ENDOGENOUS PATIENCE IN A MODEL OF ECONOMIC GROWTH WITH HUMAN AND UNPRODUCTIVE SOCIAL CAPITALS

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0.1 Introduction

Literature on the role of government in spurring economic growth reveals that the relationship between these can best be described as murky and vague. Data on a group of Organisation of Economic Cooperation and Development (OECD) countries reveals that government size has a significantly positive impact on growth (see Colombier, 2009). Whereas, data on a group of countries from the European Union (EU) shows that government size has a significantly negative impact on growth (see Romero-Avila and Strauch, 2008). These findings for developed countries are also mimicked by a set of developing countries as in the case of some of these developing countries, government size is found to be positively associated with growth, whereas in the case of some others, government size is found to be negatively associated with growth (see Bairam, 1990). One channel through which greater extent of government intervention in the economy may lower growth is that it increases the incentive for rent-seeking (see Goel and Nelson, 1998). Government size is commonly measured as the share of government expenditure in total income (see Landau, 1983, 1986; Rubinson, 1977). However, another specification defines government size in terms of growth in the relative size of government spending to income (see Ram, 1986). According to Conte and Darrat (1988), the former is a measure of long-run impact of government, whereas the latter is a measure of short-run impact of government on growth.

There also exists an intricate relationship between government size and its structure. Autocratic economies, dictatorships, and communist regimes of the past have a common stand-out feature of high level of government intervention in the economy. The reason behind these economies having a relatively large government size is that government in these economies controls almost every economic activity. Interestingly, just like the case with literature on the impact of government size on growth, literature on the role of government structure in engendering growth reveals that this relationship is also not deterministic (see Helliwell, 1992; Przeworski and Limongi, 1993; Barro 1996). On one hand, data on 72 countries for the period 1960-1985 shows that democratic regimes experience high rate of economic growth (see Barro, 1991). Whereas on the other, we observe that despite the fact that South Korea and North Korea were effectively dictatorships till 1980s, yet South Korean dictators proved to be 'good for growth' (see Glaeser et al., 2004). Glaeser et al. (2004) also conclude that the actual drivers behind the growth experienced by relatively 'autocratic' economies are the accumulation of physical and human capital.

In another strand of literature, evidence suggests that education plays a pivotal role in spurring economic growth. Barro and Sala-i-Martin (2004) show that there is a strong correlation between years of schooling and economic growth. Other examples involving theoretical literature on the impact of human capital on economic growth include Lucas (1988), Romer (1986) and Savvides and Stengos (2008). The question however, is to identify the channels through which investment in human capital causes growth, particularly in economies with markedly large government. It is difficult to argue that market returns to human capital are affected when government controls most of the economic activity since wages of workers are held fixed at pre-determined levels in such economies, instead of workers being paid according to their productivity. This is particularly true of communist economies of the past that were once a part of the former Soviet Union. Chase (1998) using dataset for communist and post-communist Czech Republic shows that returns to education for Czech men almost doubled within a period of less than a decade after dismemberment of the Soviet Union. This reflects that workers were not paid according to their productivity and that the labour market underwent a drastic correction after economic liberalisation. Therefore, it is reasonable to argue that in economies where government intervention is pervasive, non-market factors play an important role in affecting returns to various capitals instead of market factors being at play.

Given the delayed nature of realisation of returns to human capital, preferences of individuals, particularly their time preference, are amongst the most important non-market factors affecting returns to human capital. These preferences may explain why economies with relatively large government, where market returns to human capital may not be very high, may still prefer to accumulate human capital and as a result experience high growth. According to Becker and Mulligan (1997), a lower rate of time preference enables individuals to discount distant utilities less, making investment in 'future oriented' capitals more attractive. They argue that schooling is one of the key determinants which helps to instil patience in individuals, reducing their rate of time preference. Along similar lines, Oreopoulos and Salvanes (2011) suggest that along with reduction in myopia and increased long-term thinking, greater patience is one of the most important non-monetary benefits of schooling.

