measure, federal transfers to the subnational government, yields a negative relationship between fiscal decentralization and education spending per pupil (Tables 4 and 5). The results are insignificant in the baseline regression and federal transfers have a significant, albeit weak, coefficient only in the GLS estimation for all three samples. This is not unexpected. Federal transfers to lower tiers of government indicate a vertical imbalance: when local governments depend on federal transfers, these may come with strings attached. Here, federal transfers reflect a partially decentralized structure where the central government collects revenues, which subnational governments are responsible for spending. Transfers from the center may or may not be allocated to the social sectors if they are not sector-specific.

Table 3: Baseline regression results for education expenditure

Dependent variable: education expenditure per student

	Overall sample			OECD countries			Non-OECD countries		
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
GDP per capita	0.850***	0.840***	0.886***	0.723***	0.701***	0.731***	1.051***	1.005***	1.036***
	(20.45)	(21.79)	(19.94)	(10.59)	(10.40)	(8.65)	(15.53)	(15.94)	(15.47)
Government spending (% GDP)	0.509***	0.478***	0.416***	0.648***	0.532***	0.393**	0.536***	0.511***	0.507***
	(5.72)	(5.31)	(4.50)	(3.80)	(2.96)	(2.03)	(5.59)	(5.74)	(5.53)
Population aged 65+	0.574***	0.590***	0.511***	0.312	0.581**	0.316	0.174	0.063	0.190
	(4.26)	(4.76)	(3.71)	(1.11)	(2.12)	(1.03)	(0.88)	(0.35)	(1.04)
Population aged 5–14	-0.050	-0.004	-0.095	-0.084	0.046	-0.016	-0.673**	-0.747***	-0.625**
	(-0.33)	(-0.02)	(-0.54)	(-0.40)	(0.21)	(-0.07)	(-2.47)	(-2.83)	(-2.40)
Urbanization	-0.042	0.141	-0.070	0.160	0.242	0.228	-0.334*	-0.021	-0.302
	(-0.26)	(1.04)	(-0.42)	(0.54)	(0.81)	(0.65)	(-1.69)	(-0.14)	(-1.59)
Subnational govt. share of tax revenue	0.080***			0.159***			0.023		
	(2.69)			(3.89)			(0.62)		
Federal transfers to subnational govt.		-0.014			-0.098			0.029	
		(-0.36)			(-1.42)			(0.73)	
Subnational govt. share of revenue			0.083*			0.221***			0.060
			(1.95)			(2.86)			(1.38)
Constant	-7.741***	-8.239***	-7.455***	-7.218***	-7.257***	-7.278***	-5.492***	-5.952***	-5.710***
	(-9.82)	(-10.90)	(-8.81)	(-4.85)	(-4.54)	(-4.37)	(-4.70)	(-5.31)	(-5.04)
Total obs.	811	799	736	538	503	451	273	296	285
Countries	59	62	58	27	27	26	32	35	32
Average obs.	13.746	12.887	12.690	19.926	18.630	17.346	8.531	8.457	8.906
Max obs.	36	35	35	36	35	35	32	30	30
Autocorrelation coefficient	0.43	0.42	0.41	0.32	0.31	0.30	0.73	0.71	0.31
Wooldridge F-test for autocorrelation	9.915	10.265	7.659	2.761	2.258	1.638	14.162	15.034	10.828
	[0.0028]	[0.0023]	[0.0079]	[0.1096]	[0.1460]	[0.2133]	[0.0009]	[0.0006]	[0.0029]
Likelihood ratio test for heteroskedasticity	719.98	746.87	668.18	527.60	567.33	431.79	268.45	271.83	280.08
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Hausman test chi2 (6)	0.42			9.01			11.40		
(P-value)	[0.9987]			[0.1731]			[0.0768]		

Note: All variables are in log form. RE model estimated using Baltagi and Wu (1999). Min obs. = 2. Legend: b/t (cluster robust standard errors used along with AR1 errors). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's calculations.

Table 4: Robustness check for education expenditure, total sample

Dependent variable: education expenditure per student

	FE	GLS	FE	GLS	FE	GLS
Variable	**1**	**2**	**3**	**4**	**5**	**6**
GDP per capita	0.597***	1.029***	0.482***	1.014***	0.646***	1.010***
	(7.51)	(53.75)	(6.40)	(53.34)	(7.07)	(47.16)
Government spending (% GDP)	0.175	0.591***	0.089	0.567***	0.046	0.550***
	(1.51)	(13.37)	(0.71)	(11.84)	(0.36)	(10.40)
Population aged 65+	0.413*	0.325***	0.698***	0.369***	0.481*	0.422***
	(1.74)	(5.09)	(3.29)	(5.33)	(1.87)	(5.79)
Population aged 5–14	-0.853***	-0.025	-0.911***	-0.043	-0.836***	0.041
	(-5.70)	(-0.28)	(-5.50)	(-0.39)	(-4.22)	(0.36)
Urbanization	-0.512*	-0.270***	-0.253	-0.221***	-0.557*	-0.264***
	(-1.76)	(-3.95)	(-0.87)	(-4.93)	(-1.69)	(-3.37)
Subnational govt. share of tax revenue	0.153***	0.056***				
	(3.03)	(4.02)				
Federal transfers to subnational govt.			0.004	-0.034*		
			(0.07)	(-1.84)		
Subnational govt. share of revenue					0.112	0.086***
					(1.56)	(5.81)
Constant	-0.065	-8.050***	-0.039	-7.824***	-0.118	-8.293***
	(-0.99)	(-20.05)	(-0.58)	(-17.19)	(-1.58)	(-16.37)
Total obs.	752	811	737	799	678	736
Countries	59	59	62	62	58	58
Average obs.	12.746	13.746	11.887	12.887	11.690	12.690
Max obs.	35	36	34	35	34	35

Note: columns 2, 4 and 6 refer to GLS with panel-specific AR(1). All variables are in log form. FE model estimated using Baltagi and Wu (1999). Min obs. = 2. Legend: b/t (cluster robust standard errors used along with AR1 errors). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Author's calculations.

Table 5: Robustness check for education expenditure, split sample

Dependent variable: education expenditure per student

	OECD countries						Non-OECD countries					
	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
GDP per capita	0.535***	1.056***	0.436***	1.024***	0.513***	1.056***	0.994***	1.105***	0.882***	1.078***	0.956***	1.105***
	(5.32)	(22.97)	(4.74)	(20.54)	(4.61)	(19.55)	(6.74)	(56.66)	(6.23)	(52.85)	(6.80)	(52.29)
Government spending (% GDP)	0.741***	0.633***	0.831***	0.597***	0.593**	0.532***	0.378***	0.582***	0.297**	0.572***	0.304**	0.585***
	(3.31)	(7.18)	(3.28)	(6.13)	(2.02)	(5.52)	(3.08)	(15.97)	(2.33)	(12.03)	(2.52)	(14.30)
Population aged 65+	0.038	-0.092	0.329	0.079	0.192	0.119	-0.492	0.136*	-0.315	-0.029	-0.360	0.044
	(0.10)	(-0.59)	(0.85)	(0.43)	(0.43)	(0.86)	(-1.29)	(1.94)	(-0.96)	(-0.40)	(-1.06)	(0.65)
Population aged 5–14	-0.853***	-0.025	-0.871***	-0.043	-0.818***	0.169	-1.184***	-0.600***	-1.439***	-0.767***	-1.235***	-0.662***
	(-4.69)	(-0.15)	(-4.16)	(-0.21)	(-3.23)	(0.93)	(-3.38)	(-5.81)	(-4.87)	(-6.65)	(-3.84)	(-6.43)
Urbanization	-0.490	-0.335*	-0.395	-0.227	-0.461	-0.397*	-0.839*	-0.440***	-0.456	-0.209***	-0.714*	-0.388***
	(-1.10)	(-1.92)	(-0.84)	(-1.14)	(-0.88)	(-1.91)	(-1.85)	(-8.63)	(-1.20)	(-5.47)	(-1.68)	(-6.73)
Subnational govt. share of tax rev.	0.151**	0.140***					0.103	-0.020				
	(2.12)	(5.49)					(1.60)	(-1.46)				
Federal transfers to subnational govt.			-0.012	-0.075**					0.033	0.034*		
			(-0.12)	(-2.38)					(0.55)	(1.71)		
Subnational govt. share of revenue					0.155	0.221***					0.049	0.002
					(1.14)	(8.17)					(0.70)	(0.15)
Constant	-0.090	-7.326***	-0.064	-7.073***	-0.120	-8.102***	0.180***	-5.679***	0.145***	-5.724***	0.098**	-5.580***
	(-0.78)	(-7.64)	(-0.49)	(-5.87)	(-0.81)	(-8.11)	(3.80)	(-13.77)	(3.21)	(-14.18)	(2.02)	(-13.51)
Total obs.	511	538	476	503	425	451	241	273	261	296	253	285
Countries	27	27	27	27	26	26	32	32	35	35	32	32
Average obs.	18.926	19.926	17.630	18.630	16.346	17.346	7.531	8.531	7.457	8.457	7.906	8.906
Max obs.	35	36	34	35	34	35	31	32	29	30	29	30

Note: columns 2, 4, 6, 8, 10 and 12 refer to GLS with panel-specific AR(1). All variables are in log form. FE model estimated using Baltagi and Wu (1999). Min obs. = 2. Legend: b/t (cluster robust standard errors used along with AR1 errors). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Author's calculations.

The results are similar across the overall sample and OECD countries, where dependence on federal transfers produces a negative coefficient for education expenditure per pupil. In the case of non-OECD countries, the variable has a positive coefficient, indicating that subnational governments have fewer resources of their own. This supports the earlier argument that subnational governments lack the appropriate resources to improve their spending on the social sectors. The GLS results show that a 1 percent increase in federal transfers to the subnational government improves per student education expenditure by 0.03 percent in non-OECD countries. These results support the hypothesis that different fiscal decentralization policies have different effects for local governments.

Per capita GDP has a consistently positive and significant effect in all three datasets and across the different models containing the three fiscal decentralization proxies. An increase in GDP has a greater impact on education spending in non-OECD countries than in the OECD countries. Similarly, government expenditure has a positive and significant impact on per pupil education spending. The variable captures the government's commitment to education in that an increase in general expenditures does not lower education spending.

The results for the proportion of the population aged 65 and above are not consistent across models. We find no significant evidence supporting the interest group hypothesis. The coefficient remains positive, although primarily for the overall sample because the results are not robust across the different subsets of data. In the case of the decomposed samples of OECD and non-OECD countries, this proxy is not significant except in one instance in each sample.

The school-age population (5–14) variable is a key determinant of education spending because it affects the expenditure needed per student. The results for the OECD countries show that the variable is statistically insignificant in all three models. This suggests that governments in OECD countries are well equipped to cater to their countries' future education needs. Since the overall sample is dominated by OECD countries in terms of data points, the former yields similar results.

This is not the case for the non-OECD sample, where an increase in the proportion of the school-age population has a negative effect on per pupil education spending. This points to inadequate policymaking and poor governance, but might also indicate scarce resources and a high birth rate (the latter increasing the proportion of the school-age population). In

addition, with a significant number of children out of school, any drive to increase enrollment can have a potentially negative effect on the available resources, particularly in non-OECD countries.

Finally, urbanization tends to reduce the per pupil public education spending needed, which suggests that government spending per student is higher in rural areas than in urban areas where governments enjoy economies of scale. Although the variable's significance is not universal, it yields comparable coefficients wherever significant.

4.2. Education Outcomes for Teacher–Student Ratio

Since education quality is represented by the ratio of teachers to students at the primary level, it can be affected by changes in both the numerator and denominator. However, it is reasonable to assume that any shift in resources or policymaking from the center to the lower tiers will not reduce the number of available teachers, especially in non-OECD countries where the teacher–student ratio is comparatively low as it is. Thus, the major impetus for change in this ratio will be any variation in student enrollment. The results should reflect the government's ability to provide newly enrolled students with the required number of teachers to avoid reducing the teacher–student ratio.

Since this ratio is equal to the number of teachers divided by the number of students at the primary level, a higher numerical value for the series indicates the greater availability of teachers per student. It is not easy to explain a positive or negative effect because the latter might still reflect an increase in enrollment (as the positive output of a policy reform). However, if this rise in enrollment is not matched by the required number of teachers, the quality of teaching will fall. A positive coefficient suggests a larger number of teachers per student, reflecting an improvement in teaching quality.

As with the education expenditure equation, we use the same three fiscal decentralization indicators and three different subsets of data to gauge education quality. Table 6 presents the 2SLS results for the teacher–student ratio equation. As discussed earlier, education expenditure per pupil and education quality are influenced by nearly the same set of independent variables and, therefore, the 2SLS and IV methods are used to resolve the endogeneity problem.

In the 2SLS estimation, education expenditure is now presented as a relatively more comprehensive measure: per pupil education spending as a share of per capita GDP. We assume a similar set of explanatory variables apart from GDP per capita and the proportion of the population aged 65 and above. The latter is dropped because the earlier results were not robust. Again, the Hausman specification test suggests that an RE model be used. In addition to the 2SLS baseline regression with RE, the GLS estimator[10] is used in the IV approach where per pupil education expenditure (as a ratio to per capita GDP) is lagged by one and two years to avoid an endogeneity problem. Tables 7 to 9 present the results for the GLS estimation and 2SLS FE results. The results are largely comparable across the two estimation techniques and appear to be robust.

The results in Table 6 suggest that an increase in subnational tax revenues has a negative and significant effect on the dependent variable, which means that greater local autonomy increases the number of students per teacher. For the overall sample, a 1 percent increase in subnational tax revenues leads to a –0.03 percentage point change in the number of teachers per student. Despite having the lowest coefficient of all the significant variables, this is a disappointing result because it implies that local autonomy is associated with lower education quality. It can also be interpreted to mean that local governments are more likely to focus on improving enrollment than on maintaining or improving the quality of education by providing the appropriate number of teachers. This result is consistent across the overall sample and non-OECD countries.

As expected, the coefficient of subnational tax revenues is insignificant for the OECD countries. Given their level of development, they are able to plan and execute long-run education policies successfully and, therefore, any transition from central to local governments has no significant effect on education quality. In addition, with a near 100 percent enrollment rate, they are better able to assess and finance their future education needs. This does not hold for the non-OECD countries and drives the result for the overall sample.

[10] Taking care of heteroskedasticity and panel-specific AR1 using panel-corrected standard errors.

Table 6: Baseline regression results for education quality

Dependent variable: teacher–student ratio

	Total sample			OECD countries			Non-OECD countries		
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Expenditure per pupil (% of GDP pc)	0.255*** (4.27)	0.366*** (4.27)	0.318*** (4.34)	0.257** (2.42)	0.409** (2.35)	0.444* (1.88)	0.108** (2.21)	0.253*** (3.16)	0.168*** (3.70)
Population aged 5–14	-0.664*** (-8.29)	-0.583*** (-6.15)	-0.627*** (-7.01)	-0.651*** (-4.14)	-0.451* (-1.82)	-0.409 (-1.40)	-0.443*** (-4.99)	-0.391*** (-4.09)	-0.459*** (-5.06)
Dependency ratio	-0.099 (-1.08)	-0.167 (-1.64)	0.050 (0.42)	-0.405** (-2.43)	-0.716*** (-2.96)	-0.524* (-1.75)	-0.060 (-0.52)	0.033 (0.26)	0.058 (0.49)
Urbanization	0.205** (2.56)	0.118 (1.57)	0.275*** (2.89)	0.106 (0.65)	0.273 (0.89)	0.784* (1.79)	0.337** (2.50)	0.272** (2.29)	0.258* (1.92)
SNG share of tax revenue	-0.029** (-2.12)			-0.008 (-0.37)			-0.055*** (-3.30)		
Federal transfers to SNG		-0.080*** (-3.23)			-0.154*** (-3.14)			-0.045* (-1.67)	
SNG share of revenue			-0.029 (-1.12)			-0.030 (-0.39)			-0.058*** (-2.68)
Constant	-2.233*** (-4.13)	-1.912*** (-3.39)	-3.378*** (-4.66)	-0.702 (-0.77)	-0.612 (-0.35)	-4.222* (-1.69)	-3.114*** (-3.89)	-3.732*** (-5.05)	-3.358*** (-4.25)
Total obs.	588	585	529	366	344	297	222	241	232
Countries	58	59	55	26	25	24	32	34	31
Average obs.	10.138	9.915	9.618	14.077	13.760	12.375	6.938	7.088	7.484
Max obs.	32	32	32	32	32	32	31	30	30
Hausman test chi2 (5) (P-value)	3.71 [0.5925]			0.56 [0.9897]			62.37 [1.000]		

Note: SNG = subnational government. All variables expressed in log form. 2SLS results for RE estimation. Min obs. = 2. Legend: b/t (cluster robust standard errors used). * p < 0.1; ** p < 0.05; *** p < 0.01.

Source: Author's calculations.

Table 7: Robustness check for education quality, total sample

Dependent variable: teacher–student ratio

Variable	2SLS with FE 1	GLS 2	GLS 3	2SLS with FE 4	GLS 5	GLS 6	2SLS with FE 7	GLS 8	GLS 9
Expenditure per pupil (% of GDP pc)	0.278***			0.383***			0.330***		
	(4.21)			(4.02)			(4.12)		
Expenditure per pupil (% of GDP pc), L1		0.080***			0.093***			0.070***	
		(5.10)			(5.59)			(4.52)	
Expenditure per pupil (% GDP pc), L2			0.111***			0.142***			0.103***
			(6.98)			(8.02)			(6.90)
Population aged 5–14	-0.664***	-0.758***	-0.904***	-0.589***	-0.941***	-0.866***	-0.624***	-0.938***	-1.019***
	(-7.47)	(-23.52)	(-17.00)	(-5.45)	(-23.02)	(-15.91)	(-6.26)	(-22.93)	(-21.17)
Dependency ratio	-0.100	0.237***	0.401***	-0.175	0.419***	0.455***	0.078	0.337***	0.512***
	(-0.98)	(3.94)	(4.96)	(-1.53)	(7.61)	(4.95)	(0.60)	(5.78)	(6.56)
Urbanization	0.120	0.101**	0.122***	-0.015	0.040	0.291***	0.279	0.113***	0.121***
	(0.86)	(2.43)	(2.80)	(-0.09)	(1.23)	(7.14)	(1.41)	(2.58)	(2.69)
SNG share of tax revenue	-0.045***	-0.030***	-0.013						
	(-2.73)	(-3.14)	(-1.20)						
Federal transfers to SNG				-0.098***	-0.003	0.015			
				(-3.37)	(-0.34)	(1.37)			
SNG share of revenue							-0.067**	-0.040***	-0.051***
							(-1.96)	(-3.72)	(-4.05)
Constant	-1.861**	-2.363***	-2.801***	-1.250	-2.438***	-4.038***	-3.398***	-2.252***	-2.801***
	(-2.51)	(-9.24)	(-12.04)	(-1.32)	(-10.36)	(-15.55)	(-2.95)	(-8.89)	(-10.57)
Total obs.	588	475	422	585	467	418	529	428	381
Countries	58	49	43	59	49	44	55	48	44
Average obs.	10.138	9.694	9.814	9.915	9.531	9.500	9.618	8.917	8.659
Max obs.	32	30	29	32	29	29	32	29	28

Note: SNG = subnational government, L1 = lagged by one year, L2 = lagged by two years. Columns 2, 3, 5, 6, 8 and 9 refer to GLS with panel-specific AR(1). All variables expressed in log form. Min obs. = 2. Legend: b/t (cluster robust standard errors used). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
Source: Author's calculations.

Table 8: Robustness check for education quality, OECD countries

Dependent variable: teacher–student ratio

Variable	2SLS with FE 1	GLS 2	GLS 3	2SLS with FE 4	GLS 5	GLS 6	2SLS with FE 7	GLS 8	GLS 9
Expenditure per pupil (% of GDP pc)	0.244** (2.47)			0.373** (2.45)			0.308** (2.31)		
Expenditure per pupil (% of GDP pc), L1		0.045* (1.85)			0.064*** (2.69)			0.064*** (2.68)	
Expenditure per pupil (% GDP pc), L2			0.111*** (4.55)			0.112*** (4.14)			0.115*** (3.93)
Population aged 5–14	-0.645*** (-4.09)	-1.187*** (-22.28)	-1.138*** (-21.07)	-0.434* (-1.74)	-1.260*** (-25.25)	-1.233*** (-24.10)	-0.354 (-1.47)	-1.257*** (-23.34)	-1.211*** (-18.15)
Dependency ratio	-0.422** (-2.47)	0.539*** (5.28)	0.517*** (5.46)	-0.750*** (-3.09)	0.302*** (2.68)	0.373*** (3.54)	-0.684** (-2.54)	0.351*** (3.15)	0.328*** (3.00)
Urbanization	0.135 (0.76)	-0.105* (-1.67)	-0.100 (-1.61)	0.390 (1.07)	-0.051 (-0.65)	0.002 (0.04)	1.178** (2.47)	0.204*** (2.87)	0.303*** (4.70)
SNG share of tax revenue	-0.008 (-0.33)	0.012 (0.70)	0.021 (1.20)						
Federal transfers to SNG				-0.156*** (-3.17)	-0.068*** (-3.68)	-0.081*** (-4.39)			
SNG share of revenue							0.043 (0.52)	-0.046** (-2.08)	-0.055*** (-2.66)
Constant	-0.723 (-0.76)	-1.545*** (-3.76)	-1.833*** (-5.48)	-0.894 (-0.47)	-0.448 (-0.83)	-1.122*** (-2.72)	-5.277** (-2.21)	-1.844*** (-3.83)	-2.425*** (-5.60)
Total obs.	366	306	276	344	291	264	297	250	223
Countries	26	23	21	25	23	21	24	22	20
Average obs.	14.077	13.304	13.143	13.760	12.652	12.571	12.375	11.364	11.150
Max obs.	32	29	29	32	29	29	32	29	28

Note: SNG = subnational government, L1 = lagged by one year, L2 = lagged by two years. Columns 2, 3, 5, 6, 8 and 9 refer to GLS with panel-specific AR(1). All variables expressed in log form. Min obs. = 2. Legend: b/t (cluster robust standard errors used). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
Source: Author's calculations.

Table 9: Robustness check for education quality, non-OECD countries

Dependent variable: teacher–student ratio

Variable	2SLS with FE 1	GLS 2	GLS 3	2SLS with FE 4	GLS 5	GLS 6	2SLS with FE 7	GLS 8	GLS 9
Expenditure per pupil (% of GDP pc)	0.067			0.225**			0.151***		
	(1.30)			(2.52)			(3.10)		
Expenditure per pupil (% of GDP pc), L1		0.089***			0.048**			0.131***	
		(4.63)			(2.29)			(5.91)	
Expenditure per pupil (% GDP pc), L2			0.087***			0.070***			0.117***
			(3.76)			(3.02)			(4.82)
Population aged 5–14	-0.431***	-0.933***	-0.888***	-0.383***	-0.880***	-0.852***	-0.440***	-1.000***	-0.836***
	(-4.47)	(-15.74)	(-15.16)	(-3.73)	(-11.31)	(-11.20)	(-4.53)	(-13.28)	(-13.02)
Dependency ratio	-0.084	0.377***	0.299***	0.031	0.303**	0.149	0.023	0.588***	0.337***
	(-0.59)	(4.52)	(2.95)	(0.21)	(2.46)	(1.28)	(0.17)	(4.95)	(2.79)
Urbanization	0.365	0.234***	0.382***	0.271	0.334***	0.384***	0.154	0.329***	0.498***
	(1.47)	(5.38)	(5.63)	(1.14)	(4.74)	(5.47)	(0.64)	(4.94)	(7.25)
SNG share of tax revenue	-0.070***	-0.029***	-0.042***						
	(-3.92)	(-3.15)	(-3.04)						
Federal transfers to SNG				-0.040	0.035**	0.066***			
				(-1.34)	(2.18)	(4.18)			
SNG share of revenue							-0.077***	-0.050***	-0.041**
							(-3.23)	(-2.73)	(-2.08)
Constant	-2.944**	-2.957***	-3.339***	-3.619***	-3.331***	-3.133***	-2.676**	-4.084***	-4.183***
	(-2.24)	(-12.28)	(-9.05)	(-3.03)	(-7.87)	(-8.42)	(-2.12)	(-11.39)	(-9.86)
Total obs.	222	169	146	241	176	154	232	178	158
Countries	32	26	22	34	26	23	31	26	24
Average obs.	6.938	6.500	6.636	7.088	6.769	6.696	7.484	6.846	6.583
Max obs.	31	30	28	30	29	28	30	29	28

Note: SNG = subnational government, L1 = lagged by one year, L2 = lagged by two years. Columns 2, 3, 5, 6, 8 and 9 refer to GLS with panel-specific AR(1). All variables expressed in log form. Min obs. = 2. Legend: b/t (cluster robust standard errors used). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
Source: Author's calculations.

The second measure, subnational total revenues, yields similar results, with greater fiscal decentralization leading to an increase in the number of students per teacher (Table 6). However, the results are insignificant in the baseline regression for the overall sample and for the OECD countries. The weaker GLS estimator produces statistically significant results (Tables 7 and 8), while the 2SLS and IV regression yields a negative and significant coefficient for the non-OECD countries. Again, this suggests that fiscal decentralization results in more students per teacher, causing the teacher–student ratio to suffer (Tables 6 and 9). The coefficients are small, with a 1 percent change in subnational total revenues leading to a 0.06 percent change in the teacher–student ratio in non-OECD countries.

Table 6 also gives the results for federal transfers to the subnational level. Fiscal decentralization appears to have a negative and significant impact on education outcomes. This result is significant for all three datasets, including the OECD countries, which is surprising. One explanation for this is that, in developed countries, local governments receive sector-specific targeted funds. In the education sector, for example, local governments might receive transfers per student. Therefore, the federal transfers variable may be capturing the effect of higher enrollment as local governments have an incentive to improve enrollment rates even in developed countries.

The education expenditure proxy has a positive and statistically significant coefficient across different models of fiscal decentralization and all three datasets. This is as expected, with the results suggesting that higher education spending per pupil improves the quality of education. Education expenditure appears to be universally significant across different estimation techniques. In all three datasets, education spending has significantly higher coefficients in the 2SLS regression relative to the GLS regression (which uses the lagged effect of education spending as an instrument). It is worth noting, however, that using lagged values for per pupil education spending (as a percentage of GDP per capita) causes a loss of almost 100 data points in the overall sample.

A key variable with almost universal significance across different models is urbanization. Urban areas generally provide a better standard of education, with more teachers per student, than rural areas both in OECD and non-OECD countries. This effect is stronger in the latter, implying that there is a greater difference between urban and rural areas in terms of the quality of education. In the regression containing the federal transfers

variable, the effect of urbanization is driven by the non-OECD countries. Its coefficient remains insignificant for the overall and OECD samples.

Another important determinant of education quality is the proportion of the school-age population. As the latter increases, it puts further pressure on the existing infrastructure. Importantly, this variable also captures school enrollment, suggesting that an increase in the school-age population will occur regardless of whether these children eventually go to school. Its effect on education quality is difficult to explain because there is greater disparity in the coefficient estimates obtained from the 2SLS and IV model. The coefficients obtained from the GLS and IV estimation are far higher across all three datasets. Instead of focusing on the coefficient, we look at its negative sign, which suggests that a rise in the number of school-age children leads to higher enrollment and thus lower teaching quality. This is not intuitive in the case of the OECD sample, however.

The dependency ratio is equal to the proportion of dependents (the elderly and children) among the total working-age population. We include this to capture the poverty effect in non-OECD countries (most OECD countries already have social safety nets in place). The variable is significant in the overall and OECD samples, but changes signs between the 2SLS and IV-GLS models (Tables 6 to 8). However, in the case of the non-OECD countries, where the variable matters most, the sign remains consistent, although it is significant only in the IV-GLS model.

Tables 7 to 9 give the results of the IV-GLS estimation, showing that an increase in the dependency ratio has a negative relationship with school enrollment. An increase in poverty, reflected in greater pressure on limited resources, leads to lower enrollment and improves the teacher–student ratio, as the positive coefficient indicates. This suggests that a higher dependency ratio discourages households from sending their children to school rather than shifting them from private to public schools, which would have had the opposite effect as in the case of the OECD sample (Table 6).

5. Conclusion

It is important for governments to envisage the short-run and long-run effects of their policies. Short-run efforts normally focus on generating the funds needed to carry out administrative reforms, while long-run efforts are driven by the expected outcome of the policy reform. In this context, education expenditure would ideally capture the short-run effect of fiscal decentralization on education input, the enrollment rate would help gauge

the education output of decentralization reforms and education quality (as the teacher–student ratio) would measure the outcome. Unfortunately, we could not use the enrollment rate as a dependent variable because the OECD countries, which dominate the sample, have near 100 percent enrollment. The teacher–student ratio is a comprehensive measure of education outcomes and illustrates the government's ability to ensure education quality by providing resources that meet enrollment needs.

This study provides empirical evidence of the distinct effects of different fiscal decentralization policies on the education sector. Thus, different sources of subnational revenue affect education expenditure and quality differently. The most important finding is that, when subnational governments are financed by own-tax revenues, they are more efficient and likely to increase education spending to enhance enrollment. This makes a strong case for localization when self-financed. While the total revenue of the subnational government has a positive effect on education, the sources of financing – for instance, federal transfers – are associated with different results for education spending. This implies that there are political economy issues at stake, such that different policies on decentralization yield different results.

Another key finding is that OECD and non-OECD countries are associated with different results owing to differences in their economic and political structures. The most important distinction is the difference in composition of subnational revenues. The disaggregated results show that local governments have larger self-financed resources in OECD countries. While an increase in federal transfers leads to a rise in education spending in the non-OECD countries, the opposite occurs in OECD countries.

In the case of education quality in the form of the teacher–student ratio, local governments tend to favor student enrollment over maintaining the required number of teachers. This effect is more prominent in the non-OECD countries, most of which are still trying to achieve universal enrollment. Thus, when using a large international panel, it is advisable to identify what drives the results in different regions by disaggregating the datasets. This study shows that decentralized structures address local social needs better. Moreover, governments should institute checks and balances to ensure that federal transfers do not cause inefficiency.

Different policy instruments are used to improve a country's social indicators. Fiscal decentralization is particularly important in relatively less developed countries, many of which have not met their Millennium

Development Goal targets. This analysis provides evidence that local governments are better able to assess local demands and needs in the education sector, which is encouraging. However, over and above education spending and enrollment, local governments need to focus on improving the quality of education.

While federal transfers might bridge resource shortfalls, they do not carry the same incentives as local resource generation, which makes local governments answerable to their taxpayers. Local governments should, therefore, be encouraged to depend on their own resources. Improved governance, better institutions and local elections can help reduce corruption and inefficiency, such that these resources are then used more effectively.

Treisman (2000) finds that corruption is highly correlated with decentralized structures and thus affects public spending. This makes it important to incorporate this aspect in the analysis and control for the corruption perception index across countries. However, since the data for this indicator is relatively recent and provides only limited coverage, we could not analyze this aspect of decentralization and spending. Future research could examine this in detail. Similarly, other measures such as dropout rates and standardized test scores could also serve as dependent variables to determine the effect of decentralization on the quality of education. Finally, since the equation for public spending is dynamic (a function of the previous period's spending), future research could use the GMM technique to estimate and compare results across a smaller sample (for example, the OECD countries) to avoid the problems associated with unequally spaced, unbalanced panel data.

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Appendix 1

Determinants of education expenditure, enrollment and effects of fiscal decentralization on education

Table A1 presents the key variables used to explain different education indicators in the literature. This also helps identify any potential issues that might emerge during estimation. The studies listed draw on different datasets and, therefore, are associated with different potential estimation problems. In explaining different education indicators, the most important variables are per capita income, the proportion of the school-age population, age distribution, demographic characteristics and governance.

In analyzing the link between fiscal decentralization and education, the literature suggests that, when people are equipped to benefit from it, fiscal decentralization has a positive and significant effect on education. However, the effects are not uniform for the poor and nonpoor, which indicates the possibility of elite capture. Thus, when focusing on decentralization, it is equally important to consider policy prerequisites and shortcomings.

Table A1: Summary of empirical studies on the determinants of education indicators

Region, period and estimation technique	Dependent variable(s)	Explanatory variables	Main results
Busemeyer (2007)			
OECD countries, 1991–2001 LSDV with panel-corrected standard errors	Total public education spending, spending on primary and secondary education Spending on tertiary education (all in either % of GDP or per student)	*Significant variables* Fiscal decentralization, public social spending, GDP per capita, ratio of population aged 65+ to population aged 5–29, dummies *Broadly insignificant variables* Nil	Education expenditures increase with higher levels of fiscal decentralization. Local governments compete to provide better facilities to attract taxpayers from other regions.
Falch and Fischer (2012)			
OECD, unbalanced panel dataset of 25 countries, 1980–2000 Fixed effects model	Student test scores (national average of scores in mathematics and natural science tests)	*Significant variables* Decentralization lagged (one period), GDP per capita, social spending * decentralization, dummy for OECD PISA test *Broadly insignificant variables* Population size, government consumption spending as % of GDP, government consumption * decentralization, social spending as % of GDP, social spending * decentralization, primary education spending per pupil as % of GDP	Decentralization of government spending has positive effect on student performance that need not be mediated through level of education spending. Mere administrative effects of decentralization can result in efficiency gains.
Verbina and Chowdhury (2004)			
88 regions in the Russian Federation, 1999 and 2000 GLS random effects model	Per capita expenditure on education	*Significant variables* Total regional revenue, student–population ratio, population density, regional and time dummies *Broadly insignificant variables* Nil	Regional revenues have positive effect on education expenditures and enrolment. Education is a normal good in Russia. One percentage point increase in average student–population ratio increases education spending by 0.5 percentage point.
Stasavage (2005)			

Region, period and estimation technique	Dependent variable(s)	Explanatory variables	Main results
Africa, unbalanced panel of 44 countries, 1980–96 OLS, fixed effects model	Total public spending on overall education Public spending on primary education	*Significant variables* Real GDP per capita, multiparty competition, foreign aid as % of GDP, % of rural and urban population under 15 *Broadly insignificant variables* Election years	Multiparty competition and GDP per capita have positive effects on education spending. Foreign aid has negative impact on education spending.
Gupta, Verhoeven and Tiongson (2002)			
Cross-sectional data for 45 developing and transitional countries, 1993–94 OLS and 2SLS	Educational attainment (gross enrolment rate) in (i) primary and secondary education and (ii) secondary education Persistence to Grade 4 Dropout rate at the primary level	*Significant variables* Ratio of public spending on education to GDP, spending on primary and secondary education as share of total education spending, per capita GDP (in PPP terms), share of population aged 0–14, urbanization, child nutrition (proxy = child mortality), dummy variables for regions *Broadly insignificant variables* Differ across models and estimation techniques	Public spending on education is associated with improvements in access to and attainment of education. Five percentage point increase in government spending on primary and secondary education yields more than 1 percentage point rise in gross secondary enrolment.
Rajkumar and Swaroop (2008)			
57 countries, annual data for 1990, 1997 and 2003 OLS and 2SLS (with random effects)	Education failure/nonattainment: proportion of those who failed to complete adequate level of primary schooling	*Significant variables* Per capita GDP (in PPP terms), income inequality, dummy for East Asia, interaction terms (index of corruption * share of public primary education spending in GDP, quality of bureaucracy * share of public primary education spending in GDP) *Broadly insignificant variables* Share of public primary education spending in GDP, adult illiteracy rate, measures of governance (index of corruption or quality of bureaucracy), income inequality, predominantly Muslim, ethno-linguistic fractionalization, urbanization, population aged 6–12, dummy for 1997 and 2003	In the absence of good governance, public spending loses its effectiveness. Public spending increases primary educational attainment in countries with good governance, but has virtually no impact on education outcomes in countries that suffer from poor governance.

Region, period and estimation technique	Dependent variable(s)	Explanatory variables	Main results
Holmes (2003)			
Pakistan, primary data from the Pakistan Integrated Household Survey for 1991 Censored ordered probit analysis	Years of schooling for children aged 5–25, by gender	*Significant variables* Age, age squared, mother's education, father's education, value of land and property/100,000, Muslim, rural, sewage facilities, distance to middle and secondary schools, average female wage, average male wage, dummies for Balochistan and NWFP *Broadly insignificant variables* Distance to primary school, dummy for Sindh	Parental education is an important determinant of schooling demand. Boys' schooling is affected more by paternal education while maternal education increases schooling demand for girls. Household wealth and average male wage has positive effect on educational attainment. Deficiency in basic facilities (sewage) and distance to school have negative effect on schooling demand.
Schmidt and McCarty (2008)			
48 US states, panel data, 1980–2000 OLS, fixed effects, random effects and nonlinear least squares	State and local education spending per capita	*Significant variables* *State per capita income, derived future income, student fraction of state population (6–17), demographic characteristics (fraction of state population that is: high school-educated, below poverty line, over 64, living in urban areas, and ethnically Asian or Caucasian)* *Broadly insignificant variables* Federal aid for education, general (unrestricted) federal aid, reform dummy (court-ordered reform of state's education finance system), fraction of state population that is college-educated	Future income has important bearing on the state's current expenditures. Current education spending is not influenced by present or past aid.
Fernandez and Rogerson (2001)			
48 US states, panel for 1950–90 OLS with data in level and first difference	Real per student current expenditure on public primary and secondary education	*Significant variables* Real personal income, number of students in average daily attendance, population over 65 *Broadly insignificant variables* Population of school age (5–17)	Two major determinants of public education spending are personal income and number of students in average daily attendance.

Region, period and estimation technique	Dependent variable(s)	Explanatory variables	Main results
Marlow (2000)			
California, cross-sectional data for 54 counties, different years Seemingly unrelated regression	Education spending as % of personal income	*Significant variables* Per capita income, student share of population, federal share of education funding, Herfindahl index score *Broadly insignificant variables* Population density, state share of education funding, % of black, Hispanic and Asian students	Higher concentration of public school leads to monopoly. As a result, schools obtained higher funding in California.
	Teacher–student ratio Reading, writing and math scores	*Significant variables* Education spending per pupil, per capita income, population density, federal share of education funding, % of black and Hispanic students, Herfindahl index score, median education level of county residents *Broadly insignificant variables* Student share of population, state share of education funding, % of Asian students	Rise in overall and state education funding did not translate into better student performance.
Miller (1996)			
48 US states, 1960–90 with 10-year gap Fixed and random effects	State and local spending on public education (per adult)	*Significant variables* Number of adults with children/total voting-age population, population aged 65+/total voting-age population, state median income, % adults who completed high school, public enrolment/voting-age population, private enrolment/voting-age population, number of people employed in public education/voting-age population *Broadly insignificant variables* % who voted for Democrat president, % teachers in public schools who are members of the National Education Association	Interest group model at work. Parents have positive influence on public education funding. Elderly population have negative impact.

Appendix 2

A note on the construction of fiscal decentralization measures

This study is based on recent panel data for 78 developed and developing countries. The dataset it uses was released by the World Bank in October 2012[11] and is derived from the International Monetary Fund's Government Finance Statistics. These provide detailed information on revenues and expenditures for the three tiers of government and thus reflect the fiscal and administrative arrangements of each country (see World Bank, 2012). The dataset on fiscal decentralization indicators provides data for the period 1972–2010 (although with gaps)[12] and covers all the important definitions of fiscal decentralization employed in the literature. This study adopts the revenue approach and analyzes different fiscal decentralization indicators related to subnational revenues.[13]

The World Bank dataset uses two different accounting methods: accrual and cash. Historically, the Government Finance Statistics were recorded using the cash accounting method where the time assigned to flows is when cash is received or disbursed. Since 2001, many countries have switched to the accrual accounting method and report data on an accrual basis, where the time assigned to flows is when they were created. Nevertheless, the shift from the cash to the accrual method is noticeable among developing countries that either continue to report data on a cash basis or that shifted to the accrual method later. Given the difference in definitions (how the money disbursed is recorded in a certain year), there is a slight difference between the figures obtained from either method and the data cannot be readily combined into one series.

The number of observations for the fiscal decentralization data varies by accounting method. Figures obtained on an accrual basis generally start from 1999/2000 and continue to date, while historical figures are reported using the cash accounting method. There is some overlap around 2000, with figures reported in both series, but this is not always the case. Moreover, for some countries, the figures reported in both series are close together, while for others they diverge considerably.

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[11] The previous dataset covered fewer countries, with observations available only till 2001.

[12] Although the data used in this study is unbalanced and has missing values, we have not created imputed values for the missing observations because this can lead to measurement errors.

[13] We avoid the expenditure approach to fiscal decentralization measures, which tends to overestimate the authority of subnational governments and thus overstate the degree of fiscal decentralization.

To combine the two series, we analyze the data for each country separately and then decide on a consistent method. To avoid any loss of data, we combine both series not only to increase the number of observations, but also to minimize the chances of potential sample selection bias. This is important because data reporting on an accrual basis presumably indicates the developed nature of the country. Countries with better accounting systems shifted to the accrual accounting method more quickly. Combining the two series for each fiscal decentralization measure yields four different scenarios:

- Data reported solely on a cash basis: the same values are retained in the combined series without being treated.
- Data reported solely on an accrual basis: the same values are retained in the combined series without being treated because the accounting method itself cannot affect the volume of resources available at the subnational level. The only difference in the two methods lies in the recording time of the transaction. Therefore, by default, the two series should report a similar trend over the long run.
- Data reported using both the cash and accrual methods, with overlap: both series are spliced together by converting the accrual series to a cash base.[14]
- Data reported using both the cash and accrual methods, with no overlap and figures in both series next to each other in consecutive years. For example, data on subnational tax revenues for the US was reported on a cash basis till 2001 and on an accrual basis thereafter. The accrual series is then extended backward by one year, assuming the same value for the previous year to create an overlap. Accordingly, the two series are spliced together.