It is well-established in literature that societies where government size is large, rent-seeking by agents is pervasive since greater government intervention in the economy inevitably leads to creation of rents (see Goel and Nelson, 1998; Ehrlich and Lui, 1999). Individuals who indulge in the 'opportunist' and 'unproductive' act of rent-seeking build a form of social capital by establishing links and contacts with various pressure groups and lobbies in order to extract rents. A distinguishing feature of this unproductive social capital is that it can be accumulated in the same way as any of the productive capitals, such as human capital. However, it is very different when it comes to the timing of realisation of returns. Returns to productive capitals usually involve a considerable delay, whereas returns to unproductive social capital may be realised quickly. This distinction between these two capitals becomes very important when it comes to the possible role played by patience. A longer lag is associated with the realisation of returns to human capital, which requires patience, for investment of time in it. While this might not be the case with unproductive social capital, which usually has smaller time lag for the realisation of returns. Ehrlich and Lui (1999), and Wadho (2014) study the link between accumulation of political capital (a form of negative social capital which helps in rent-seeking), accumulation of human capital, and economic growth. Where the latter highlights the distinction between the two capitals in terms of timing of their accumulation and the realisation of returns, the former however, fails to make a distinction between the nature of returns to human and political capital. Both studies, on the other hand, treat individuals' patience as exogenous, and therefore do not study the implications of the profound role it plays in affecting agents' payoffs to these two distinct activities of acquiring education and indulging in rent-seeking.

There is no such framework in theory of economic growth, to the best of our knowledge, which tries to study the interplay between human capital, (unproductive) social capital, and economic growth with agents' preferences treated as endogenous. At the most, existing theoretical models have tried to describe some of these phenomena in groups. As mentioned above, Ehrlich and Lui (1999), and Wadho (2014) study the link between accumulation of human and political capital and economic growth, but with exogenous patience. Bar-Gill and Fershtman

(2005) model endogenous rate of time preference in a model of public policy formation. In the same vain, Dioikitopoulos and Kalyvitisy (2010) study the impact of fiscal policy on endogenous time preferences, which are determined by an externality stemming from the aggregate stock of public capital. Bauer and Chytilova (2008) develop an endogenous growth model involving endogenous patience (determined by human capital), giving rise to development traps due to reinforcement of the result of the 'bad' equilibrium involving less time investment in human capital in successive periods through reduced patience.

In this paper, we incorporate the following elements into an endogenous growth model where accumulation of human and unproductive social capital is determined by parameters of the model. The extent of government intervention in our model economy affects agents' incentive for rent-seeking and to acquire education. Above all, we treat patience as endogenous and it determines the configuration of the equilibrium regime within which an economy operates. We model patience of a particular generation of agents as a function of the average initial human capital of that particular generation. We show that for successively larger thresholds of average initial human capital, the high growth equilibrium may persist even when the size of government becomes relatively large (implying higher potential rents). This is because of the fact that each successively higher threshold of average initial human capital is associated with a corresponding higher level of patience, therefore agents may find it profitable to invest in the accumulation of human capital notwithstanding the potential rents on offer. We also show that for an intermediate range of average initial human capital, there exist multiple equilibria, implying a non-monotonic relationship between government size and economic growth. Furthermore, we show that the average initial level of human capital is affected by ex-ante and ex-post institutional controls by the government. Therefore, institutions and policy affect growth by altering the rate of time preference of the society as a whole through education, and hence, a more patient society may experience high growth despite a larger government size and a higher potential for rent-seeking because of its preference of 'future oriented' human capital over 'unproductive' social capital.

Economists are unable to establish any consensus on the direction of relationship between government size and economic growth despite existence of vast empirical literature studying the relationship between the two. On one hand, data on OECD countries from 1970 to 2001, reveals that there is a positive and significant relationship between total government expenditure and growth (see Colombier, 2009). Whereas on the other hand, data on fifteen EU countries from 1960 to 2001 shows that there is a negative and significant relationship between total government expenditure and growth (see Romero-Avila and Strauch, 2008). Same can be said in the case of developing countries, as Bairam (1990) finds that there is a positive impact of government size on growth for some countries, whereas negative in the case of others. In the same vain, the literature studying the relationship between government structure and economic growth also gives puzzling findings (see Helliwell, 1992; Przeworski and Limongi, 1993; Barro 1996). Glaeser et al. (2004) show that South Korea and North Korea had comparable average scores of 1.71 and 2.16 for the political institutional measure of 'executive constraints' during the period after the Korean war till 1980s; implying that both countries were effectively dictatorships. However, as it turned out, the South Korean dictators proved to be 'good for growth' as opposed to their North Korean counterparts. They argue that the actual drivers behind the growth experienced by relatively 'autocratic' economies such as South Korea were the accumulation of productive capitals, such as physical and human capital.