Tables A2–A5 describe the data available. The cash series has more observation points, but the accrual series provides the most recent data for the last ten years. Tables A2 and A3 give the summary statistics for the combined series of fiscal decentralization measures and present a disaggregated form of the available data for OECD and non-OECD

[14] The data splicing is carried out in a manner similar to changing the base year for a GDP series. Once an overlap between the two series for each year is obtained, we find the first available data point in the accrual data series and divide it by the last available cash series figure for the same year. This provides a unique multiplying factor for each variable series, which is then multiplied by the given accrual data series for each country to convert the figures to a cash accounting base. Having converted both series to the same base, a combined series for each fiscal decentralization measure is produced that has a cash accounting base.

countries. This bifurcation highlights the availability of data for the variables used (fiscal decentralization proxies). The OECD countries are more decentralized, based on the suggested proxies. We combine the series because a large number of observations is available for both the accrual and cash series and it would be inefficient to lose data reported in either.

Table A2: Descriptive statistics for fiscal decentralization measures, OECD countries

Variable		Mean	SD	Min	Max	Observations
Accrual method						
Subnational govt. share of tax revenue	Overall	30.48	12.23	1.37	57.76	N = 247
	Between		14.69	1.52	56.35	n = 25
	Within		2.20	21.92	40.04	T-bar = 9.88
Vertical grants as share of subnational govt. revenue	Overall	41.17	18.88	8.51	79.67	N = 247
	Between		18.64	9.33	75.02	n = 25
	Within		4.85	26.22	58.79	T-bar = 9.88
Subnational govt. share of revenue	Overall	31.56	11.95	1.37	57.76	N = 201
	Between		14.69	1.52	54.28	n = 23
	Within		1.48	27.45	38.37	T-bar = 8.74
Cash method						
Subnational govt. share of tax revenue	Overall	20.82	14.45	1.29	58.74	N = 326
	Between		15.30	4.21	54.84	n = 22
	Within		2.42	12.51	28.13	T-bar = 14.82
Vertical grants as share of subnational govt. revenue	Overall	43.94	18.33	9.54	86.66	N = 298
	Between		18.43	10.94	79.49	n = 23
	Within		5.86	18.05	74.71	T-bar = 12.96
Subnational govt. share of revenue	Overall	29.39	12.14	1.70	57.21	N = 295
	Between		13.91	1.80	51.99	n = 24
	Within		2.65	12.47	37.99	T-bar = 12.29
Combined series						
Subnational govt. share of tax revenue	Overall	20.67	14.37	0.80	58.74	N = 538
	Between		16.14	1.61	54.84	n = 27
	Within		3.09	5.69	36.00	T-bar = 19.92
Vertical grants as share of subnational govt. revenue	Overall	43.57	18.94	8.51	90.56	N = 503
	Between		17.75	9.83	77.51	n = 27
	Within		6.49	20.32	70.41	T-bar = 18.63
Subnational govt. share of revenue	Overall	29.48	12.08	5.40	57.76	N = 451
	Between		13.91	5.53	54.28	n = 26
	Within		2.52	12.56	38.08	T-bar = 17.35

Source: Author's calculations.

Table A3: Descriptive statistics for fiscal decentralization measures, non-OECD countries

Variable		Mean	SD	Min	Max	Observations
Accrual method						
Subnational govt. share of tax revenue	Overall	20.22	11.75	1.03	47.11	N = 97
	Between		13.74	1.08	45.82	n = 17
	Within		1.65	14.90	24.60	T-bar = 5.71
Vertical grants as share of subnational govt. revenue	Overall	46.64	14.88	8.26	78.00	N = 95
	Between		16.96	9.56	78.00	n = 15
	Within		4.31	31.19	57.78	T-bar = 6.33
Subnational govt. share of revenue	Overall	24.07	18.71	1.57	98.27	N = 96
	Between		17.72	1.70	68.79	n = 15
	Within		9.21	-14.80	53.55	T-bar = 6.4
Cash method						
Subnational govt. share of tax revenue	Overall	11.38	10.60	0.16	48.13	N = 213
	Between		11.98	0.18	47.55	n = 37
	Within		1.90	5.48	19.39	T-bar = 5.76
Vertical grants as share of subnational govt. revenue	Overall	46.22	23.09	1.39	92.72	N = 232
	Between		23.34	4.04	87.51	n = 40
	Within		10.60	18.59	76.31	T-bar = 5.8
Subnational govt. share of revenue	Overall	17.93	11.35	0.82	48.96	N = 216
	Between		13.07	0.82	47.83	n = 36
	Within		2.86	8.90	31.13	T-bar = 6
Combined series						
Subnational govt. share of tax revenue	Overall	13.05	11.32	0.16	48.13	N = 286
	Between		12.13	0.18	46.75	n = 42
	Within		2.25	-3.97	22.29	T-bar = 6.81
Vertical grants as share of subnational govt. revenue	Overall	45.72	21.85	1.39	92.72	N = 308
	Between		22.49	4.04	87.51	n = 45
	Within		9.92	18.09	77.30	T-bar = 6.84
Subnational govt. share of revenue	Overall	19.86	14.51	0.82	98.27	N = 295
	Between		14.72	0.82	68.79	n = 40
	Within		5.82	-19.00	49.35	T-bar = 7.37

Source: Author's calculations.

Table A4: List of countries and maximum data points for any estimation

OECD countries (observations)		Non-OECD countries		
Australia (16)	Japan (5)	Argentina (7)	Georgia (1)	Nicaragua (1)
Austria (35)	Luxembourg (20)	Armenia (3)	Guatemala (1)	Pakistan (16)
Belgium (23)	Malta (4)	Azerbaijan (2)	Honduras (1)	Panama (1)
Denmark (29)	Netherlands (32)	Belarus (1)	Hungary (27)	Paraguay (1)
Finland (34)	New Zealand (14)	Bolivia (7)	India (8)	Peru (11)
France (36)	Norway (33)	Botswana (1)	Iran (9)	Poland (8)
Germany (5)	Portugal (29)	Brazil (3)	Jamaica (2)	Romania (5)
Greece (2)	Spain (28)	Bulgaria (9)	Jordan (1)	Senegal (2)
Iceland (16)	Sweden (21)	Cape Verde (2)	Kenya (1)	Serbia (3)
Ireland (35)	Switzerland (18)	Chile (19)	Korea, Rep. (4)	Slovak Rep. (13)
Israel (32)	UK (31)	China (3)	Latvia (11)	Slovenia (7)
Italy (14)	US (17)	Colombia (7)	Lesotho (3)	South Africa (11)
		Congo, Rep. (2)	Lithuania (7)	Swaziland (3)
		Costa Rica (4)	Malaysia (8)	Thailand (28)
		Cyprus (3)	Mauritius (9)	Tunisia (1)
		Czech Rep. (16)	Mexico (9)	Uganda (3)
		Dominican Republic (1)	Moldova (4)	Zambia (2)
		El Salvador (6)	Morocco (7)	
		Estonia (10)		

Table A5: List of countries that joined OECD later

No.	Country	Data starts	Data till	Maximum observations	Joined OECD
1	Czech Rep.	1993	2009	16	1995
2	Korea	2006	2009	4	1996
3	Poland	2002	2009	8	1996
4	Chile	1974	2009	19	2010
5	Estonia	1997	2008	10	2010
6	Slovenia	1992	2003	7	2010
7	Israel	1974	2009	32	2010
8	Hungary	1981	2009	27	1996
9	Mexico	1989	2000	9	1994
10	Slovak Rep.	1996	2009	13	2000

Note: For the study's purposes, countries 1–3 are considered OECD countries because the bulk of the data was collected after they had joined the OECD. Countries 4–7 are considered non-OECD countries because the data was collected before they joined the OECD. Countries 8–10 are considered non-OECD countries because, although the year they joined the OECD falls within the data collection period, on average they had a similar number of observations falling before and after that year. Dividing a single country's data into two parts would have led to double counting.

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The Diversification Puzzle: The Role of Asymmetric Information and Insider Trading in Pakistan

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Abstract

While corporate diversification is a fundamental issue both in the management literature and in corporate policy, the question that remains is whether it destroys or enhances firm value. This empirical study of the corporate diversification–value relationship for Pakistani firms looks at the role of asymmetric information and insider trading over a 10-year sample period, 2005–14. Using the industrial entropy index and purchase ratio to capture corporate diversification and insider trading, respectively, the study provides empirical evidence that questions the agency theory-based explanation of the corporate diversification–value relationship. Our results show that, in cases of asymmetric information, insiders increase the purchase of their firms' shares in the open market when diversification is high. This contradicts the corporate diversification–value destruction stance of agency theory as well as the idea that outside investors' undervaluation occurs due to information asymmetries. These results have strategic implications for corporate diversification strategies and are relevant to firm managers, regulators and shareholders.

Keywords: Corporate diversification, agency effect, information asymmetry, insider trading, Pakistan.

JEL classification: G14, G32.

1. Introduction

Understanding the nature and effects of corporate diversification has long been a fundamental issue in both the management literature and corporate policy. However, there is still no consensus on whether corporate diversification destroys or enhances firm value (Erdorf et al., 2013; Rudolph & Schwetzler, 2013). The literature tends to show that managers seek to benefit themselves at the expense of firm shareholders through their corporate diversification strategies rather than pursing investments that would enhance firm value (see Jensen & Meckling, 1976; Amihud & Lev,

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1981; Fama & Jensen, 1983; Denis, Denis & Sarin, 1997; Aggarwal & Samwick, 2003). Similarly, most companies do not diversify efficiently, which has an adverse impact on shareholders' wealth (Martin & Sayrak, 2003).

Inefficient corporate diversification also gives managers a chance to increase their nonpecuniary benefits, the cost of which is borne by the firm's shareholders (McConnell, McKeon & Xu, 2010). These personal or nonpecuniary benefits include empire building (Jensen, 1988), increased managerial compensation, which depends on firm size (Jensen & Murphy, 1990) and self-preservation, which is achieved by utilizing their personal skills (Shleifer & Vishny, 1989). A number of studies underline this corporate diversification–value destruction stance of agency theory, noting that a significant discounted value is associated with firms that are more diversified (see Lang & Stulz, 1994; Berger & Ofek, 1995; Lins & Servaes, 1999; Denis, Denis & Yost, 2002; Hund, Monk & Tice, 2010; Hoechle et al., 2012). These results have led researchers to assume that diversification destroys firm value – this is known as the agency effect of corporate diversification.

However, the information effect of corporate diversification assumes there is not necessarily a conflict of interest between managers and shareholders when it comes to strategic decisions such as corporate diversification (Fox & Hamilton, 1994; Davis, Schoorman & Donaldson, 1997). In case of asymmetric information, shareholders may not be able to gauge managers' ability to make efficient decisions (Gomez-Mejia & Wiseman, 2007) and the latter's diversification decisions may be mistaken for value-decreasing strategies by outside shareholders (Seyhun, 1986). This is the information effect of corporate diversification.

Ataullah et al. (2014) compare the effects of corporate diversification (agency and informational) for a sample of British firms. They argue that, when managers implement diversification strategies to benefit themselves rather than to increase firm value, they are less likely to purchase their own firm's shares in the open market (agency effect). Even if managers happen to be pursuing an efficient diversification strategy to enhance the firm's value, the prevailing information asymmetries may keep outside shareholders from perceiving this. In this case, managers are likely to purchase their firm's shares in the open market more actively (information effect).

Although there is a vast body of literature on the corporate diversification–value relationship in developed countries, these studies tend to neglect the issue in relation to developing countries. To the best of our knowledge, this is the first attempt to empirically investigate the corporate

diversification–value relationship under asymmetric information and insider trading with reference to developing countries. Ataullah et al. (2014) raise two questions in this context. First, do insiders follow strategies for corporate diversification primarily to benefit themselves? Second, do outside investors believe that managers use diversification strategies solely to pursue personal benefits?

We conjecture that the results obtained by Ataullah et al. (2014) for the UK market do not necessarily apply to developing countries where financial markets are characterized by weak corporate governance/control and inadequate disclosure, which enhance agency problems, information asymmetries and insider trading. This argument is supported by Tsai, Young and Hsu (2011), who argue that developing markets in Asia have high information asymmetries and market inefficiencies such as less robust legal investor protection and disclosure systems.

This study is significant in that it compares the impact of corporate diversification – agency and informational – and explores the dominant effect of both on stock markets in developing countries. The two effects of corporate diversification have different practical implications for corporate-level policies and the management literature. If the agency effect dominates whereby corporate diversification is considered a value-destructive strategy, this would call for steps to improve corporate governance to ensure that managers focus on the core competencies of their firm to increase value (Denis et al., 2002). If the information effect dominates, corporate diversification is unlikely to be considered a value-decreasing strategy. As a result, the focus would likely be on enabling corporate managers to realize the potential benefits of diversification strategies and to signal the value of these strategies to outside shareholders (Lane, Cannella & Lubatkin, 1998).

The remainder of the study is organized as follows: Section 2 provides a literature review. Section 3 describes the dataset used. The study's variables and methodology are discussed in Sections 4 and 5. The results are analyzed in Section 6. The final section provides a summary and concluding remarks.

2. Literature Review and Hypotheses

Corporate diversification is defined as a combination of business units that operate in different industries under the common control of a single firm (Martin & Sayrak, 2003). The considerable literature on corporate diversification and firm value looks at the agency effect, the role of

asymmetric information and insider trading with respect to the corporate diversification–value relationship. In the case of the agency effect, the literature reports the existence of a significant discount associated with diversified firms and finds a negative relationship between diversification strategies and firm value.

Lang and Stulz (1994) were among the first to identify a diversification discount for diversified firms in comparison to a portfolio of focused firms. After adjusting the control variables for firm size, research and development (R&D) expenses and access to financial markets, they find that diversified firms trade at a significant discount. Berger and Ofek (1995) report similar results for a sample of internationally diversified firms. They show that diversified firms trade at a 13–15 percent discount compared to focused firms. Similarly, Hund et al. (2010) examine a sample of firms for the period 1978 to 2005 and report a diversification discount of approximately 11 percent for all diversified firms.

Lins and Servaes (1999) use a sample of European firms to investigate the impact of corporate diversification on firm value. Except for German firms, the results are similar across all other European countries. Rudolph and Schwetzler (2013) report a diversification discount for continental Europe. Some studies focus specifically on the US market and find a significant diversification discount. For instance, Doukas and Kan (2006) study a sample of US firms between 1992 and 1997 and report a diversification discount of 12 percent for all diversified firms. Other studies by Claessens et al. (1998) and Lins and Servaes (2002) conducted for Asian economies also report significant discounts: 14 and 16 percent, respectively, for the diversified firms in their samples.

These results have several explanations. For instance, diversified firms may trade at a discount for risk reduction purposes (Mansi & Reeb, 2002), institutional factors (Fauver, Houston & Naranjo, 2003) or due to the impact of increasing leverage on firm value (Doukas & Kan, 2006). Hoechle et al. (2012) note that diversification discounts are partly caused by poor corporate governance in addition to risk-reducing effects and agency problems. Recent studies argue that diversified firms trade at a discount due to merger and acquisition activities and their accounting implications (Custodio, 2014) as well as negative transfer effects (Zahavi & Lavie, 2013).

This stream of research on corporate diversification also extends to Asian markets. For instance, Afza, Slahudin and Nazir (2008) assess the relationship between diversification and corporate performance for a

sample of 65 Pakistani firms and find a negative relationship between the observed variables. Qureshi, Akhtar and Imdadullah (2012) also document a negative relationship between diversification strategies and firm performance for their sample. Grigorieva and Petrunina (2015) test whether mergers and acquisitions create value for shareholders in developing countries for the period 2003–09. They find a decline in the performance of combined firms after mergers and acquisitions have taken place.

These findings reveal that diversification destroys firm value. This argument is consistent with the agency effect of corporate diversification, which Ataullah et al. (2014) link to insider trading. They argue that, when managers implement diversification strategies to benefit themselves rather than to increase firm value (the agency effect), they are less likely to purchase their own firm's shares in the open market (insider trading). This points to a negative relationship between the corporate diversification strategies of managers and their propensity to purchase shares in their own firms. Based on this argument, if the agency effect of corporate diversification dominates the information effect, we assume:

Hypotheses 1 (H1): There exists a negative relationship between corporate diversification and insider trading.

On the other hand, the information effect suggests that managers usually implement diversification strategies to enhance firm value, but that information asymmetries lead external investors to undervalue these strategies. Thomas (2002) argues that corporate diversification influences the level of information asymmetry between managers and shareholders. This argument is consistent with the information transparency hypothesis pioneered by Hadlock, Ryngaert and Thomas (2001), who argue that managers have access to segment-level information on cash flows in diversified firms while outsiders have less value-relevant information.

The literature also reports that corporate insiders acquire an informational advantage by purchasing undervalued 'value stocks' and selling overvalued 'growth stocks' (Rozeff & Zaman, 1998). Such purchases convey insiders' private, firm-specific favorable information to the market, while insider sales convey their private, firm-specific unfavorable information to the market (Fidrmuc, Goergen & Renneboog, 2006). Agarwal and Singh (2006) argue that insiders usually hold private information and take market positions (long or short) based on these specific sets of information. Piotroski and Roulstone (2005) report a negative relationship

between insider purchases and firms' current performance and a positive relationship with firms' future performance.

Insider trading is dependent on firm-specific attributes that determine the information asymmetries between insiders (managers) and outside investors (Jeng, Metrick & Zeckhauser, 2003). One of these attributes is R&D expenditure. Coff and Lee (2003) note that firms engaging in R&D face more reaction from the market because outside investors are unable to value these tacit projects correctly with the relatively little information available to them. Following financial analysts also decreases insiders' informational advantage over outside investors (Frankel & Li, 2004).

Jagolinzer, Larcker and Taylor (2011) find that active monitoring by the general counsel is linked to a significant reduction in insider trading profits and in the ability of insider traders to predict earnings surprises. Skaife, Veenman and Wangerin (2013) link the quality of internal control to insider trading and find that its profitability is considerably greater in firms that disclose material weaknesses in internal control than in firms wielding effective control. Joseph and Wintoki (2013) report that insider profits are substantially higher among firms characterized by advertising investments relative to firms that have no advertising investments. Cziraki, De Goeij and Renneboog (2014) argue that governance rules influence insider profitability and that insider transactions are more profitable among firms where shareholder rights are not restricted by anti-shareholder mechanisms.

Alldredge and Cicero (2015) note that, among firms with a concentrated sales relationship, insiders appear to sell their own stock profitably based on public information on their principal customers. It is widely accepted that this insider trading conveys private information to outside investors (John & Lang, 1991; Fidrmuc et al., 2006) and provides credible signals to the market on the value relevance of various corporate events such as investment expenditure and dividend policy (Damodaran & Liu, 1993).

These findings reveal that, in case of information asymmetries, managers (insiders) implement corporate strategies to increase firm value and this argument is consistent with the information effect. Within this strand of research, Ataullah et al. (2014) link the information effect of corporate diversification to insider trading through asymmetric information. They argue that managers may be pursuing an efficient diversification strategy to enhance their firm's value, which the prevailing information asymmetries prevent outside shareholders from grasping (the

information effect). Hence, managers are likely to purchase their firm's shares in the open market more actively (insider trading) to generate a positive signal associated with diversification strategies.

At the same time, when managers implement diversification strategies, their propensity to purchase shares in their own firm also increases. There appears to be a positive relationship between the corporate diversification strategies of managers and their propensity to purchase shares in their own firm in the open market. Thus, if the information effect of corporate diversification dominates the agency effect, then:

Hypotheses 2 (H2): There exists a positive relationship between corporate diversification and insider trading.

3. Sources of Data

This paper analyzes the ordinary stocks of 12 industries listed on the Pakistan Stock Exchange. Of the 130 companies originally identified, we exclude 30 firms for lack of data on share transactions by corporate insiders, yielding a final sample of 100 companies. The sample construction is based on market capitalization. The sample period spans 10 years from 2005 to 2014. We look at stocks from the nonfinancial sector that have been traded for at least the past eight months.

The data was obtained from several sources. The accounting and financial data for entropy measures (corporate diversification) and the control variables was sourced from the Karachi Stock Exchange and *Business Recorder* websites. We have also used the State Bank of Pakistan's balance sheet analysis as a source of secondary data. The data on corporate insider trading (purchase and sale of shares) was collected from the annual reports of each company.

4. Measurement of Variables

This section explains the variables employed: corporate diversification, asymmetric information, insider trading. It also describes the control variables used.

4.1. Corporate Diversification

We use the corporate industrial entropy index to capture total diversification for several reasons: it is technically rigorous and has a strong theoretical base and fewer shortcomings than other measures of corporate

diversification discussed in the literature (Sambharya, 2000). Jacquemin and Berry (1979) show that a fundamental advantage of the entropy measure over the Herfindahl index and other measures is that it decomposes diversification into related and unrelated components. This decomposition is important because, as Palich, Cardinal and Miller (2000) note, unrelated corporate diversification gives managers a greater chance to reduce the risk associated with their human capital. Hence, the agency effect of diversification is likely to be stronger in the case of unrelated corporate diversification. Following Clarke, Fee and Thomas (2004), Haultz et al. (2013) and Ataullah et al. (2014), we calculate the entropy index for total diversification as:

$$IND\_ENT_{it-1} = \sum_{h=1}^{N} P_{hit}\ ln(\,{}^{1}/_{P_{hit}}\,)$$

where P_{hit} is the percentage of firm sales generated in industry segment *h* in year *t* and the summation over *N* segments in which firm *i* operates at the beginning of the year. The greater the value of entropy, the higher will be the level of diversification. The unrelated component of the entropy index UN_ENT_{it-1} for firm *i* in year *t* is calculated as:

$$UN\_ENT_{it-1} = \sum_{s=1}^{K} P_{sit}\ ln(\,{}^{1}/_{P_{sit}}\,)$$

where P_{sit} is the percentage of firm sales generated by industry segment *s* in year *t* and the summation over *K* industry segments in which firm *i* operates at the beginning of the year.