There is however lack of discussion of any channels through which human capital (or physical capital for that matter) may affect growth, particularly in the case of economies which are marked by large extent of government intervention, which creates a greater potential for rent-seeking. Ex-communist countries that were once a part of the former Soviet Union serve as a perfect example of economies where government intervention is pervasive. In such economies, returns to productive capitals (particularly human and physical) were determined by the government and were often held fixed at pre-determined levels, instead of being determined by the market forces. It is thus implausible to assume that in regimes where government controls most of the economic activity, any change in market returns to the accumulation of human capital will encourage agents to accumulate it. Chase (1998) using dataset for Communist and post-communist Czech Republic shows that returns to education for Czech men increased significantly from 2.4% in 1984 (when it was a part of the Soviet Union) to 5.2% in 1993 (after the dismemberment of the Soviet Union). This almost doubling of returns to education within the period of less than a decade reflects that the government determined wage rate did not pay workers according to their productivity and thus market factors cannot be a possible channel affecting returns to education in economies where government is in control of markets. We therefore argue that non-market factors affecting capital returns are responsible for the observation of high growth experienced by countries with a large government. Amongst these non-market factors are preferences of agents, which affect agents' incentive to accumulate various capitals with distinct return profiles.

Individuals accumulate human capital because of greater market returns or because their preferences are so that despite delay in realisation of returns to human capital, they still prefer its accumulation. Factors affecting market returns to human capital are the productivity of the human capital production technology, inherited human capital, and investment (of time or monetary resources) by agents in the accumulation of human capital. All of these factors affect wages of agents and thus their incentive to accumulate human capital. Non-market factors affecting returns to human capital accumulation are influenced by, amongst other factors, preferences of individuals (the rate of time preference in the present context), which together with the market factors, influence the decision of an individual to accumulate human capital. Almost the entire existing literature studying the impact of human capital accumulation on growth incorporates the element of market factors affecting returns to human capital accumulation and does not consider the role played by non-market factors, particularly preferences, therefore one of the objectives of this paper is to bridge this gap to some extent.

The importance of preferences and other non-market factors in terms of the profound role these play in the determination of returns to various capitals and therefore economic growth cannot be underestimated. However, unfortunately, preferences have thus far been modelled in the growth literature as a 'black box' with little attention paid to the question that what factors determine individuals' preferences. According to Acemoglu (2009), the literature on economic growth attributes the presence and persistence of income and growth differences across countries to 'proximate causes' of economic growth. These proximate causes involve investment in physical capital, human capital, and technology. There is however little research on 'fundamental causes' (see Acemoglu, 2009) of economic growth which include, amongst other factors, individual values, preferences and beliefs. Amongst these preferences is the discount factor or an individual's patience, which is the inverse of the rate of time preference, also known as the discount rate. Discount rate has become a common feature of most of the models explaining economic growth since these models are mostly variants of the neoclassical growth model which has at its heart the consumer optimisation problem. However, for the purpose of tractability and also, until recently, due to lack of interest in the fundamental causes of economic growth, determination of the rate of time preference, generally, has remained an under-researched field in economics.

The rate of time preference is defined as the marginal rate of substitution between current and future consumption. It is the relative weight an individual places on future pleasures. Its significance in inter-temporal optimization problems is of a critical nature as it affects the choices made by individuals regarding consumption, savings, investment, etc. With reference to growth literature, since majority of the contemporary work on growth explores microeconomic foundations; the decision to invest in various forms of capital is greatly affected by the rate at which one discounts future payoffs.

Following the influential contribution by Samuelson (1937), most of the economic models involving inter-temporal optimisation assume that the rate of time preference is determined outside of the system. Its treatment is the same as that of the interest rate used in the problems of time value of money encountered in the field of finance. However, in their seminal paper, Becker and Mulligan (1997) argue that rational human beings may be aware of their inability to properly recognise and imagine future utilities and therefore may make conscious efforts to allocating resources towards enabling them recognize future utilities better. They argue that due to its application in various sub-disciplines of economics, endogenising the rate of time preference can have a profound impact on results and policy implications of models ranging from those on economic growth to interest rate determination and from addiction to uncertainty.

Existing theoretical literature on endogenous time preferences within the framework of economic growth is dominated by models which incorporate the discount factor as a function of consumption by agents. Within this strand of literature, patience is modelled both as an increasing function of consumption (decreasing marginal impatience) which implies that as individuals consume more of the final good today, they will become more patient and discount their future less (see Sarkar, 2007; and Das, 2003) as well as as a decreasing function of consumption (increasing marginal impatience) which, counter-intuitively, implies that rich individuals discount patience more (see Uzawa, 1968; Epstein and Hynes, 1983). The former strand of literature is relatively newfound in response to the latter, however, the implication that poor nations are less likely to escape poverty as well as the assumption that abstracts from the role of factors such as education in affecting agents' rate of time preference are in of themselves not a very good depiction of reality.

Literature on models which have endogenised the rate of time preference in the realm of economic growth includes Haaparanta and Puhakka (2004), which studies the impact of endogenising the rate of time preferences (determined through the stock of physical capital) on economic growth and suggests that low investment in physical capital may lead to a 'bad equilibrium' which is characterised by poverty trap. Stern (2005) defines a broad notion of 'future-oriented' capital in line with Becker and Mulligan (1997) in one-sector growth model and tests for existence and stability of steady-states. Sarkar (2007) introduces endogenous rate of time preference which is decreasing in the level of consumption in a growth model and shows that innate patience responsible for persistent cross-country income differences. Zee (1997) using an endogenous growth model with the rate of time preference depending on average propensity to consume draws a conclusion totally opposite to that of Sarkar (2007) in that convergence is shown to be taking place at the equilibrium. However, none of these has attempted to study in tandem the link between (unproductive) social capital, human capital, role of government, rent-seeking in a framework with endogenous time preferences. This is another gap in the existing literature which we aim to fill through our research.

In the process of endogenous time preferences, equally important are the factors that affect individual preferences. Becker and Mulligan (1997) argue that schooling is one of the key determinants which helps to instil patience in individuals. According to them:

"schooling focuses students' attention on the future...it can communicate images of the situations and difficulties of adult life, which are the future of childhood and adolescence".

Also schooling or education can aid children in 'scenario simulation' which enables them to better imagine future pleasures and hence can lead to reduction in discounting of distant utilities. Comparable results are obtained by Oreopoulos and Salvanes (2011), which show that an increase in years of schooling results in higher patience and it also reduces myopia.

The theoretical logic of endogenizing time preferences is finding some empirical support in recent empirical literature. For example, one study on the impact of education on growth reveals that when considering improvement in workers' productivity, the impact of education only explains less than half of the relationship between education and growth (see Bils and Klenow, 2000). This shows the possibility of other channels through which education affects growth, which are not considered when we look at workers' productivity only. A plausible channel through which education can impact growth is that of its impact on reducing the rate of time preference and hence making investment in human capital more attractive for individuals. This premise is strengthened by Harrison et al. (2002), which uses a Danish survey to show that educated individuals are on average more patient than uneducated ones. Similarly, Perez-Arce (2011) using data on individuals seeking admission in public colleges in Mexico shows that successful applicants were, on average, more patient than those who were denied admission.

There is a growing consensus among economists that patience and education reinforce each other. However the question that is patience the result of a deliberate effort by an individual, as suggested by Becker and Mulligan (1997), or it is an unintentional by-product of education is largely unsettled. But before we debate on this, it is reasonable to say that moulding of individuals' preferences is a process which begins during the early part of their lives and therefore the role played by their ancestors is of a critical nature. Children's preferences are affected even by the way of their parents' conduct and by the various tools and methods used by their parents to reward or to punish them. Parents usually promise some reward (in future) for the successful completion of a desirable act in the present, whereas punishment is inflicted immediately after any digression by their children. This strategy, in of itself, makes children more patient since they realise that returns to effort (made to achieve desirable ends) are realised after some delay. Similarly, children of educated and accomplished parents realise that their parents achieved success after they spent a considerable amount of time acquiring education and equipping themselves with skills that yielded rewards later in their lives. Once again, the idea of delayed returns to productive activities is reinforced in children's mind. Therefore, the role played by parents constitutes an important element in formation of individuals' preferences. In addition to that, the surrounding environment and the society, as we call it, affects individual preferences since traits such as patience are not just influenced 'vertically' by ancestors, but also 'horizontally' by peers. Individuals observe as to what sort of actions are rewarded by the society and which are not. All actions are reflective of a specific set of traits and characteristics possessed by individuals. When they observe a particular form of activity yields higher rewards within the environment surrounding them, individuals try to mimic the actions of their 'role models' and as a result develop traits and attributes possessed by these role models of theirs. In a corrupt society where rent-seeking is pervasive, yielding returns that are higher than those yielded by productive activities, agents develop attributes and traits that are suited for rent-seeking. A common feature in the above stated examples of preference formation is that these preferences are formed not by agents' deliberate decision, but instead these are a by-product of agents' decision to replicate the activities that yielded high returns in the market. Thus, it can be argued that agents only observe the market outcomes of various activities and opt to perform any of these activities if it yields more returns than its alternatives. Since each activity has a distinct set of associated traits and preferences, agents pick up on these traits and preferences only as a consequence of their decision to act in a particular way.