The percentage of firm sales generated in industry segments (related and unrelated) is based on the 4-digit Pakistan Standard Industrial Classification. The industrial entropy index (total entropy) is slightly different from the unrelated component of the entropy index in the following way. In the case of total entropy (IND_ENT_{it-1}), we consider firm sales generated in both related and unrelated segments (*N* segments). In the case of unrelated entropy (UN_ENT_{it-1}), firm sales generated in the unrelated segments (*K* industry segments) are considered. We define unrelated diversification as the firm being involved in different segments from its core activities.

4.2. Asymmetric Information

Asymmetric information is captured through insiders' superior information on future performance. Following earlier studies, we construct a dummy variable ($GDROA_{(i,t+1)}$) that takes a value of 1 if the value of the next year's net income before extraordinary items divided by the total book value of assets is greater than the corresponding value for this year, and 0 otherwise (Piotroski & Roulstone, 2005; Ataullah et al., 2014).

4.3. Insider Trading

Following Piotroski and Roulstone (2005), insider trading is captured using the purchase ratio, which is calculated as:

$$PR_{i,t} = \frac{Buy_{i,t}}{Buy_{i,t} + Sell_{i,t}}$$

where $Buy_{i,t}$ is the number of shares purchased and $(Buy_{i,t} + Sell_{i,t})$ equals the total shares traded by the insiders (directors) of firm i in year t. We use this purchase ratio in linear regressions as the dependent variable.

4.4. Control Variables

It is important to control the variables (other than the explanatory variables) that may influence insider trading to overcome omitted variable bias (Davidson & MacKinnon, 2004). Firm leverage $Lev_{(i,t-1)}$ is used as a control variable as debt holders are likely to monitor highly leveraged firms, which, in turn, may decrease information asymmetries (Harris & Raviv, 1991). We use the ratio of long-term debt to the total market value of equity as a measure of firm leverage. Firm risk $FR_{(i,t-1)}$ is also used as a control variable because, as mentioned earlier, firm-specific risk can influence insider trading. Here, firm risk is measured as the standard deviation of daily returns for 180 days prior to the first day of the year on which an insider trades (Coff & Lee, 2003).

Firm size FS_{t-1} is used as a control variable because investors react to smaller firms more readily in terms of insider trading: insiders are seen as having greater access to the relevant information, which is signaled to the market through their frequent trade (Seyhun, 1986). We use the natural logarithm of market capitalization at the beginning of the year to measure firm size. Finally, R&D expenditure $R\&D_{t-1}$ is also used as a control variable. Following Coff and Lee (2003), it is measured as a dummy variable that is

equal to 1 if the firm's R&D expenditure at the beginning of the year is non zero and 0 otherwise.

5. Estimation Model

Following the literature, we consider the link between corporate diversification and insider trading (see Krishnaswami & Subramaniam, 1999; Clarke et al., 2004; Manne, 2005; Ataullah et al., 2014). The aim is to investigate the corporate diversification–value relationship under conditions of asymmetric information and insider trading. To this end, we estimate a fixed-effects panel data model. The choice of model is based on the likelihood ratio (common versus fixed effects) and Hausman test (fixed versus random effects).

Table 1 shows that, in both cases (cross-section and period), the null hypothesis is rejected for the likelihood ratio as well as the Hausman test. Accordingly, we use a firm-year fixed-effects model.

Table 1: Choice between fixed and random effects models

Test cross-section fixed effects (likelihood ratio)

Effects test	**Statistic**	**d.f.**	**Prob.**
Cross-section F	8.455365	(99,894)	0.0000
Cross-section chi-square	660.795678	99	0.0000
Correlated random effects (Hausman test)			
Test summary	Chi-sq. stat	Chi-sq. d.f.	
Cross-section random	113.186550	7	0.0000
Test period fixed effects (likelihood ratio)			
Effects test	**Statistic**	**d.f.**	**Prob.**
Period F	2.056410	(9,983)	0.0308
Period chi-square	18.652711	9	0.0283
Test period random effects (Hausman test)			
Test summary	Chi-sq. stat	Chi-sq. d.f.	
Period random	18.146532	7	0.0113

Note: The following null and alternative hypotheses are tested: (i) for common versus fixed effects, H_0 = common effects more appropriate, H1 = fixed effects more appropriate, (ii) for fixed versus random effects, H0 = random effects more appropriate, H1 = fixed effects more appropriate.
Source: Authors' calculations.

To test H1 and H2 on corporate diversification (total and unrelated), information asymmetry and insider trading, we estimate the following regression equation:

$$PR_{i,t} = \alpha_{i,t} + \beta_1 Ind\_Ent_{i,t-1} + \beta_2 Un\_Ent_{i,t-1} + \beta_3 GDROA_{i,t+1} + \gamma control_{i,t} + \varepsilon_{i,t} \quad (1)$$

where β_1, β_2 and β_3 capture all variations in the dependent variable, γ captures the effect of the control variables, $\alpha_{i,t}$ is the intercept and $\varepsilon_{i,t}$ is the error term.

6. Empirical Results and Discussion

Our sample size is limited to 1,000 firm-years (observations), given the availability of data for the selected variables. Table 2 presents the descriptive statistics for the data for the period 2005–14. The means of the total and unrelated entropy measures (corporate diversification) of diversified firm-years are 0.767 and 0.470, respectively. The mean of the unrelated component of the entropy measure is about 61 percent of the mean of total entropy, which suggests a high level of unrelated diversification among the firms in the sample.

Most of the values are negatively skewed. If the kurtosis value is equal to 3, then the normal distribution and pattern are mesokurtic. If the value is greater than 3, then the pattern is leptokurtic, which is associated with a peaked, fat-tailed distribution. A kurtosis value of less than 3 is referred to as platykurtic and is associated with a less peaked distribution and thinner tail. Most of the values in Table 2 show leptokurtic behavior (greater than 3), with a maximum value of 8.796 and a minimum value of 1.000. The kurtosis values show that the data follows a peaked, fat-tailed distribution.

Table 2: Summary statistics for firm-level attributes and insider trading

Statistic	$PR_{i,t}$	Ind_Ent_{t-1}	Un_Ent_{t-1}	$GDROA_{t+1}$	FR_{t-1}	FS_{t-1}	Lev_{t-1}	$R\&D_{t-1}$
Mean	0.508	0.767	0.470	0.905	0.758	8.526	1.168	0.493
Median	0.517	0.844	0.450	1.000	0.833	8.367	0.906	0.000
Maximum	1.000	1.180	0.880	1.000	0.968	13.910	5.670	1.000
Minimum	0.0008	0.003	0.039	0.000	-0.239	2.332	0.010	0.000
SD	0.273	0.232	0.185	0.293	0.206	1.621	0.977	0.500
Skewness	0.010	-1.630	-0.021	-2.762	-2.495	-0.012	1.035	0.028
Kurtosis	1.840	5.039	2.062	8.631	8.796	4.607	3.616	1.000
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observ.	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Note: See Table A1 in the Appendix for an industry classification of the sample.
Source: Authors' calculations.

Table 3 reports the results of multicollinearity checks. Panel A presents the correlation matrix and Panel B reports the variance inflation factors for the explanatory variables. There is a weak correlation among all the explanatory variables except firm risk and industrial entropy (0.603).

Table 3: Multicollinearity checks

Panel A: Correlation matrix

Variable	$PR_{i,t}$	Ind_Ent_{t-1}	Un_Ent_{t-1}	$GDROA_{t+1}$	FR_{t-1}	FS_{t-1}	Lev_{t-1}	$R\&D_{t-1}$
$PR_{i,t}$	1.000***							
Ind_Ent_{t-1}	0.088***	1.000						
Un_Ent_{t-1}	0.356***	0.331	1.000					
$GDROA_{t+1}$	0.010***	-0.079	-0.025	1.000				
FR_{t-1}	-0.084***	0.603	0.376	-0.058	1.000			
FS_{t-1}	-0.168***	0.279	0.073	-0.088	0.288	1.000		
Lev_{t-1}	0.542***	-0.206	0.175	0.001	-0.192	-0.183	1.000	
$R\&D_{t-1}$	-0.062	-0.227	-0.062	-0.001	-0.180	0.193	0.039	1.000

Panel B: Variance inflation factors

Variable	Coefficient variance	Un-centered VIF	Centered VIF
Ind_Ent_{t-1}	0.0013	20.3550	1.7091
Un_Ent_{t-1}	0.0017	10.7990	1.4546
$GDROA_{t+1}$	0.0004	10.6510	1.0118
FR_{t-1}	0.0019	28.5340	1.9695
FS_{t-1}	2.00E-0	35.6140	1.2421
Lev_{t-1}	5.25E-0	2.8809	1.1846
$R\&D_{t-1}$	0.0001	2.2843	1.1581
Const.	0.0023	55.8930	0.0000

Note: *** and ** = coefficient is statistically significant at 5% and 10%, respectively.
Source: Authors' calculations.

For further confirmation, the variance inflation factors are computed as $VIFq = 1/(1 - q)$, where q is the correlation coefficient obtained by regressing the explanatory variable q on all the remaining explanatory variables in the model. The results are essentially free of any serious multicollinearity among the explanatory variables. The variance inflation factors reported in Panel B range from 1.0118 to 1.9695, showing there is no significant multicollinearity among the explanatory variables.

Table 4 reports the results for insider trading and corporate diversification, using multivariate regression analysis. We use linear panel data models with both firm and year fixed effects to estimate the results. Most of the control variables have the expected signs. The coefficient of firm size (FS_{t-1}) is negative and significantly different from 0, suggesting that, with an increase in firm size, insider trading falls. This finding is consistent with earlier studies (see Seyhun, 1986; Jeng et al., 2003). Firm risk FR_{t-1} and leverage Lev_{t-1} are positive and significantly different from 0, suggesting that insider trading increases with a rise in firm-specific risk and leverage. These results are in line with the findings of Coff and Lee (2003) and Harris and Raviv (1991).

Table 4: Insider trading and corporate diversification (linear panel firm and year fixed effects)

Variable	Coefficient	SE	t-value	Prob.
Ind_Ent_{t-1}	0.322***	0.047	6.804	0.000
Un_Ent_{t-1}	0.404***	0.074	5.448	0.000
$GDROA_{t+1}$	0.034**	0.020	1.712	0.087
FR_{t-1}	0.282***	0.085	3.310	0.001
FS_{t-1}	-0.046***	0.014	-3.224	0.001
Lev_{t-1}	0.042***	0.008	5.123	0.000
$R\&D_{t-1}$	-0.005	0.020	-0.264	0.791
Const.	0.172	0.151	1.141	0.253
Adj. R2	0.680			
F-statistic	19.700			
F (p-value)	0.000			

Note: The dependent variable is the purchase ratio ($PR_{i,t}$). The independent variables are total diversification (Ind_Ent_{t-1}), unrelated diversification (Un_Ent_{t-1}) and asymmetric information ($GDROA_{t+1}$). *** and ** = coefficient is statistically significant at 5% and 10%, respectively. See Table A2 in the Appendix for individual firm and year fixed effects.
Source: Authors' calculations.

The explanatory variables are total industrial diversification (Ind_Ent_{t-1}), unrelated industrial diversification (Un_Ent_{t-1}) and asymmetric information ($GDROA_{i,t+1}$). The coefficients of total and unrelated diversification are positive and statistically significant at the 95 percent significance level. The coefficient of asymmetric information is positive and statistically significant at the 90 percent significance level.

Overall, the effect of corporate diversification holds even after controlling for other variables and our results based on the intensity of insider purchases support the theory of the information effect of diversification. This is because the findings suggest that when insiders implement diversification strategies with the intention of increasing the value of their firm, they also increase their own purchase of the firm's shares, particularly when they believe that outside investors may undervalue their strategies due to information asymmetries (the information effect). This is consistent with H2, but inconsistent with H1. Thus, the information effect of corporate diversification holds for the Pakistani stock market.

These findings are similar to those in the literature (see Krishnaswami & Subramaniam, 1999; Clarke et al., 2004; Ataullah et al., 2014). As with other studies, we consider insiders to be executive directors because they have substantial exposure to their equity via the firm's executive compensation schemes (Conyon, Core & Guay, 2011). Hence, their willingness to buy shares in their own firm in the open market in the case of high diversification is a strong indicator of the information effect of corporate diversification. However, nonexecutive directors do not seem to purchase more shares when undervaluation by outside investors is high because they are not as close to the firm as its executive directors.

7. Summary and Conclusion

The discussion above shows that there are two different views on implementing diversification strategies by corporate insiders and its impact on firm value. The agency theory-based view argues that managers implement diversification strategies to gain personal benefits rather than to increase the firm's value. The alternative view is that corporate diversification is a useful strategic decision that helps improve firm value, but is not valued optimally by outside investors due to information asymmetries.

The two views have different implications for corporate policies and the management literature. In terms of the agency effect, corporate diversification is considered a value-destructive strategy. Therefore, further

work is needed to improve the corporate governance system to ensure that managerial decision making focuses on enhancing firm value. In terms of the information effect, corporate diversification is not considered a value-decreasing strategy if the firm's managers are able to generate positive signals to external shareholders.

Our analysis is based on the literature on insider trading and supports the information effect of diversification. We suggest that insiders consider their strategies to enhance value and try to deliver this information to outside shareholders by purchasing their own firm's shares in the open market. In the Pakistani stock market, the information effect of diversification dominates the agency effect because its financial markets are characterized by high information asymmetries and market inefficiencies.

This result is supported by Morck, Yeung and Yu (2000) and Alves, Peasnell and Taylor (2010), who find that poorer economies tend to have high information asymmetries and market inefficiencies such as less robust legal investor protection and disclosure systems. These information asymmetries and market inefficiencies, in turn, enhance the existence of the information effect in developing countries. Hence, it is necessary to help managers develop strong mechanisms to improve the information asymmetries associated with their diversification strategies. Managers also need to communicate the value of their diversification strategies to outside investors rather than simply focusing on governance mechanisms. This can be done by improving information disclosure mechanisms and investor protection laws in the stock markets of developing countries.

Future research could take the following directions: First, it could investigate why the agency effect of corporate diversification seems to be disappearing over time. What possible factors may have transformed the agency effect into the information effect of corporate diversification? Second, this study is limited to one developing country. It could be extended to a larger sample to provide a cross-country comparison.

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Appendix

Table A1: Industry classification of sample

Industry	Number of firms in the sample	Firm-year observations
Automobiles and parts	8	80
Chemicals	10	100
Construction and materials	12	120
Electricity	9	90
Foods	10	100
Household goods	3	30
Industrial engineering	2	20
Industrial metals and mining	2	20
Oil and gas	8	80
Pharma	4	40
Sugar	14	140
Textiles	18	180
Total	100	1,000

Note: The industries above are all listed on the Pakistan Stock Exchange.

Table A2: Individual firm and year fixed effects

Fixed effects (cross)		Fixed effects (cross)	
AABS–C	-0.366779	HSPIL–C	-0.163921
AASM–C	-0.150153	ICCT–C	-0.157730
ABOT–C	0.223289	ICI–C	0.234418
ADML–C	0.076374	ICL–C	-0.110949
ADTM–C	0.078566	IFPL–C	-0.205969
ALNRS–C	-0.025167	IIL–C	-0.136200
ALQT–C	0.156339	ISTM–C	-0.152377
ANL–C	-0.143781	JVDC–C	-0.305378
APOT–C	-0.172393	KML–C	0.252924
ARUJ–C	-0.086396	KOHC–C	0.108906
ASHT–C	-0.217751	KOHTM–C	0.282442
ATBA–C	0.061465	KOSM–C	0.273080
ATRL–C	0.045780	KSBP–C	-0.356770
AYTM–C	0.071487	KSTM–C	-0.349877
AZTM–C	0.081571	KTML–C	-0.187694
BERG–C	-0.014222	LPGL–C	0.017928
BPL–C	0.144930	LUCK–C	0.005209

Fixed effects (cross)		Fixed effects (cross)	
BROT–C	-0.123699	MEHT–C	0.001480
BTL–C	0.245100	MLCF–C	0.039838
BWL–C	0.052287	MRNS–C	-0.266328
CHAS–C	-0.121773	MTL–C	-0.052378
CHCC–C	-0.367214	MUREB–C	0.130896
COST–C	-0.102350	NFL–C	0.051665
CPL–C	-0.215821	NMFL–C	-0.265625
CSML–C	0.222787	NONS–C	0.055747
CWSM–C	0.112035	NPL–C	-0.004566
DBL–C	0.116730	NRL–C	-0.004695
DEL–C	-0.233010	PEL–C	-0.341133
DGKC–C	0.129245	PGCL–C	0.202402
DINT–C	-0.142102	PIOC–C	0.027350
DKTM–C	-0.171910	PLCL–C	0.080227
DMTM–C	-0.097172	PNGRS–C	0.201899
DSML–C	0.018234	POML–C	-0.147433
DWSM–C	-0.185039	RMPCL–C	0.055779
DWTM–C	0.052401	SANSM–C	-0.002618
EIL–C	0.006112	SAPL–C	-0.136729
FAEL–C	-0.046782	SARC–C	0.059786
FASM–C	0.010733	SEARL–C	0.157733
FCCL–C	-0.208745	SECL–C	-0.108572
FZCM–C	0.143214	SGML–C	-0.061504
GADT–C	0.059753	SHEL–C	0.542367
GFIL–C	-0.065207	SHEZ–C	0.665084
GLAT–C	-0.348257	SHSML–C	0.434174
GLAXO–C	0.120699	SIL–C	0.444770
GUSM–C	-0.218251	SITC–C	0.345098
HABSM–C	-0.132381	SSOM–C	0.361044
HAL–C	-0.271440	STCL–C	0.247262
HCCL–C	-0.326373	SURAJ–C	0.404479
HIL–C	-0.067201	TICL–C	0.061950
HINOON–C	-0.351065	WYETH–C	0.515807
Fixed effects (period)			
2005–C	-0.012313	2010–C	0.022845
2006–C	-0.027391	2011–C	0.025648
2007–C	-0.042210	2012–C	0.022441
2008–C	-0.025654	2013–C	-0.015614
2009–C	0.079521	2014–C	-0.027274

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Financial Contagion in EFA Markets in Crisis Periods: A Multivariate GARCH Dynamic Conditional Correlation Framework

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Abstract

This paper uses the multivariate GARCH dynamic conditional correlation framework proposed by Engle (2002) to investigate time-varying conditional correlation between developed markets and emerging and frontier Asian (EFA) markets. It employs monthly returns data for 2000–14 to capture the potential contagion in developed (the US, Europe and Japan) and EFA stock markets. A key finding is the increasing conditional correlation among EFA and developed markets, especially during the 2008 financial crisis. The study finds that, during periods of financial turmoil, EFA markets are exposed to shocks and spillover effects from developed markets along with a substantial shift in the regime of conditional correlation. This has important implications for investors interested in diversifying portfolios in EFA markets during financial crises.

Keywords: Emerging and frontier Asian markets, financial contagion, financial crisis, dynamic conditional correlation.

JEL classification: G11, G15, F3, F65.

1. Introduction

A number of emerging market economies experienced crises in the 1990s, including the 'Tequila effect' of 1994, the Asian financial crisis of 1997, the Russian 'cold' of 1998 and Brazil 'fever' of 1999. While these started as country-specific events, the effects soon spread to other countries and had a worldwide impact. Indeed, the past decade has seen a great deal of news centering on financial crises and economic depressions. The term 'financial crisis' encompasses several subsets of crises, such as in banking, exchange rates and stock markets. The transmission of a financial crisis from its

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country of origin (as a country-specific phenomenon) to other countries occurs through the contagion effect.[1]

The literature describes three categories of financial crises. The first-generation concept proposed by Flood and Garber (1984) and by Krugman (1997) looks at the existence of speculative shocks and their impact on exchange reserves. These studies suggest that such crises occur when macroeconomic fundamentals are neglected. Obstfeld and Rogoff (1994) and Cole and Kehoe (1996) attribute second-generation crises to the financial turbulence that hit the European monetary system in 1992/93 (considered the first financial globalization experience). Obstfeld and Rogoff (1994) argue that this particular crisis resulted from the conflict between fixed exchange rate regimes and government attempts to implement a more expansionist monetary policy.

The third-generation concept has emerged from the Asian crisis. The model proposed by Krugman (2001) and Cartapanis and Gilles (2003) is an accumulation of the first- and second-generation crises, combining the twin crises in exchange rates and banking. This also reveals the fragility of the financial and banking spheres. Such crises tend to occur when banking sector panic moves the economy from a good equilibrium to a crisis equilibrium. This is what most researchers refer to as the contagion effect[2] although there is little consensus on its precise definition and origin.

Definitions of financial contagion vary widely in the literature on financial crises.[3] The definition most commonly used is that of Eichengreen and Hausmann (1999), who describe contagion as a significant increase in the crisis probability of a country, conditioned by the occurrence of a crisis in another country. This definition is important in models where exchange rate collapse is the main cause of a financial crisis. In practice, this requires a sufficiently large number of countries that are experiencing a crisis.