When they decide to acquire education (or alternatively, if this decision is taken by their parents), individuals take into account market returns to education in the form of higher income after graduation from high school or college and compare these returns to returns from alternative activities which they can undertake. It is reasonable to assume that individuals who acquire education till a particular level share certain traits and preferences as a result of their shared environment which makes it conducive for them to acquire these traits. However, it is also reasonable to assume that any externalities or spill-overs resulting from the process of education are not internalised by agents. We posit this idea since the intention by agents behind their decision to acquire education is to obtain a certain type of skill set, which makes them more productive and efficient at work, resulting in higher income. Any traits or preferences developed, which do not directly affect their productivity, can then be described as a result of indeliberate action on part of agents. Since higher patience increases returns to human capital indirectly, as a result of agents placing greater value on their future utility, therefore we argue that as opposed to the belief held by Becker and Mulligan (1997), agents' decision to acquire education is not motivated by their desire to place a greater weight on their future welfare through increased patience, which in turn makes investment in human capital more attractive. On the contrary, we argue that agents decide to accumulate human capital because it earns them higher returns and that the higher valuation of these returns, implied by higher patience, is only a by-product of their decision which only acts as a reinforcement instead of serving as the motivation behind their decision to accumulate human capital.

Given the significance of the role played by their ancestors as well as by their peers in forging agents' preferences, we model individual patience as a function of their inherited human capital. Inherited human capital over here does not refer to human capital of an agent's ancestor only, but we resort to a broader definition of inherited human capital and it refers to the average level of initial human capital of the entire generation. Bisin and Verdier (2005) argue that preferences and traits can be transmitted both across and within generations. Therefore it is apt to define the rate of time preference in terms of the average stock of initial human capital of an entire generation in order to capture both 'horizontal' or within generation transmission as well as 'vertical' or across generation transmission mechanisms. Bjorklund and Salvanes (2011) indicate that amongst other factors, an agent's incentive to accumulate human capital is influenced by the stock of her parental human capital as well as her family's cultural background which includes preference for risk and time.

In the theory of economic growth, literature studying 'human capital driven preferences' is virtually absent. At the best of our knowledge, Bauer and Chytilova (2008) is the only endogenous growth model involving endogenous patience which is determined by human capital. It gives rise to a development trap due to reinforcement of the result of the 'bad' equilibrium involving decumulation human capital in successive periods through reduced patience. This implies that the poverty trap sets in by a decline in the rate of economic growth due to decumulation of human capital until a point is reached where the level of human capital is zero and thus there is zero income in equilibrium. The finding of zero income in the poverty trap is at an extreme odds with the observation of reality since even countries that face development traps are unlikely to have zero income in equilibrium after experiencing a persistently negative rate of growth. Furthermore, it is a simple one-good economy with one productive capital implying that agents only face the trade-off between investing in human capital or producing more of the final good today. The absence of an unproductive capital yielding returns in the period of investment and hence creating another trade-off which is between two different capitals, as in our model, is an additional limitation of this model. In addition to that, unlike our argument, here individuals deliberately invest time in building up human capital in expectation of having greater patience in future. Also, since patience is a function an agent's own human capital, therefore, the impact of vertical and horizontal transmission mechanism of preferences which we discussed above is absent in this model.

In addition to that, we assume that there are threshold effects to education when it comes to the impact of education on patience. Parents may require to pass some minimum years of schooling in order to enable their children in what Becker and Mulligan (1997) regard as scenario simulation. A primary school graduate may do very little to instil patience in her children, whereas a high school graduate or a college graduate may have a profound impact in forging her children's preferences. Similarly, an educated society, on average, beyond a specific level of education, may create an environment conducive for instilling higher patience in agents. We therefore argue that an agent's rate of time preference exhibits threshold effects in terms of her inherited human capital. Haveman, Wolfe and Spaulding (1991) and Manski et al. (1992) show that parental completion of high school and one or two years of post-secondary schooling are typically found to have a larger effect on children's schooling when compared to other levels of parental education.