Market volatility is another aspect of contagion, referring to cases where volatility in one financial market spills over into another in a crisis period. In empirical terms, an analysis of equity market co-movements reveals that financial turmoil triggers stock market volatility. This suggests

[1] Contagion is also defined as increased correlation values among countries' asset returns in different financial markets.

[2] According to Forbes and Rigobon (2002), contagion refers to an increase in cross-market co-movement among stock returns in a crisis period. Any interdependence before and after the crisis is referred to as interdependence between the associated markets, whereas contagion is an increase in such linkages during the financial turmoil.

[3] See Masson (1999) and Pericoli and Sbracia (2003) for different definitions of financial contagion.

that an increase in volatility can help identify a crisis. The contagion effect is the speed at which this volatility is transmitted. There is much debate on the medium through which this effect occurs: the herding effect and irrational investor behavior are often cited as likely channels.

Forbes and Rigobon (2001) show that contagion is the result of a significant increase in financial market linkages lagged by a shock in a country or group of countries. This increase in financial linkages among various markets has implications for how transmission channels are generated and how they intensify in a crisis period for a given country, irrespective of its fundamentals. In general, contagion is the expansion of one country's financial market disturbances to another country or group of countries. This expansion is evident from the increasing level of co-movement among exchange rates, capital mobility and spreads in liability.

In this study, we adopt the definition proposed by Forbes and Rigobon (2002). Instead of explaining the mechanism through which shocks are propagated at the international level, we define contagion as an increase in cross-market linkages resulting from the shocks to a country or group of countries. Therefore, in the case of higher-return co-movement before and during a crisis, we use the term 'cross-market interdependence' rather than 'the contagion effect' as the latter is associated with an increase in the relationship only in a crisis period (Caporale, Cipollini & Spagnolo, 2005). Studying crises and their aftermath helps researchers investigate the initiation and transmission of such shocks to various markets across the world.[4]

The rest of the paper is structured as follows. Section 2 reviews the literature on contagion models. Section 3 explains the econometric techniques used and Section 4 interprets the data.

2. Literature Review

Carrieri, Errunza and Hogan (2007) show that integration among world stock markets tends to increase over time. In recent years, there has been a significant increase in private capital inflows from developed to emerging markets. With growing integration between developing and

[4] Pritsker (2001) outlines four different transmission channels: correlated information (King & Wadhwani, 1990) or the wakeup-call hypothesis (Sachs, Tornell & Velasco, 1996), the wealth effect (Kyle & Xiong, 2001), liquidity (Claessens, Dornbush & Park, 2001) and cross-market hedging (Kodres & Pritsker, 2002). Although using specific transmission channels to test for financial contagion may be more useful, insufficient microstructure data makes this more difficult without any priori identification of the relevant fundamental variables. As a result, many empirical studies apply different correlation methods to investigate the co-movement of asset returns in an effort to analyze the contagion effect.

emerging markets and the world market, financial crises have gained more importance. While Broner, Gelos and Reinhart (2006) argue that contagion results from scaling back overweighed areas, Bayoumi et al. (2007) show that an important precondition of a financial crisis may be the herding behavior of developed market[5] investors in emerging markets. Collins and Gavron (2004) identify seven major financial crises in the following order: the Czech koruna crisis (May 1997), the Asian crisis (July 1997), the Zimbabwean dollar crisis (November 1998), the default crisis in Russia (August 1998), the Brazilian real crisis (January 1999), the Argentine peso crisis (July 2001), the dot.com bubble crisis (March 2000), the world stock market crash (September 2008) and the European debt crisis (January 2011).[6]

Bensafta and Semedo (2014) analyze different financial markets using multivariate return dynamics. They model the conditional mean of returns using vector autoregression and the conditional variance using a multivariate GARCH framework.[7] Wongswan (2006) applies a stock volatility model to high-frequency data for US, Korean, Japanese and Thai stock market returns. The author studies the effect of macroeconomic announcements in the US and Japan on trading volume and stock volatility in Thailand and Korea. Edwards and Susmel (2003) use a switching ARCH model to examine interest rate volatility in emerging markets and identify periods of high volatility. They conclude that volatility transmission patterns are geographically distinct.

Looking at shocks spread across the asset markets of eight Latin American economies, Martinez and Ramirez (2011) measure market reactions using principal component analysis and an ARCH/GARCH framework to investigate asset market volatility. While their study does not support the hypothesis of financial contagion, the interrelationship among various markets is evident, as is their mild sensitivity to recent shocks. However, the study is limited in that it does not include emerging and frontier Asian (EFA) markets.

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[5] Fong (2003) observes a smaller degree of correlation for Canada, with significant results by pairing the US with four major markets. The author applies a bivariate regime-switching model with the same limitation of assuming a single country (the US in this case) as the source of propagating volatility shocks.

[6] In another instance, the Hong Kong market is assumed to be the origin of contagion. This treatment does not yield sound results: in a crisis period, adverse situations can trigger turbulence in any neighboring financial market. This leads to the bias of simultaneous equations.

[7] This involves a similar multivariate GARCH model, along with constant conditional correlation to estimate the correlation coefficients, using breakpoints to split a single sample period into two. The results are similar to those achieved under unconditional correlation.

Unlike most other studies, we examine EFA markets against a panel of developed markets – the US, Japan and Europe. Contrary to Martinez and Ramirez (2011), Li (2007) investigates the existence of a volatility relationship between two emerging (Hong Kong and China) markets and a developed market (the US), using a multivariate GARCH model.[8] Li yields better results as the application of multivariate GARCH dynamic conditional correlation (DCC) models allows the flexibility of univariate GARCH techniques along with parsimonious parametric models to measure correlation.

The proposed multivariate GARCH model resembles the BEKK framework (Engle & Kroner, 1995) used to capture the regularities characterizing stock market indices. Our study can therefore be considered an extension of Li (2007) in that it incorporates the effects of the 2008/09 global financial crisis with a larger panel of both developed and emerging markets. Yu, Fung and Tam (2010) also use a DCC-GARCH model to analyze cross-market correlation among 11 markets.[9] Unlike traditional GARCH models, their results show a strong contagion effect from the US economy to the Asian economies during the 2007 crisis, whereas there is no spillover from the Asian markets to the developed markets during the Asian crisis period

Another important aspect of contagion is the use of conditional correlation to test the shift in linkages across financial markets during a crisis. However, a regime-switching methodology such as the Markov model provides more consistent results. Many subsequent studies have followed King and Wadhwani (1990) and attempted to refine the approach to data generation, which can have a significant effect on validity tests such as heteroskedasticity, common factor influence and endogeneity (Corsetti, Pericoli & Sbracia, 2005).

Dungey et al. (2002) estimate a dynamic latent factor model to determine the presence of contagion in stock and bond markets during a crisis period. From a factor model perspective, Bekaert, Harvey and Lundblad (2005) find that, allowing for time-varying integration among global markets, contagion implies excess cross-country correlation in terms of model residuals in a crisis period. Given the widespread effects of past financial turmoil on frontier and emerging markets, most research has focused on contagion and financial shocks originating in these markets rather than in developed economies.

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[8] See Longin and Solnik (1995) on the application of GARCH. The factors affecting conditional correlation can also be determined through this framework, with the limitation that one is dealing with a single factor at a time and a greater number of parameters.

[9] Australia, Hong Kong, Japan, Malaysia, the Philippines, Thailand, China, Indonesia, Korea, New Zealand and Singapore.

Many studies have looked at the implications of market integration and liberalization for volatility spillover and the correlation of returns. However, in analyzing the linkages between mature and emerging markets, the 'shift contagion' perspective is often ignored, the volatility in mature markets having already peaked. The financial crisis of 2007/08 – and the last decade in general – have had important implications for the episodic turbulence that spills over from mature to emerging markets in the shape of the contagion effect. The Global Competitiveness Report for 2013 notes that financial crises have had a considerable impact on emerging markets. Furthermore, the tenuous recovery of the European and US markets post-crisis follows the continuous underperformance of emerging markets in terms of slower economic growth relative to previous years.

Cross-market correlation analysis is essential for risk management and optimizing cross-country portfolios. Many studies have analyzed the time-varying correlation of cross-market returns during an economic downturn caused by the transmission of shocks from other countries (Ham, Kim & Boyce, 2005). Syllignakis and Kouretas (2011) note that many researchers define contagion as the spread of financial shocks from one country to the other. The bulk of the literature, however, focuses on various contagion channels in the context of mature markets rather than emerging and frontier markets. As a result, more research is now being conducted on cross-market time-varying correlation among emerging markets in periods of financial turmoil (Suardi, 2012).

Dooley and Hutchison's (2009) study on emerging markets during the US subprime crisis looks at market decoupling before and recoupling during the crisis period. Aloui, Aïssa and Nguyen (2011) use the copula approach to examine the returns of BRIC countries vis-à-vis the US market from 2004 to 2009. Their results indicate a high level of significant time-varying persistent correlation among these markets. Samarakoon (2011) notes that the transmission of financial shocks from the US to frontier and emerging markets reflects a strong degree of interdependence and contagion.[10] However, when Choe et al. (2012) apply a structural DCC framework to a larger sample of countries during the Asian crisis of 1997, they find no evidence of contagion based on constant cross-correlation.

[10] Comprehensive surveys are provided by Pericoli and Sbracia (2003) and by Karolyi (2003). Masson (1998), Kaminsky and Reinhart (2000), Claessens et al. (2001) and Kaminsky, Reinhart and Vegh (2003) look at channels of financial transmission and analyze different approaches to contagion. Pritsker (2001) and Pericoli and Sbracia (2003) also examine different channels of financial contagion.

In their analysis of the BRIC economies during 1995–2006, Kenourgios, Samitas and Paltalidis (2011) assess the contagion effect of financial crises on other countries for each crisis period. Further evidence of contagion emerges in Kenourgios and Padhi (2012), who find that the Russian and Asian crises had a distinct effect on emerging markets while the Argentine crisis had a limited contagion effect.

The impact of the US subprime crisis on emerging markets is analyzed by Chua, Suardi and Tsiaplias (2012), using four market indices: Latin American emerging markets, Asian emerging markets, emerging markets and the world market. Their results show that the crisis had a substantial impact on emerging and mature markets. While there is no real consensus on spillover and contagion effects from developed to emerging markets, some studies do identify such spillovers in crisis periods for selected markets. Our sample is based on the Morgan Stanley classification index in order to generalize the findings across EFA markets.

3. Empirical Framework

Much of the literature uses conventional time-series models such as co-integration, vector autoregression and causality tests. The volatility model is rarely used in the context of financial contagion. We employ a multivariate DCC-GARCH model to assess time-varying correlation among multiple markets. This has the advantage of ensuring the flexibility of univariate GARCH techniques along with parsimonious parametric models to measure correlation. Moreover, the model is consistent with univariate and multivariate volatility forecasts. When a new variable is added, the correlation and volatility forecasts of the original assets remain unchanged. Engle (2002) states that the DCC-GARCH models are superior to the traditional simple GARCH models in terms of the mean absolute error, tests based on value at risk and other diagnostics.

This study contributes to the literature by applying the DCC-GARCH technique[11] to EFA markets vis-à-vis the developed markets of US, Europe and Japan to capture the effects and transmission of financial contagion. It also presents the policy implications of changing patterns in international stock market co-movement among developed, emerging and frontier markets during a crisis.

[11] Other techniques such as the BEKK and vector error correction models can also be used as multivariate GARCH models, but they are difficult to expand to three asset returns.

3.1. Preliminary Analysis

Table 1 lists the stock markets included in the sample. The last three indices represent developed markets and the rest represent EFA markets. Table 2 gives descriptive statistics for the sample stock market returns. Pakistan has the highest monthly return (1.8 percent) while Korea and Bangladesh have the lowest (0.3 percent). Pakistan also has the highest variation, almost 8.3 percent, thus representing a higher comparative risk to other markets.

The ARCH effect is present in all the markets except Thailand. The normality hypothesis is rejected for all the stock market indices. All the indices are negatively skewed, except for Bangladesh and Sri Lanka. Thailand, Indonesia, Pakistan and Bangladesh all have a leptokurtic distribution. Pakistan also has the highest return per unit of risk (RPU) (12.69 percent) while Korea has the lowest. India, the Philippines and Bangladesh have moderate RPU values of around 10 percent. The RPU has standardized returns in terms of risk. The interpretation of these values is the same as the mean values of the respective stock market indices.

Table 1: Stock markets, by country of origin and symbol

Country	Stock market index	Symbol
Pakistan	Karachi Stock Exchange 100	KSE 100
India	Bombay Stock Exchange Sensex	Sensex
Bangladesh	Chittagong Stock Exchange	CSCX
China	Shanghai Composite Index	Shanghai Cp China
Sri Lanka	Colombo Stock Exchange	CSE
Indonesia	Jakarta Composite Index	Jakarta Cmp
Korea	Korea Composite Stock Price Index	KOSPI
Malaysia	Kuala Lumpur Stock Exchange Composite Index	KLSE Comp
Philippines	Philippine Stock Exchange Composite Index	PSE Comp
Thailand	SET Index Thailand	SET
US	Standard and Poor's 1200 Index	SP 1200
Europe	Dow Jones Industrial Average	DJIA
Japan	Nikkei 225 Index	Nikkei

The results of the return correlation are presented in Table 3. The Korean stock market has the highest return correlation values with respect to Europe and Japan, while the Malaysian stock market is highly correlated with the US. It is also important to note that all three developed country stock markets are moderately correlated with one another.

Table 2: Descriptive and statistical properties of returns

Variable	Pakistan	India	Bangladesh	China	Sri Lanka	Indonesia	Korea	Malaysia	Philippines	Thailand	DJIA	Nikkei	SP 1200
Mean	0.018	0.009	0.003	0.004	0.014	0.011	0.003	0.004	0.007	0.005	0.002	0.000	-0.014
Max	0.267	0.249	0.101	0.243	0.225	0.183	0.203	0.127	0.154	0.212	0.101	0.121	0.309
Min	-0.448	-0.273	-0.098	-0.283	-0.176	-0.377	-0.263	-0.165	-0.275	-0.244	-0.152	-0.272	-0.667
SD	0.083	0.071	0.022	0.078	0.071	0.069	0.069	0.045	0.063	0.05	0.083	0.071	0.022
Skew.	-1.500	-0.508	0.253	-0.548	0.271	-1.130	-0.428	-0.423	-0.690	-0.659	-0.689	-0.757	-0.795
Kurtosis	6.701	1.457	7.180	1.627	0.665	4.679	1.036	1.385	1.903	7.624	1.222	1.629	2.195
ARCH	46.22*	23.60**	18.01*	30.82*	38.42*	42.96*	42.12*	26.83*	41.21*	19.28*	25.46**	66.98*	66.91*
JB	404.32*	0.293*	0.823*	0.503*	5.547*	1.800*	1.616*	0.961*	0.203*	3.398*	0.471*	3.279*	2.783*
RPU	21.69	12.68	13.64	5.13	19.72	15.94	4.35	8.89	11.11	10.00	21.69	12.68	13.64

Note: JB = Jarque–Bera normality statistic, RPU = return per unit of risk (percentage), SD = standard deviation.
* = rejection of null hypothesis at 1 percent, ** = at 5 percent, *** = at 10 percent. Conditional heteroskedasticity is represented by ARCH values of order 12.
Source: Author's calculations.

Table 3: Correlation among sample returns

Variable	Pakistan	India	Bangladesh	China	Sri Lanka	Indonesia	Korea	Malaysia	Philippines	Thailand	DJIA	Nikkei 225	SP 1200
Pakistan	**1.000**	**0.200**	0.017	0.098	0.104	0.144	**0.213**	**0.235**	0.135	0.132	**0.187**	**0.206**	0.110
India		**1.000**	-0.023	**0.340**	**0.233**	**0.629**	**0.628**	**0.497**	**0.542**	**0.288**	**0.226**	**0.573**	**0.294**
Bangladesh			**1.000**	-0.029	-0.068	-0.061	-0.049	-0.019	-0.041	-0.079	0.088	-0.050	-0.044
China				**1.000**	0.035	**0.249**	**0.284**	**0.342**	**0.218**	-0.024	-0.038	**0.294**	0.086
Sri Lanka					**1.000**	**0.243**	**0.202**	**0.172**	**0.199**	0.022	**0.159**	**0.208**	**0.149**
Indonesia						**1.000**	**0.562**	**0.500**	**0.642**	**0.290**	**0.190**	**0.481**	**0.260**
Korea							**1.000**	**0.406**	**0.514**	**0.403**	**0.309**	**0.562**	**0.292**
Malaysia								**1.000**	**0.368**	**0.203**	**0.217**	**0.337**	**0.339**
Philippines									**1.000**	**0.442**	**0.234**	**0.387**	**0.246**
Thailand										**1.000**	**0.294**	**0.202**	0.146
DJIA											**1.000**	**0.243**	**0.215**
Nikkei 225												**1.000**	**0.313**
SP 1200													**1.000**

Note: Values in bold indicate significance level.
Source: Author's calculations.

Figure 1 illustrates the average monthly returns for the sample of developed and EFA markets. It is evident that all these markets experienced disturbances in 2008/09 due to the financial crisis. Bangladesh and Thailand have the smallest comparative variation. The Chinese stock market's monthly returns exhibit the largest variation from 2006 to 2009, after which they appear to return to normal.

Figure 1: Average monthly returns for selected markets

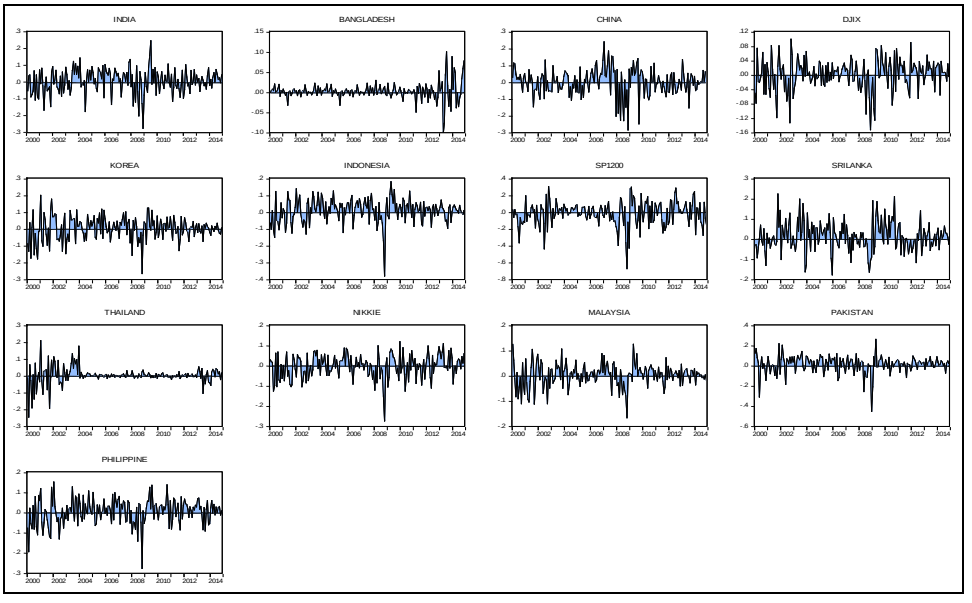

Table 4 applies the Zivot–Andrews structural break unit root test to identify the turbulence caused by the global financial crisis. The stock returns of the sample indices are all stationary at level, but the impact of the global financial crisis is obvious in most cases. Most stock markets show excessive volatility in the first quarter of 2009, while some emerging markets – China, Bangladesh and Japan (Nikkei 225) – experienced a disturbance in the second quarter of 2007. This implies that both pre-crisis and post-crisis effects were felt in the sample of developed, frontier and emerging markets.

Table 4: Unit root test with structural break statistics

Country or index	Zivot–Andrews stat.	Breakpoint date
Pakistan	-9.567*	March 2009
India	-10.623*	March 2009
Bangladesh	-9.680*	April 2007
China	-4.631*	November 2007
Sri Lanka	-10.596*	January 2009
Indonesia	-9.777*	March 2009
Korea	-11.474*	March 2009
Malaysia	-6.899*	April 2009
Philippines	-11.892*	February 2009
Thailand	-4.136*	March 2009
DJIA	-13.076*	April 2009
Nikkei 225	-12.139*	July 2007
SP 1200	-11.458*	June 2009

Source: Author's calculations.

3.2. DCC Model Estimation

The study uses Engle's (2002) model, which itself is an extension of Bollerslev, Chou and Kroner's (1992) constant conditional correlation framework.[12] It was originally designed to test for a dynamic relationship between Asian and Latin American markets. A key advantage of the DCC-GARCH multivariate framework is that it yields pairwise correlation coefficients in the index returns, which helps study their associated behavior during the crisis period.[13] Based on Engle's assumption, the returns are calculated after filtration, as given below:

$$R_t|F_{t-1} \sim N(0, H_t) \tag{1}$$

$$H_T = D_t R_t D_t \tag{2}$$

[12] Dungey et al. (2004) and Pericoli and Sbracia (2003) review various methodologies, including probability models and extreme value theory in the literature on contagion. Probability models examine crises index changes in one country due to another country, whereas extreme value theory deals with the correlation values of a returns distribution with negative values.