Presence of thresholds in terms of the impact of inherited human capital on agents' preferences is also supported by a different strand of literature. Hryshko et al. (2011) indicate that agents' risk aversion is affected in part by parental education and in part by the environment. They also observe that parental education beyond grade 11 has a significant impact on an agent's risk aversion, indicating the presence of a threshold level of parental education, below which it does not affect children's attitudes towards risk. Furthermore, they observe that including controls of parental risk aversion and their occupation in the regression of agents' risk aversion on levels of parental educational attainment did not dampen the effect of parental education on children's risk aversion and parental educational attainment beyond grade 11 still appeared to significantly reduce children's risk aversion. Time and risk preference of individuals are two intricately related concepts. Dohmen et al. (2010) find a significant and a robust relationship between an increase in risk aversion exhibited by agents and them being impatient. Based on this evidence on the relationship between agents' risk aversion and patience, it is logical to conclude that the rate of time preference exhibits threshold effects in inherited human capital of agents, which is in congruence with risk aversion exhibiting threshold effects in terms of individuals' inherited human capital.

In order to show how can a country, where a considerably large government controls most of the economic activity, experience high growth (through impact of non-market factors on human capital accumulation), we need to incorporate government into our model. A higher government size or a greater extent of government intervention in the economy implies that there may be large rents on offer for agents. We model government intervention in the economy differently from Barro (1990), since in the case of our model, government provides a public consumption good to agents for which they must all contribute a fraction of their income which is a function of the extent of government intervention in the economy. Ehrlich and Lui (1999) argue that an inevitable consequence of government intervention in the economy is the creation of rents. This encourages agents to indulge in rent-seeking. Unlike the existing literature on rent-seeking, which treats the cases of evasion by agents from being subject to government intervention and their act of appropriating away government revenue resulting from its intervention in the economy, we incorporate both these elements into our model, which then yields profound policy implications in terms of ex-ante and ex-post institutional controls deterring each of these forms of rent-seeking and thus determining the growth regime within which an economy operates.

Individuals who indulge in the 'opportunist' and 'unproductive' act of rent-seeking build a form of social capital, by establishing links and contacts with various pressure groups and lobbies so that they can extract rents. We assume that unproductive social capital is accumulated and in addition to that, returns to its accumulation are realised in the period of investment, without any significant delay, as is the case with the accumulation of human capital. Ehrlich and Lui (1999) as well as Wadho (2014), both study the impact of trade-off between human capital and political capital (synonymous to unproductive social capital in our case), however, only Wadho (2014) considers quick realisation of returns to political capital as a distinctive feature of the model, accentuating the trade-off between the two capitals. However, it treats individuals' patience as exogenous, despite the fact that endogenising patience can play a significant role in affecting agents' payoffs when the model incorporates two different capitals with markedly different return profiles. In a different strand of literature, Doepke and Zilibotti (2008) show how market incentives affected parents' decision to mould their childrens' preferences in the pre-Industrial Revolution era. Middle income earners chose to instil patience and work ethic in their children since return to occupations that required effort and skill was high, whereas the landed elite chose to instil taste for leisure in their children. It must noted over here that this model also treats preference formation as a delibrate decision on part of parents.

We model an overlapping generations economy comprising of identical individuals living for two periods who face the trade-off between investing in a 'future oriented' capital, i.e. human capital and a 'contemporaneous' capital which is manifested in the form of unproductive social capital. Accumulation to human capital yields return in the latter part of individuals' lives since it affects the income earned by these agents when they work in the skilled sector. On the other hand, the social capital enables agents to indulge in rent-seeking as soon as it is accumulated to develop contacts and links with certain pressure groups and lobbies in order to avoid and escape from government intervention in the economy and to divert away government revenue.