[13] Serwa and Bohl (2005) test for the contagion effect among seven developed and three emerging markets, incorporating the US stock market crash and accounting scandals of 2002. There is little evidence of contagion in Corsetti et al. (2005) and Forbes and Rigobon (2002), who use adjusting correlation coefficient variants. Studies on mature markets include Fratzscher (2002), Bae and Karolyi (1994), Longin and Solnik (1995) and Hamao, Masulis and Ng (1990). Emerging market contagion studies include Caporale, Pittis and Spagnolo (2006), Edwards (1998) and Ng (2000).

In equation (2), D_t represents a k x k diagonal matrix with a time-varying standard deviation from GARCH[14] along with $\sqrt{h_{it}}$ on the ith diagonal and R_t representing time-varying correlation. The model's log likelihood is expressed below:

$$L = -\frac{1}{2}\sum_{t=1}^{T}(klog\ (2\pi) + 2\log|H_t| + r_t H_t^{-1} r_t) \tag{3}$$

$$= -\frac{1}{2}\sum_{t=1}^{\mathrm{T}}(klog\ (2\pi) + 2\log|D_t R_t D_t| + r_t D_t^{-1} R_t^{-1} D_t^{-1} r_t)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}(klog\ (2\pi) + 2\log|D_t| + \log(|R_t| + \epsilon_t R_t^{-1}\epsilon_t)$$

Here, $\epsilon_t \sim N(0, R)$ are the standardized residuals based on their conditional standard deviations. To obtain the individual asset conditional variance, we write the univariate GARCH model as

$$h_{it} = \omega_i + \sum_{q=1}^{pi} \propto_{ip} r_{it-p}^2 + \sum_{q=1}^{Qi} \beta_{iq}\, h_{it-p} \text{ for } i = 1, 2, 3 \ldots k \tag{4}$$

Given the normal restrictions of stationarity and nonnegativity (of variances), and with GARCH $\sum_{p=1}^{pi} \propto_{ip} + \sum_{q=1}^{Qi} \beta_{iq} < 1$, the correlation structure of the proposed dynamic is:

$$Q_t = (1 - \sum_{m-1}^{M} \alpha_n - \sum_{n-1}^{N} \beta_n)\bar{Q} + \sum_{m-1}^{M} \alpha_m\, (\epsilon_{t-m}\epsilon'_{t-m}) + \sum_{n=1}^{N} \beta_n\, Q_{t-n} \tag{5}$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{6}$$

where $\bar{Q}$ is the unconditional covariance of the standardized residuals from the univariate GARCH equation. The diagonal matrix for Q_t' is:

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[14] Mean equation: $r_t = \gamma_1 r_{t-1} + \gamma_2 r_{t-1}^{US,EUR,JAP} \varepsilon_t$ where $r_1 = (r_{1,t}, r_{2,t}, \ldots r_{10,t}), \varepsilon_t = (\varepsilon_{1,t}, \varepsilon_{2,t}, \ldots \varepsilon_{10,t})$ and $\varepsilon_t\ |I_{t-1} \sim N(0, H_t)$.

Variance equation: $h_{ii,t} = \omega_i + \alpha_{i,1}\varepsilon_{i,t-1}^2 + \beta_{i,1} h_{ii,t-1}$, for i = 1, 2, … 10.

$$q_{ij,t} = \rho_{ij}(1 - a - b) + b q_{ij,t-1} + a\aleph_{i,t-1}\aleph_{j,t-1}$$

DCC equation: $\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}\sqrt{q_{jj,t}}}}$ where i, j = 1, 2, … 10, and $i \neq j$.

$$Q_t' = \begin{bmatrix} \sqrt{q_{11}} & 0 & \cdots & 0 \\ 0 & \sqrt{q_{22}} & \ldots & 0 \\ \vdots & \vdots & \vdots & 0 \\ 0 & 0 & \ldots & \sqrt{q_{kk}} \end{bmatrix} \quad (7)$$

The expression for R_t is given by $\rho_{ijt} = \frac{q_{ijt}}{\sqrt{q_{ii}q_{jj}}}$. The R_t matrix is a positive constant that can be written as $H_t = D_t R_t D_t$.

3.3. Results of Multivariate DCC-GARCH Model

Panels A, B and C of Table 5 present the results of the multivariate DCC-GARCH model. In panel A, the constant term in the mean equation is statistically significant for all markets except China, Korea and Thailand. In panel B, it is significant only for Pakistan, Bangladesh, Sri Lanka, Indonesia and the Philippines. In panel C, the constant is significant for all countries except China, Korea and Malaysia. The autoregressive term in the mean equation (γ_1) is statistically significant for Indonesia and Thailand in panels A and C, and insignificant for all countries except Indonesia and Thailand in panel B. The effect (γ_2) of US markets on EFA stock returns is highly significant for all markets except China, India and Sri Lanka in panel A and for all markets other than India and Bangladesh in panel C.

Table 5: Multivariate DCC-GARCH model results

	Pakistan	Bangladesh	China	India	Sri Lanka	Indonesia	Korea	Malaysia	Philippines	Thailand
Panel A: EFA-US										
Panel A: mean equation										
M	0.0176*	0.00229*	0.0009	0.0103*	0.0127*	0.0119*	0.0041	0.0055**	0.008**	0.0000
	(0.0063)	(0.0010)	(0.0049)	(0.0048)	(0.0052)	(0.004)	(0.0038)	(0.0027)	(0.004)	(0.0000)
$\gamma 1$	0.098	-0.0276	0.0634	0.0531	0.099	0.1710*	-0.0457	0.0070	0.033	1.0000*
	(0.090)	(0.0852)	(0.0785)	(0.0789)	(0.086)	(0.077)	(0.064)	(0.0709)	(0.053)	(0.0000)
$\gamma 2$	0.1137*	-0.0122*	0.0150	0.0410	0.0429	0.074***	0.1015*	0.0812*	0.098**	0.0000*
	(0.052)	(0.0065)	(0.0387)	(0.0367)	(0.0367)	(0.0425)	(0.039)	(0.0199)	(0.044)	(0.0000)
Panel A: variance equation										
ω	0.0003	0.0001	0.0003	0.0001	0.0014	0.0002	0.003	0.0002	0.0006*	0.0000
	(0.0006)	(0.0001)	(0.0003)	(0.0001)	(0.0014)	(0.0002)	(0.003)	(0.0003)	0.0018	(0.0000)
A	0.1373*	0.1140	0.1288*	0.1008**	0.1145***	0.1199	0.1238*	0.0911**	-0.065*	0.1500
	(0.063)	(0.0805)	(0.0635)	(0.0560)	(0.069)	(0.1178)	(0.050)	(0.048)	(0.0171)	(0.1944)
B	0.8689*	0.8921*	0.8172*	0.8859*	0.6083*	0.8162*	0.8661*	0.8905*	-0.6208**	0.0000*
	(0.037)	(0.0581)	(0.0867)	(0.0550)	(0.2843)	(0.1409)	(0.0424)	(0.057)	(0.3765)	(0.0000)
Panel A: multivariate DCC equation										
Pers.	0.999	0.330	0.713	0.671	1.000	0.647	0.647	0.531	1.030	0.950
Panel B: EFA-EUR										
Panel B: mean equation										
M	0.0168*	0.0025*	0.0003	0.0063	0.1164*	0.0116*	0.0011	0.00438	0.0089*	-0.0001
	(0.0061)	(0.0010)	(0.0051)	(0.0052)	(0.0051)	(0.0044)	(0.0039)	(0.0029)	(0.0042)	(0.0001)
$\gamma 1$	0.0230	-0.0144	0.0485	0.0603	0.099	0.1636*	-0.0204	0.0609	0.0501	1.0000*
	(0.0962)	(0.0835)	(0.0780)	(0.0605)	(0.0887)	(0.0756)	(0.0674)	(0.0759)	(0.0737)	(0.0000)
$\gamma 2$	0.3432**	-0.0136	0.1254	0.4037*	0.1579	0.1929	0.2721*	0.1710*	0.2986*	0.0001*
	(0.1827)	(0.0198)	(0.1324)	(0.1592)	(0.1315)	(0.1461)	(0.1089)	(0.0829)	(0.1320)	(0.0000)

	Pakistan	Bangladesh	China	India	Sri Lanka	Indonesia	Korea	Malaysia	Philippines	Thailand
					Panel A: EFA-US					
Panel B: variance equation										
ω	0.0002	0.001	0.0003	0.0081*	0.0013	0.0030*	0.0001	0.0001	0.0002	0.0000
	(0.0002)	(0.0001)	(0.0003)	(0.0017)	(0.0014)	(0.0007)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
A	0.1222**	0.1092	0.1287*	-0.0888*	0.1053	0.3100	0.1160*	0.0999	0.1055	0.1500
	(0.0680)	(0.0741)	(0.0636)	(0.0181)	(0.0708)	(0.1976)	(0.0567)	(0.0632)	(0.0714)	(0.1127)
B	0.8626*	0.9008*	0.8153*	-0.5933*	0.6228*	-0.0023	0.8794*	0.8672*	0.8298*	0.6000*
	(0.0418)	(0.0548)	(0.0880)	(0.3172)	(0.2934)	(0.0995)	(0.0487)	(0.0782)	(0.0998)	(0.2207)
Panel B: multivariate DCC equation										
Pers.	0.727	0.981	0.787	0.931	1.001	0.2603	0.9490	0.6103	0.2899	0.9519
					Panel C: EFA-JAP					
Panel C: mean equation										
M	0.0152*	0.0025*	0.0005	0.0098*	0.0124*	0.0089*	0.0029	0.0040	0.0085*	0.0001*
	(0.0065)	(0.0010)	(0.0050)	(0.0047)	(0.0051)	(0.0044)	(0.0035)	(0.0028)	(0.0037)	(0.0001)
$\gamma 1$	0.0489	-0.0163	0.0666	0.0535	0.1085	0.2296*	-0.0572	0.0502	0.0551	0.0001*
	(0.0777)	(0.0845)	(0.0782)	(0.0804)	(0.0894)	(0.0697)	(0.0651)	(0.0673)	(0.0637)	(0.0001)
$\gamma 2$	0.3529*	-0.0040	0.1854*	0.0589	0.2419*	0.5876*	0.5540*	0.2305*	0.3927*	1.0000*
	(0.1120)	(0.0252)	(0.0994)	(0.0893)	(0.0906)	(0.1121)	(0.0718)	(0.0509)	(0.0948)	(0.0001)
Panel C: variance equation										
ω	0.0002	0.0001	0.0003	0.0001	0.0016	0.0060*	0.0002	0.0001	0.0004	9.2700
	(0.0002)	(0.0001)	(0.0003)	(0.0001)	(0.0014)	(0.0015)	(0.0002)	(0.0001)	(0.0003)	(2.110)
A	0.1469*	0.1082	0.1304*	0.1066*	0.1385	-0.0420	0.2088*	0.0689	0.1894*	0.1500
	(0.0750)	(0.0744)	(0.0592)	(0.0550)	(0.1399)	(0.0392)	(0.08098)	(0.0493)	(0.0865)	(0.2779)
B	0.8325*	0.9013*	0.8215*	0.8861*	0.5299***	-0.7542*	0.7484	0.9097*	0.6845*	0.6000
	(0.0346)	(0.0547)	(0.0789)	(0.0512)	(0.3189)	(0.3928)	(0.1142)	(0.0612)	(0.1540)	(0.8178)
Panel C: multivariate DCC equation										
Pers.	0.989	0.778	0.802	0.704	0.8331	0.9159	1.0103	0.7054	0.8210	0.8954

Note: * = rejection of null hypothesis at 1 percent, ** at 5 percent, *** at 10 percent. Values in bold are different from 0 with a significance level alpha = 0.05. Values in parentheses are standard errors.
Source: Author's calculations.

The last two rows of each panel report the estimates for DCC (1, 1) persistence. All the countries have high persistence values except for Bangladesh in panel A and Indonesia and the Philippines in panel B. In panel C, all the countries have high values, indicating high volatility persistence across the sample. Overall, the results show that EFA markets exhibit a high volatility persistence based on their GARCH estimates. The table also reports the parameter estimates of the mean and conditional variance equation for the sample. The lagged conditional volatility coefficients and ϵ^2 in the variance equation have high significant values, thereby justifying the use of the GARCH (1, 1) model to capture the contagion effect among the sample markets during a crisis.

Boyer, Kumagai and Yuan (2006) suggest that contagion can arise from a fundamental base or investor portfolio rebalancing induced behavior. The former is described as interdependence by Forbes and Rigobon (2002) and the latter as herding behavior in behavioral finance. Hirshleifer and Teoh (2003) define herding behavior as the convergence of investor behaviors: investors follow other investors, thereby trading in the same direction over a specific period. Many studies, including Corsetti et al. (2005), Chiang, Jeon and Li (2007), Boyer et al. (2006) and Jeon and Moffett (2010) use DCC measures to investigate herding behavior.

Table 6 illustrates the dynamic relationship between EFA markets and the US, Japanese and European stock markets. The results indicate that the mean and variance equation coefficients significant for Pakistan and Sri Lanka, moderately significant for Korea and Thailand and the less significant for Indonesia, Malaysia and the Philippines with respect to the developed markets of the US, Japan and Europe.

The dynamic coefficients for the EFA markets are reported in the adjacent column. Indonesia and the Philippines appear to be the only markets with significant coefficient values vis-à-vis European stock markets (DJIA). All the EFA markets have significant coefficients with respect to Japanese stock returns (Nikkei), barring Korea and the Philippines. Thailand, Malaysia, Indonesia and Sri Lanka's stock markets appear to have significant values with respect to US returns (SP 1200).

Table 6: Dynamic relationship between EFA and stock markets

	Independent variables			
Dependent variables	**DCC estimation**	**DJIA**	**Nikkei**	**SP 1200**
Pakistan		0.2962	0.4655*	0.0507
		(0.1243)	(0.094)	(0.0356)
ϕ	0.3244*			
	(0.1090)			
6	0.6230*			
	(0.1076)			
γ	0.0005**			
	(0.0003)			
Sri Lanka		-0.1288	0.1799**	0.0769*
		(0.1335)	(0.1026)	(0.0386)
Φ	0.1403**			
	(0.0770)			
6	0.6881*			
	(0.1348)			
γ	0.0009**			
	(0.0005)			
Indonesia		0.0735*	0.2217*	0.0735*
		(0.0343)	(0.0894)	(0.0343)
ϕ	0.0990			
	(0.0673)			
6	0.2360			
	(0.5169)			
γ	0.0032			
	(0.0023)			
Korea		0.0327	0.0575	0.0327
		(0.0304)	(0.1206)	(0.0304)
Φ	0.0076			
	(0.0050)			
6	1.0056*			
	(0.0130)			
γ	0.0001*			
	(0.0001)			
Malaysia		0.0277	0.0987**	0.0403*
		(0.0780)	(0.0585)	(0.0208)
Φ	0.0068			
	(0.0079)			
6	1.0080*			
	(0.0237)			
γ	-0.0001			
	(0.0001)			

	Independent variables			
Dependent variables	**DCC estimation**	**DJIA**	**Nikkei**	**SP 1200**
Philippines		0.2353**	0.1008	0.0174
		(0.1285)	(0.0827)	(0.0318)
Φ	0.0093			
	(0.0499)			
6	0.9138*			
	(0.2083)			
γ	0.0003			
	(0.0007)			
Thailand		-0.0354	-0.0206**	-0.0205**
		(0.0277)	(0.0079)	(0.0079)
Φ	0.3566*			
	(0.1099)			
6	0.6626*			
	(0.0665)			
γ	0.0001*			
	(0.0001)			

Note: Φ= mean, 6 = variance, γ= DCC equation coefficients. * = rejection of null hypothesis at 1 percent, ** at 5 percent, *** at 10 percent. Values in bold are different from 0 with a significance level alpha = 0.05. Values in parentheses are standard errors.
Source: Author's calculations.

3.4. Robustness Test Results

Tables 7 and 8 test the robustness of the DCC multivariate GARCH models. Table 7 highlights the conditional quasi-correlation among the standardized residuals of the EFA and developed markets (US, Europe and Japan) included. In almost all the markets, the conditional dynamic correlation value is lower than the unconditional correlation value presented in Table 3.

This finding has important implications for the spillover from developed to emerging markets in a period of financial turmoil. The last row presents the adjustment coefficient estimates of the DCC (1, 1) parameters *a* and *b*. Both coefficients are highly significant, indicating substantial time-varying co-movement among the stock market indices of EFA and developed markets.

Table 7: Robustness test results

Variable	Pakistan	Sri Lanka	Indonesia	Korea	Malaysia	Philippines	Thailand
Correlations							
Pakistan	**1.000**	0.018	0.126	0.148	0.413	-0.005	-0.259
Sri Lanka		**1.000**	0.697	0.470	0.376	0.521	0.123
Indonesia			**1.000**	0.863	0.802	0.903	0.202
Korea				**1.000**	0.847	0.727	0.072
Malaysia					**1.000**	0.799	0.021
Philippines						**1.000**	0.399
Thailand							**1.000**
Adjustment coefficient							
A	0.0044** (0.0017)						
B	0.9740* (0.0118)						

Note: * = rejection of null hypothesis at 1 percent, ** at 5 percent, *** at 10 percent. Values in bold are different from 0 with a significance level alpha = 0.05. Values in parentheses are standard errors.
Source: Author's calculations.

Table 8: DCC (1, 1) model results

	Average	Standard deviation	Trend (*1000)	t-statistic	Δp
Panel A: US-EFA DCC					
Pakistan	-0.03057	0.00252	-0.038	-17.3610	-1.14%
Bangladesh	0.01672	0.15625	0.066	-0.2950	-7.79%
China	-0.12658	0.08963	-0.127	-0.9882	13.40%
India	-0.03934	0.16051	-0.214	-0.9279	2.69%
Sri Lanka	-0.04201	0.01644	-0.230	-14.0260	-2.03%
Indonesia	-0.04830	0.07473	-0.040	0.3691	2.71%
Korea	-0.06074	0.04147	-0.246	4.3283	6.41%
Malaysia	0.03466	0.11838	-0.055	-0.3200	9.77%
Philippines	0.19403	0.24046	-3.027	-11.5910	-45.13%
Thailand	0.98292	0.01626	0.238	15.7720	3.12%
Panel B: EUR-EFA DCC					
Pakistan	-0.07546	0.07583	-0.330	-3.1091	-3.68%
Bangladesh	-0.01039	0.02987	0.192	4.7557	-0.87%
China	-0.08531	0.13009	-0.570	-3.1295	-7.69%
India	0.13019	0.25236	0.114	0.3154	12.40%
Sri Lanka	-0.04699	0.00991	-0.175	-31.0330	-2.65%

	Average	Standard deviation	Trend (*1000)	t-statistic	Δp
Indonesia	-0.05301	0.20087	-0.026	-0.0887	2.44%
Korea	-0.01373	0.13023	1.975	17.1980	2.67%
Malaysia	-0.00295	0.04502	-0.044	-0.6765	1.63%
Philippines	-0.06830	0.06703	-0.007	-0.0671	-2.72%
Thailand	0.99591	0.00577	0.001	0.1113	2.05%
Panel C: JAP-EFA DCC					
Pakistan	-0.10668	0.01612	-0.081	-3.6321	-3.59%
Sri Lanka	0.01448	0.04798	0.012	-0.1742	-5.24%
Bangladesh	0.06727	0.12351	0.439	2.5140	1.03%
China	-0.04032	0.08019	-0.376	-3.3605	-3.94%
India	-0.06090	0.07897	0.514	4.8148	8.24%
Indonesia	-0.00880	0.05145	-0.113	1.5435	-2.99%
Korea	-0.80686	0.35681	0.208	-30.0350	-1.19%
Malaysia	0.02592	0.14655	-0.103	-0.4893	-16.60%
Philippines	0.01351	0.07798	-0.289	-2.6269	-4.26%
Thailand	-0.14459	0.08645	-0.950	-9.3152	-15.10%

Note: The slope of the regression of conditional correlation $\varrho_{ij,t}$ is represented by "trend" on a constant. The t-ratio represents the t-statistic. Δpdenotes the difference between the last and first fitted values of the conditional correlation regression on the time trend of a zero mean and constant.
Source: Author's calculations.

3.5. Conditional Correlation Coefficient Analysis

Next, we study the impact of a crisis on dynamic correlation for further insights into the additional independent variables that explain stock market correlation. Initially, we had considered the impact of external shocks on the coefficients of conditional correlation. The financial turmoil factor is very important in explaining the conditional correlation coefficient in this case: stock market turbulence has implications for international investors and the diversification of stocks.

We use dummy variables for three different, evenly spaced crisis periods to analyze their impact on dynamic correlation in the sample markets. The regression analysis takes the time-varying correlation coefficient as a dependent variable and each of the crisis dummy variables as explanatory variables. The first dummy variable represents the dot.com bubble from 10 March 2000 to 27 September 2002. The second dummy is the 2008/09 stock market crash from 26 September 2008 to 31 December 2009.

The third dummy variable is the European debt crises from 1 January 2011 to 30 November 2013. Each dummy variable is equal to 1 for a crisis period and 0 otherwise. The resulting equation is expressed below:

$$\rho_{ij,t} = \omega + \sum_{k=1}^{3} \alpha_k DM_{k,t} + \epsilon_{ij,t} \quad (8)$$

The first column of Table 9 underlines the effect of the dot.com bubble crisis on dynamic correlation between EFA markets and the US. Since the crisis was related to information technology, it had a negative impact on returns in Thailand though the impact on returns in Pakistan was positive (perhaps reflecting Pakistan's role as a hedge market). In terms of the European and EFA market correlations during the dot.com crisis, there was a negative impact in China and Indonesia. However, in the case of correlation between Japan and the EFA markets, only Bangladesh and India are affected.

Table 9: DCC (1, 1) model applied to crisis periods

	Dot.com bubble (10 Mar 2000–27 Sep 2002)	**2008 stock market crash (26 Sep 2008–31 Dec 2009)**	**European debt crisis (1 Jan 2011–30 Nov 2013)**
Panel A: US-EFA DCC			
Pakistan	0.004436*	0.000139	-0.000758*
	(0.000373)	(0.000488)	(0.000356)
Bangladesh	0.029214	0.019541	-0.013485
	(0.032338)	(0.042315)	(0.030902)
China	-0.001154	-0.009799	-0.053948*
	(0.018104)	(0.023690)	(0.017301)
India	-0.007859	0.066895*	0.079637*
	(0.011671)	(0.015272)	(0.011153)
Sri Lanka	0.030469*	0.002118	-0.008326*
	(0.002183)	(0.002856)	(0.002086)
Indonesia	0.003615	0.010710	0.002893
	(0.015517)	(0.020304)	(0.014828)
Korea	-0.009701	0.005353	0.009987
	(0.008522)	(0.011151)	(0.008144)
Malaysia	0.006360	0.041414	-0.004256
	(0.024470)	(0.032020)	(0.023384)
Philippines	0.313054*	0.019881	-0.017585
	(0.043342)	(0.056713)	(0.041417)
Thailand	-0.028889*	-0.003058	0.010023*
	(0.002183)	(0.002856)	(0.002086)

	Dot.com bubble (10 Mar 2000–27 Sep 2002)	**2008 stock market crash (26 Sep 2008–31 Dec 2009)**	**European debt crisis (1 Jan 2011–30 Nov 2013)**
Panel B: EUR-EFA DCC			
Pakistan	0.015554	-0.005393	-0.031311*
	(0.015453)	(0.020221)	(0.014767)
Bangladesh	0.152492*	-0.055715	0.148375*
	(0.033448)	(0.043767)	(0.031963)
China	0.018173	-0.122874*	0.127697*
	(0.044026)	(0.057608)	(0.042071)
India	-0.019599*	0.057095*	0.005239
	(0.010662)	(0.013951)	(0.010188)
Sri Lanka	0.018133*	0.003919*	-0.009003*
	(0.001082)	(0.001416)	(0.001034)
Indonesia	0.024201	-0.013050	0.015861
	(0.041677)	(0.054535)	(0.398242)
Korea	-0.086352*	-0.062261*	0.155977*
	(0.021460)	(0.028081)	(0.020507)
Malaysia	0.023033*	0.024943*	0.009746
	(0.009122)	(0.011936)	(0.008717)
Philippines	0.006315	0.012916	0.004243
	(0.013906)	(0.018196)	(0.013288)
Thailand	0.127478*	0.147003*	-0.039518*
	(0.015909)	(0.020817)	(0.015202)
Panel C: JAP-EFA DCC			
Pakistan	0.015139*	-0.007817*	-0.003494
	(0.003039)	(0.003917)	(0.002905)
Bangladesh	-0.147646*	-0.361641*	-0.072444*
	(0.031552)	(0.041287)	(0.030151)
China	-0.007592	0.058159*	0.007992
	0.017362	(0.022719)	(0.016592)
India	-0.027760**	0.086697*	-0.011970
	(0.015856)	(0.020747)	(0.015152)
Sri Lanka	0.013256	0.080369*	0.013095
	(0.008828)	(0.011552)	(0.008436)
Indonesia	0.017311*	0.121747*	0.024088*
	(0.008051)	(0.010535)	(0.007694)
Korea	0.634551*	-0.237901*	-0.192584*
	(0.045458)	(0.059482)	(0.043409)
Malaysia	0.006965	0.224016*	-0.020481
	(0.027251)	(0.035658)	(0.026041)

	Dot.com bubble (10 Mar 2000–27 Sep 2002)	2008 stock market crash (26 Sep 2008–31 Dec 2009)	European debt crisis (1 Jan 2011–30 Nov 2013)
Philippines	0.050120*	0.173213*	-0.001703
	(0.012344)	(0.016153)	(0.011796)
Thailand	0.167942*	0.028497	-0.041682*
	(0.021216)	(0.027761)	(0.020274)

Source: Author's calculations.

The second column of Table 9 corresponds to the 2008 stock market crash (the dummy variable is DM2). In terms of correlation with the US, India was the only market in which returns are affected. With respect to European markets, China and Korea exhibit reduced returns. This shows that all these markets were subject to dynamic correlation.

In terms of dynamic conditional correlation between the Japanese and EFA markets, only Pakistan, Bangladesh and Korea show negative values, indicating the effect of the global financial crisis on these markets. A key finding is that the coefficient values increase during the 2008 financial crisis and then decrease (at a falling rate) during the European debt crisis. Most markets also exhibit herding behavior, which can be attributed to the financial liberalization in emerging markets. Since this helped international investors diversify their portfolios in these markets to minimize risk, we can argue that the increasing level of foreign ownership in EFA markets has given rise to herding behavior.

Finally the third column of Table 9 shows the impact of the European debt crisis. In terms of correlations the US, returns in Pakistan. China, India and Sri Lanka were negatively affected. In terms of correlation with the European markets, returns in Pakistan and Thailand were negatively affected. And in terms of correlations with Japanese and EFA markets returns in Bangladesh and Korea were negatively affected.

In light of these results, most EFA markets appear to have experienced a disturbance during the sample crisis periods. This has key implications for investors regarding international diversification. Our findings support most crisis-contingent theories of asset market linkages in East Asia.

4. Concluding Remarks

This paper applies a multivariate DCC framework to determine the short-term relationship between EFA markets (Pakistan, Bangladesh, China, India, Sri Lanka, Indonesia, Korea, Malaysia, the Philippines and Thailand) and developed markets (the US, Europe and Japan), based on a monthly return series for January 2000 to December 2014. The coefficients of conditional correlation show significant variation over the sample period in general and during three specific crisis periods (the dot.com bubble, the 2008 stock market crash and the European debt crisis). The findings support the use of the multivariate GARCH-DCC framework to identify increased correlation coefficients in times of financial turmoil. These results are in accordance with Li (2007), Yu et al. (2010), Aloui et al. (2011), Samarakoon (2011), Kenourgios and Padhi (2012) and Chua et al. (2012).

The analysis of conditional correlation favors the contagion effect due to herding behavior in EFA financial markets. However, the financial contagion hypothesis cannot be accepted across the panel for all crisis periods. The increased impact on EFA markets can also be attributed to greater sensitivity to incoming foreign investment. The results indicate that all crisis periods do not have a uniform impact on EFA markets. Rather, each market behaves differently in each crisis period. Nonetheless, the global financial crisis of 2008 had a significant impact on these markets in the form of financial contagion followed by herding behavior.

Other factors also play an important role as control variables during periods of financial turbulence, of which exchange rates and international oil prices are the most influential (Rehman, 2014). While this study focused on measuring the impact of spillovers from developed equity markets on EFA financial markets, other market and financial variables are not taken into account (see Rehman & Shah, 2016a, 2016b). Therefore, the study could be extended by incorporating these variables along with the control variables (exchange rates and international oil prices) before, during and after a global crisis.

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Do Financial Sector Activities Affect Tax Revenue in Pakistan?

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Abstract

By mobilizing savings, financial markets play a crucial role in economic development. Given that the literature does not fully explore the nexus between financial activities and tax revenue, this study attempts to analyze the role of financial markets in generating tax revenue in Pakistan, using time series data for the period 1975–2014. It finds that, in the long run, the number of bank branches and market capitalization have a positive and significant impact on tax revenue. While credit to the private sector has a bidirectional relationship with tax revenue, public sector credit has an insignificant impact. In the short run, only the number of bank branches and market capitalization have a significant impact on tax revenue.

Keywords: Financial sector, financial liberalization, tax revenue, Pakistan.

JEL classification: G1, G38, H21, C32.

1. Introduction

The development of financial markets is crucial to the economic growth of developing countries such as Pakistan. As early as 1912, Schumpeter found that financial development stemming from a country's individual savings could improve social wellbeing and stimulate economic growth. Subsequent studies have supported the view that financial development has a positive impact on economic growth. Additionally, the effectiveness and efficiency of the tax collection mechanism is very important because tax revenues are needed to meet the government's development and nondevelopment expenditures. However, taxes should be levied in such a way that they do not discourage investment (Padda & Akram, 2009).

Fiscal policy affects the overall economy and growth in various ways, of which financial markets are an important transmission channel

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The views presented in this paper are those of the author and do not necessarily reflect the views of the institution with which he is affiliated.

(Arin, Mamun & Purushothman, 2009). The key issues that need to be examined are whether taxes affect financial sector development and the role of the financial sector in tax collection. Assuming that both financial and investment activities are similar, an increase in the tax rate can distort financial system development (Clark, 2007). Golob (1995) argues that taxes affect financial markets through three different channels: (i) interest on loans, (ii) municipal securities and (iii) firms' publicly traded shares, which are taxable.

Numerous studies have analyzed the impact of taxation on investment decisions, generally finding that tax policy has a strong impact on financial sector activities. Most studies suggest that an increase in taxes has a negative impact on the activities of the financial sector and that the tax structure significantly influences stock market returns. Taxes have a negative impact on banking activities for foreign banks and a positive impact for domestic banks (see Tavares & Valkanov, 2001; Laopodis, 2009; Clark, 2007; Arin et al., 2009; Ardagna, 2009; Demirgüç-Kunt & Huizinga, 2001).

Banks, other financial institutions and insurance companies supply liquidity to both businesses and consumers by providing different types of payment systems that are essential for noncash transactions (Elliott, 2010). If a country's financial institutions are well developed, transparent and efficient, then businesses and taxpayers will use them to conduct their transactions. In turn, the tax collecting authorities can obtain valuable information from these institutions on taxpayers' income and assets. However, in the case of underdeveloped financial institutions, the size of the underground economy increases and it becomes difficult to collect accurate tax information. Hence, the development of the financial sector is also an important determinant of tax revenue.

A review of the literature suggests that the impact of financial development on taxation is relatively under-investigated in the context of developing countries. Bohn (1990) concludes that there is a positive relationship between financial development and tax revenue. Boyd (2009) emphasizes the significant impact of a downturn in investment in capital markets on tax revenue collection, concluding that, since financial sector development helps determine investment, it also has an impact on tax revenue.

Hung and Lee (2010) find that tax policies play an important role in the development of the banking system, while the taxes paid by foreign

banks increase only slightly with the local statutory tax. Taha, Colombage and Maslyuk (2010) establish a two-way relationship between direct tax revenue and the financial sector. They find that direct tax revenue has a significant relationship with financial activities. Similarly, the development of the bonds and stocks market has a crucial role in revenue generation.

Although tax revenue is the main source of government income, Pakistan has, over the years, failed to collect adequate tax revenue. In FY2014, the tax-to-GDP rate was only 10.1 percent, which is very low compared to other countries: 17 percent in India, 11.6 percent in Sri Lanka and 14.4 percent in the Philippines. Nonetheless, Pakistan's financial market has performed well: in 2014, it was ranked among the top ten best-performing markets in the world (Pakistan, Ministry of Finance, 2015). In this regard, it becomes extremely important for policymakers to design the fiscal policy in such a way that it stimulates the financial market, in turn, contributing to better revenue collection.

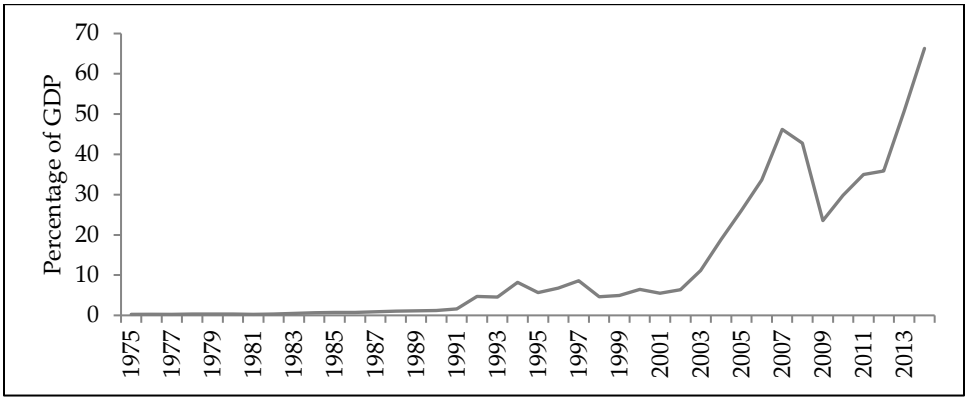
This paper is organized as follows. Section 2 describes tax revenues and financial sector development in Pakistan. Section 3 presents the data and estimation methodology used and Section 4 summarizes the results. Section 5 provides a conclusion, policy recommendations and suggestions for future research.

2. An Overview of Financial Development and Tax Revenue

Post-independence, Pakistan inherited an underdeveloped economy and financial system. The country's leadership was very keen to boost the economy and develop a well-organized financial system. To this end, the first stock exchange (the Karachi Stock Exchange) was founded in 1947 and the central bank, the State Bank of Pakistan, came into being in 1948. Pakistan's performance in various financial markets and tax revenue collection is described below.

In the last three years, Pakistan's financial market performance has improved substantially. In 2014, it was ranked the third best-performing market in the world. The key factors behind this remarkable performance are the country's improved macroeconomic indicators (particularly forex reserves), expected investment by China, business-friendly reforms, the confidence of donor agencies in Pakistan's economy (particularly the IMF program) and government privatization plans. Figure 1 shows that, after 1991, there was steady growth in market capitalization as a percentage of GDP, with added momentum after 2002.

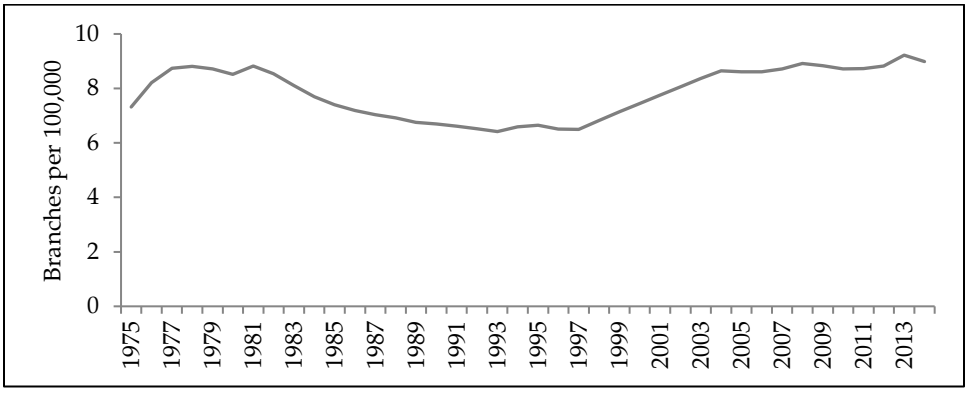
Figure 1: Market capitalization as a percentage of GDP



Source: Author's calculations, based on data from the State Bank of Pakistan.

The number of bank branches per 100,000 persons is a performance indicator of the banking sector. Figure 2 suggests there was a decline in the number of branches during 1975–91. Post-1997, banks began to expand their business and open more branches, leading to an increasing trend in the number of bank branches.

Figure 2: Number of bank branches per 100,000 persons

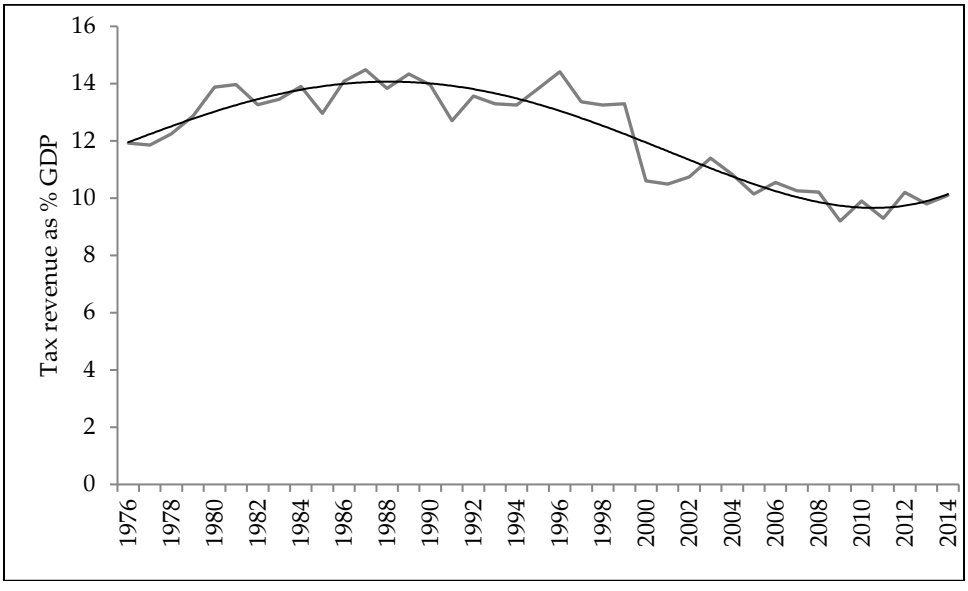


Source: Author's calculations, based on data from the State Bank of Pakistan and Pakistan Bureau of Statistics.

Figure 3 shows that tax revenue as a percentage of GDP has not increased over the years. On average, tax revenues were 13.7 percent of GDP in the 1980s. In the 1990s, this ratio fell slightly to 13.1 percent. In FY2014, tax revenues were only 10.1 percent of GDP. In 2001, Pakistan introduced comprehensive tax reforms to raise its tax revenue. The Federal Board of Revenue has taken steps to enlarge the tax base, introducing a

universal self-assessment scheme and bifurcating medium and large taxpayer units. In absolute terms, there has been a considerable increase in tax revenue, but if we measure taxes as a percentage of GDP, then the reforms appear to have been less successful.

Figure 3: Tax revenue as a percentage of GDP

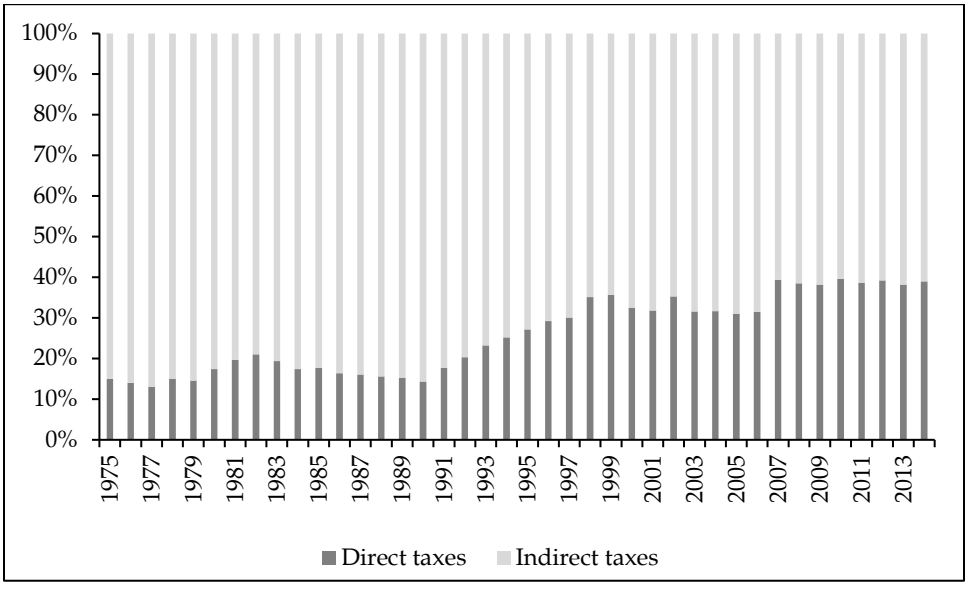


Source: Author's calculations, based on data from the Ministry of Finance.

Taxes in Pakistan are broadly divided into direct and indirect taxes. Direct taxes are further divided into income tax, wealth tax and the Workers Welfare Fund. Indirect taxes are collected primarily under three heads: custom duties, excise duties and sales tax.

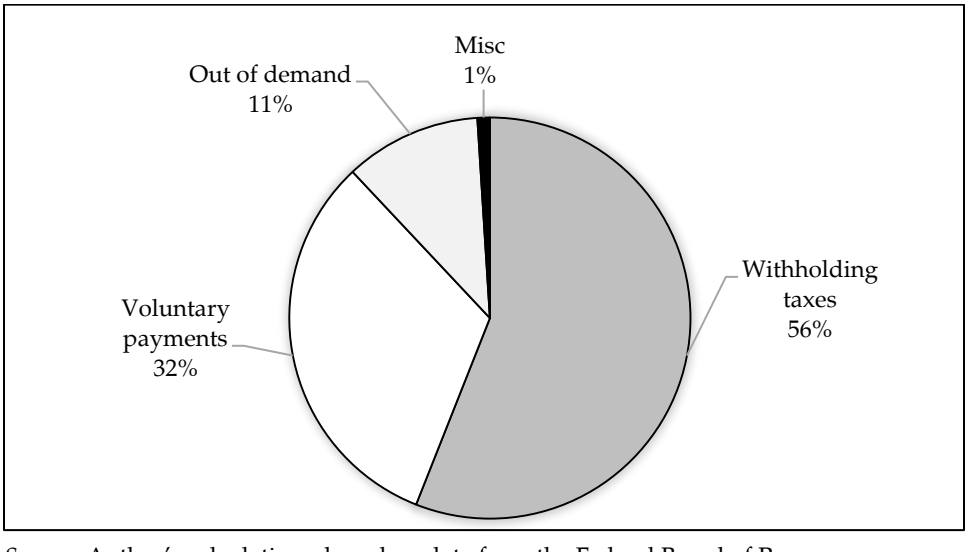
Figure 4 shows the composition of tax revenue in Pakistan. The share of direct taxes has increased from 18 percent in 1975 to 40 percent in 2014. This suggests that, over the years, there has been a considerable policy shift from indirect to direct taxation and the share of indirect taxes has fallen. In direct taxes, income tax plays a crucial role, accounting for about 97 percent of total direct taxes. Income tax consists of withholding taxes (56 percent), voluntary payments (32 percent) and out-of-demand taxes (11 percent) (Figure 5).

Figure 4: Direct and indirect taxes as a share of total tax revenue



Source: Author's calculations, based on data from the Ministry of Finance.

Figure 5: Components of income tax

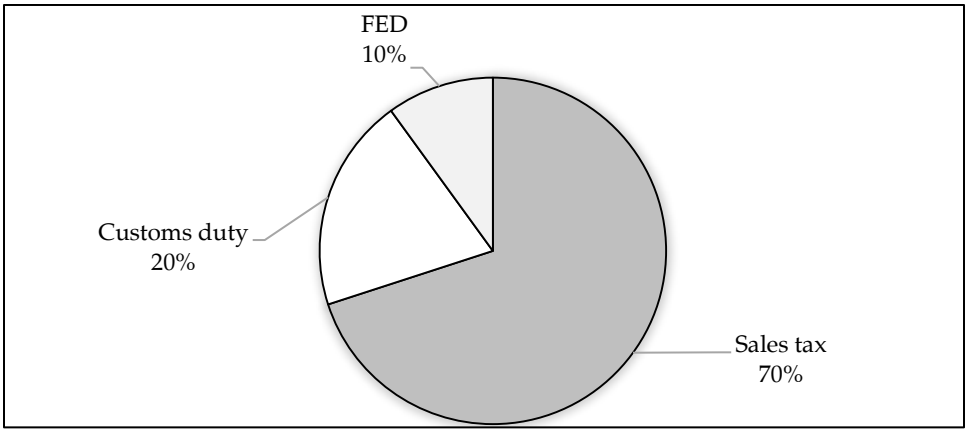


Source: Author's calculations, based on data from the Federal Board of Revenue.

Withholding tax is an advance tax that is levied at source on certain economic activities. Unlike income tax, most of the impact of withholding tax is transferred to the consumer. The highest share is that of contracts. In

the case of indirect taxes, the major share is that of sales tax (70 percent), followed by customs and excise duties (see Figure 6).

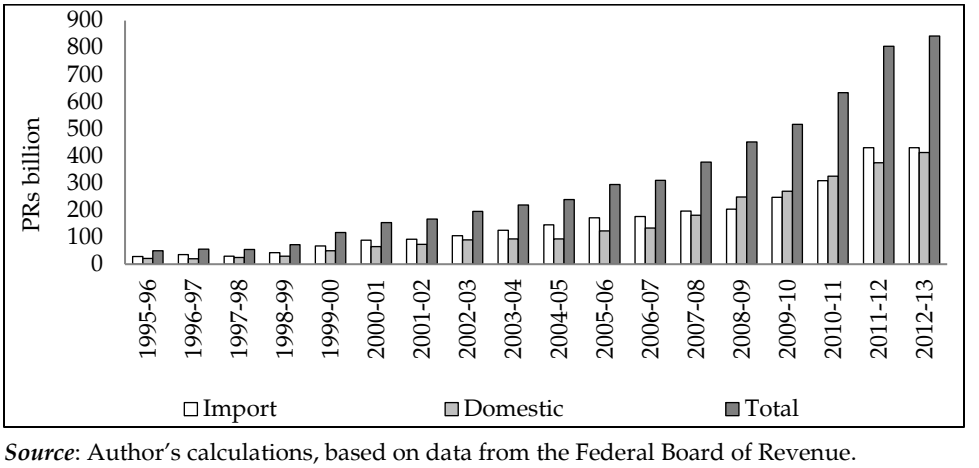
Figure 6: Components of indirect taxes



Source: Author's calculations, based on data from the Federal Board of Revenue.

In Pakistan, sales tax is liable on the sale of all taxable goods and services, excluding those goods that are exempted under the sixth schedule of the Sales Tax Act 1990. Sales tax is the leading source of tax revenue, accounting for 43.3 percent of the total tax revenue. Figure 7 illustrates the historical trend in sales tax revenue over the years. Sales tax is divided into two components: sales tax on domestic supplies and on imports. The former accounts for 49 percent of the total sales tax and the latter for the remaining portion.

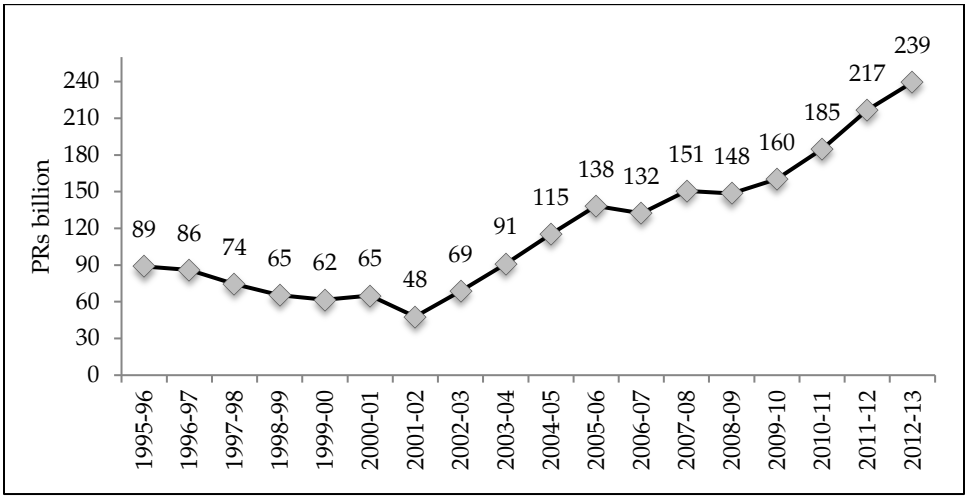
Figure 7: Historical trend in sales tax collection



Source: Author's calculations, based on data from the Federal Board of Revenue.

Customs duties, which are levied on dutiable imports, account for 20 percent of indirect tax revenues. The volume of customs duty collection plays a crucial role in creating a base for other taxes on imports such as withholding taxes, excise duty and sales tax on imports. Figure 8 shows the historical trend in customs duty collection over the years.

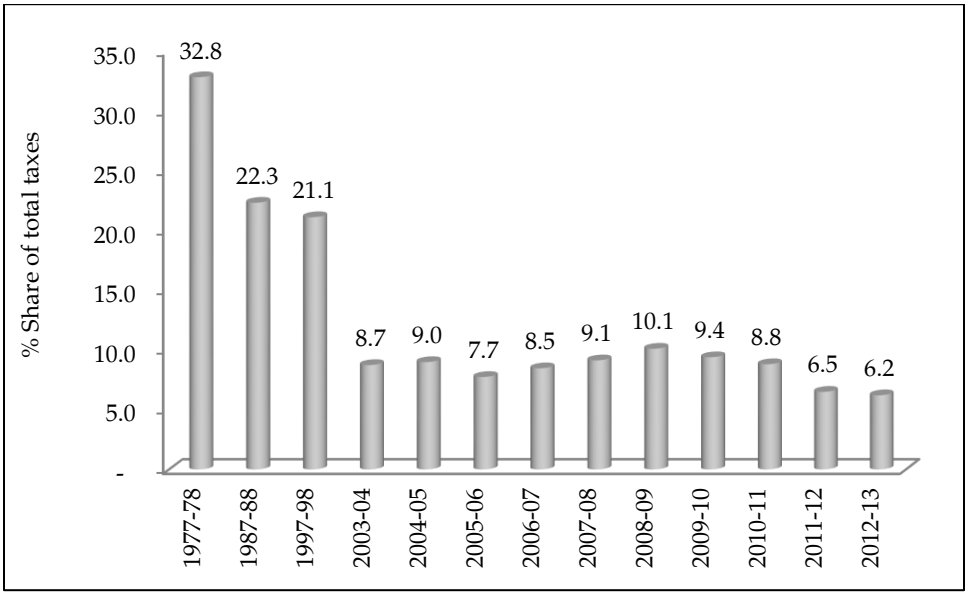
Figure 8: Historical trend in customs duty collection



Source: Author's calculations, based on data from the Federal Board of Revenue.

As Figure 6 above shows, 10 percent of the indirect tax revenue is collected in the form of federal excise duty (FED), which is levied on the production of selected commodities and services. These include beverages, cigarettes, cement, air travel, natural gas and POL products. Commodities that are domestically liable to FED are also liable at the import stage. Figure 9 indicates that, unlike other taxes, FED revenues have declined primarily because more and more commodities are being exempted from FED. Nonetheless, its share of total tax revenue remains significant.

Figure 9: Trend in FED collection



Source: Author's calculations, based on data from the Federal Board of Revenue.

3. Data and Empirical Model

The study's dataset comprises 40 annual observations spanning the period 1975–2014. Based on this, we analyze the impact of financial sector growth on tax revenues. The variables used are presented in Table 1.

Table 1: Variables and sources of data

Variable	Data source	Description
Tax revenue (TX)	Finance Division	Tax revenue as a percentage of GDP (dependent variable)
Market capitalization (MC)	State Bank of Pakistan	Market capitalization of the Karachi Stock Exchange. Used widely as a performance benchmark of capital markets in Pakistan.
Number of banks (NB)	Federal Bureau of Statistics + State Bank of Pakistan	Number of banks per 100,000 persons. Used as an indicator of financial inclusion in the banking sector.
Credit to private sector (LPR)	State Bank of Pakistan	Credit given to the private sector and to the public sector by commercial banks as a percentage to GDP. Used as indicators of banking sector development.
Credit to public sector (LPU)	State Bank of Pakistan	

All the values are taken in natural log form. The calculated long-run and short-run coefficients are their respective elasticities. Tax revenue (*TX*) is assumed to be a function of market capitalization (*MC*), credit to the public sector (*LPU*), credit to the private sector (*LPR*) and the number of bank branches (*NB*):

$$TX = f(MC, LPU, NB) \quad (1)$$

From equation 1, we derive the following reduced-form equation:

$$TX_t = \propto + \beta MC_t + \gamma LPU_t + \omega LPR_t + \delta NB_t + \varepsilon_t \quad (2)$$

where *TX* denotes tax revenue (the dependent variable) and *MC*, *LPU*, *LPR* and *NB* represent market capitalization, credit to the public sector, credit to the private sector and the number of bank branches per 100,000 people, respectively. The $\propto$ term represents the intercept and ε_t is the error term. The data on tax revenue is, arguably, subject to nonrandom measurement error. While this error in the dependent variable will not lead to biased estimates, it can lead to inflated standard errors to some extent.

4. Empirical Methodology and Results

We apply the Granger causality test to check the direction of causality between tax revenue and financial development, the results of which are summarized in Table 2.

Table 2: Granger causality test results

Null hypothesis	F-statistic	Prob.
NB does not Granger-cause TX	1.81602	0.0262
TX does not Granger-cause NB	2.39884	0.0748
MC does not Granger-cause TX	1.09367	0.3796
TX does not Granger-cause MC	2.90807	0.0402
LPU does not Granger-cause TX	0.60612	0.6616
TX does not Granger-cause LPU	1.35893	0.2742
LPR does not Granger-cause TX	3.68828	0.0160
TX does not Granger-cause LPR	1.74122	0.0722

Source: Author's calculations.

The results indicate bidirectional causality between the number of bank branches and tax revenue. In the case of market capitalization, there is unidirectional causality, with the tax revenue variable causing the market capitalization variable. Credit to the public sector does not have a causality

relationship with tax revenue. However, there is bidirectional causality between credit to the private sector and tax revenue. These results suggest that taxes affect financial sector development while the financial sector also affects tax collection.

Since the study focuses on the role of the financial sector in tax revenue generation, we explore the impact of financial sector development on tax revenue, using cointegration. Given that we are using time-series data, the first step is to resolve the stationarity of the data. Granger and Newbold (1974) show that, if certain variables are integrated of order 1 or higher, then standard OLS can yield spurious results. This makes cointegration analysis the most appropriate methodology. The stationarity of the data is determined using the augmented Dickey–Fuller test, the results of which are given in Table 3.

Table 3: Results of unit root test

Variable	Level			First difference		
	Intercept	Trend + intercept	Neither	Intercept	Trend + intercept	Neither
TX	0.542453	-1.684771	12.885210	-5.504681*	-5.493810*	-0.458226
MC	-0.239872	-2.550045	3.617997	-5.910934*	-5.827949*	-4.483500*
NB	0.331735	-2.047563	2.397001	-4.511156*	-4.481678*	-3.755365*
LPR	-0.871464	-2.553923	9.501091	-5.964175*	-5.983396*	-1.766236**
LPU	0.784762	-1.070847	2.435894	-5.583282*	-5.834992*	-5.063219*

Note: Null hypothesis = existence of unit root. * and ** = rejection of null at 5% and 10%, respectively.
Source: Author's calculations.

The results show that all the variables are first-order integrated, i.e., I(1). Accordingly, we apply Johansen's (1988) cointegration test to the multivariate model. This entails the following four steps:

- Determine the order of stationarity (the variables must be stationary of the same order).
- Select an optimal lag length using either the Akaike or Schwarz criterion. In this case, we use the Akaike criterion to determine a lag length of two as optimal for the model.
- Determine the number of cointegrating vectors, based on the eigenvalue and trace statistics.
- Estimate the normalized equation of the cointegration and error correction model.

The results of the eigenvalue and trace statistics are summarized in Tables 4 and 5, respectively. Both tests suggest that there is one cointegrating vector. Next, we analyze the normalized cointegrating equation, the results of which are presented in Table 6.

Table 4: Unrestricted cointegration rank test (maximum eigenvalues)

Hypothesized no. of CE(s)	Eigenvalue	Max-eigen statistic	0.05 critical value	Prob.**
None*	0.580070	32.971340	34.805870	0.0815
At most 1	0.508144	26.963640	28.588080	0.0794
At most 2	0.270503	11.985210	22.299620	0.6563
At most 3	0.148616	6.113907	15.892100	0.7751
At most 4	0.074303	2.933902	9.164546	0.5931

Note: Max-eigenvalue test indicates no cointegration at 0.05 level.
* = rejection of hypothesis at 0.10 level. ** = MacKinnon–Haug–Michelis p-values.
Source: Author's calculations.

Table 5: Unrestricted cointegration rank test (trace values)

Hypothesized no. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
None *	0.580070	80.968000	76.972770	0.0240
At most 1	0.508144	47.996660	54.079040	0.1560
At most 2	0.270503	21.033020	35.192750	0.6601
At most 3	0.148616	9.047809	20.261840	0.7318
At most 4	0.074303	2.933902	9.164546	0.5931

Note: Trace test indicates one cointegrating equation at 0.05 level.
* = rejection of hypothesis at 0.05 level. ** = MacKinnon–Haug–Michelis p-values.
Source: Author's calculations.

Table 6: Normalized cointegrating equation

Variable	Coefficient	Standard error	T statistic
Constant	-0.74025*	0.352720	-2.09870
NB(-1)	0.45073*	0.052100	8.65132
MC(-1)	0.19664*	0.020150	9.75696
LPU(-1)	0.09785	0.075741	1.29191
LPR(-1)	0.45367*	0.036680	12.36700
Log likelihood = 203.8905			

Source: Author's calculations.

The normalized cointegration coefficients reveal that, in the long run, credit to the private sector is a major determinant of generating tax revenue, given that it has the largest coefficient of the variables. This result is borne out by the financial deregulation that took place in Pakistan after 1990. The number of bank branches is an indicator of financial inclusion or the expansion of the banking sector and has a significant and positive impact on tax revenue in Pakistan. In the long run, therefore, there is potential for generating tax revenue by expanding the banking sector, which would lead to better documentation of the economy.

The study also finds that stock market capitalization has a significant impact on tax revenue. This underlines the importance of stock market activities in Pakistan and suggests that the government should offer incentives for investment in the equity market so that stock markets flourish and generate more revenues. Credit to the public sector does not appear to have a significant impact on generating tax revenue. This can be explained by the unproductive use of public loans in recent years, with most loans being used by the government to clear circular debt or the fiscal deficit. Only a very limited portion of these loans has been used for development purposes. Overall, in the long run, both banking as well as nonbanking financial activities play a significant role in tax collection. This underscores the importance of financial liberalization in Pakistan through regulations and reforms that improve the performance of the financial sector.

The Granger results indicate a bidirectional relationship between credit to the private sector and tax revenue, which raises the possibility of simultaneity bias. However, this problem is unlikely here because the regressors are typically in lagged levels or lagged differences. In addition, OLS is more consistent in the presence of cointegration. Having estimated the long-run coefficients, it is also vital to estimate an error correction model because the existence of cointegration among the variables can lead to short-run error corrections. The results of the short-run error correction model are summarized in Table 7.

Table 7: Short-run error correction model

Variable	Coefficient	Standard error	T statistic
D(NB(-1))	0.621872	0.430530	1.444430
D(NB(-2))	0.581599**	0.328010	1.773120
D(MC(-1))	0.074007*	0.033050	2.239510
D(MC(-2))	0.102944*	0.031460	3.272480
D(LPU(-1))	0.019346	0.019150	1.010220
D(LPU(-2))	-0.012141	0.018730	-0.648360
D(LPR(-1))	0.034481	0.115480	0.298590
D(LPR(-2))	0.251977	0.212833	1.183920
Error correction	-0.671544*	0.112820	-5.952560
R-squared	0.582434	F-statistic	33.626561
Adj. R-squared	0.421832	P-value of F-stat	0.000000

Source: Author's calculations.

The significant error correction term confirms the existence of a stable long-run relationship among the variables. The coefficient of the error correction term represents the speed of adjustment. The results show that, following a shock, approximately 67 percent of the adjustment toward long-run equilibrium is completed after a year.

In the short run, only a few variables have a significant impact on tax revenue. This suggests that the effects of financial sector activities on tax revenues generally materialize in the long run. However, in the short run, the number of bank branches and market capitalization have a positive and significant impact on tax revenue. This implies that bank branches can mobilize tax revenues by channeling financial activities in a short period. Similarly, stock exchange activities have a brief time lag.

5. Conclusion

Over the years, Pakistan's performance among financial markets has improved remarkably, ranking it among the best in the world. On the other hand, the country's revenue collection remains dismal, with a tax-to-GDP rate of only 10 percent. Financial markets can help generate tax revenues by taxing the interest on loans, municipal securities and publicly traded shares of corporations. This study assesses the impact of different financial market activities on tax revenue, using data for the period 1975–2014.

The study finds that, in the long run, the number of bank branches and market capitalization have a positive and significant impact on tax revenue. Credit to the private sector has a bidirectional relationship with tax revenue while public sector credit has an insignificant impact. In the short run, only the number of bank branches and market capitalization have a significant impact on tax revenue.

A key result is that the stock market has a positive and significant impact on tax revenue both in the short run and long run. This has important policy implications. For Pakistan's corporate sector, equities are a major source of funds to finance other investment projects. The government could inject additional liquidity into the stock market by educating potential investors, reducing transaction costs, fees and charges and establishing an efficient trading system. If the dividends earned by shareholders were taxed, this would generate further revenue.

The results also suggest that promoting additional banking activities would help generate tax revenues both in the short and long run. Policymakers could consider waiving the tax on banking transactions: although this yields some revenue in the short run, it also hampers the development of the banking sector and documentation of the economy, with adverse consequences for tax generation in the long run. Cash withdrawals from banks could, however, continue to be taxed. Another important implication concerns the more effective role of credit to the private sector in comparison to the public sector in terms of revenue generation. Policymakers could consider avoiding domestic loans because these crowd out banks' loans to the private sector.

As Arin et al. (2009) suggest, different taxes produce different financial responses. This makes it important to decompose tax revenue by source, including taxes paid by individuals or corporations, taxes in the form of withholding tax, sales tax, income tax and petroleum levy, the share of banks in tax revenues and taxes collected from stock market operations. Such an analysis would provide a more comprehensive picture of the relationship between financial system activities and tax revenue. Moreover, future research could extend this study by conducting a cross-country analysis to gauge Pakistan's performance in comparison to other countries and determine whether financial sector development has had a similar impact on tax revenues.

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