Without incorporating endogenous patience into our model, the preliminary analysis shows that a larger extent of government intervention in the economy encourages agents to accumulate the unproductive social capital since a larger size of the government translates into more rents which reduces agents' time investment in the accumulation of human capital, resulting in lower growth. Similarly, when the extent of government intervention is low enough, agents do not indulge in rent seeking since returns to human capital accumulation are greater than the available share of rents. Also, an increase in ex-ante and ex-post measures of government administrative controls increases the range of values of government size for which the high growth equilibrium exists and decreases the range of value of size of government for which the low growth equilibrium exists implying that individuals living in countries where government administrative and law enforcement institutions are strong are less likely to invest in the accumulation of unproductive social capital since higher costs to rent seeking dilute returns to the accumulation of this capital and therefore such economies experience high growth. These results are consistent with existing literature which argues that even countries that relatively less developed can experience high rate of economic growth if they build ‘appropriate institutions’ which help in fostering economic growth (see Gerschenkon, 1962). Similarly, Tanzi and Davoodi (1998) also argue that when some critical ‘auditing’ and ‘controlling’ institutions are weak, leading to weak institutional controls, which increases the chances of misappropriation of government resources.

These preliminary results however fail to answer the question, just like the empirical literature, that how is it possible for economies where government intervention is pervasive to experience high growth despite the fact that the size of rents on offer is considerably large. We then endogenise agents’ patience by expressing it in terms of the average level of initial human capital of agents belonging to that particular generation. We assume that agents’ patience exhibits threshold effects in terms of the average initial stock of human capital. This specification ensures that we capture the elements of across and within generation influence of human capital (education) on preferences in our model. The former objective is accomplished since we define patience in terms of the ‘average’ level of initial human capital and the latter is ensured by the fact that initial human capital of agents from any generation is equivalent to their ‘inherited’ human capital. In addition to that, since agents take the average initial level of human capital as given, therefore investment in patience is modelled as an indeliberate act on part of every individual agent. We show that beyond a certain threshold of average initial human capital, agents are characterised by very high level of patience where it is not optimal for agents to indulge in rent-seeking, regardless of the extent of government intervention in the economy. Therefore, in this case, agents will always opt to be honest, implying greater accumulation of human capital by successive generations and high rate of economic growth. Similarly, we show that below some very low threshold level of average initial human capital, agents are characterised by very low level of patience where it is not optimal for agents to accumulate human capital, irrespective of the size of government. As a result, in this case, agents will always opt to be rent-seekers, implying less accumulation of human capital by successive generations and low rate of economic growth. In addition to that, we also show that corresponding to intermediate levels of average initial human capital, there are intermediate levels of patience which imply the existence of multiple equilibria where low growth and high growth equilibria co-exist for different range of values of government size. Furthermore, we show that since agents do not internalise the subsequent impact of their decision to accumulate human capital on the level of patience, therefore, government policy of increasing ex-ante and ex-post institutional controls can ensure that economies with low level of education (and thus low level of patience) can still opt to invest more in the accumulation of human capital and therefore experience a high rate of economic growth, even when the extent of government intervention is large. Our results, indicating a non-monotonic relationship between government size and economic growth, are in line with empirical evidence which is unable to establish any consensus on the direction of relationship between these two variables.

The rest of the paper is organised as follows: The next section gives a description of the economy being modelled including the behaviour of households and different production technologies. After that we discuss Government intervention and rent-seeking in the economy detailing how rents are created in our economy and the various ways in which agents can indulge in rent-seeking. Moving on, we describe the components of agents' income and consumption, discussing the various sources from where agents earn their income, net of any deductions. We then solve for agents' decision problem defining the thresholds of government size, for which the different equilibria exist. After that we endogenise patience and show how endogenous patience effects the configuration of the two growth regimes modelled in our economy. The following section summarises comparative statics of the model and after that we conclude.

0.2 Description of the Economy

0.2.1 Households

Time is discrete and it ranges from 0 to $+\infty$. The economy comprises of overlapping generations of two period lived agents with agents being *young* in period 1 and *old* in period 2. We assume that there is no population growth and therefore each generation is of mass n. Every agent acts as both a producer and a consumer in each period. At the beginning of period 2, each agent begets a child and therefore the total population in this economy is constant at $2n$. Agents within each generation are identical. Every agent has a unitary time endowment in each period. When young, they allocate their time between receiving education, working, and accumulating unproductive social capital. When old agents, they spend their entire time working. Since young agents haven't accumulated human capital, they can only work as unskilled workers. In the second time period, they work as skilled workers.

All agents from the generation t have identical preferences given by the log utility function of form:

$$U_t = \ln(c_{1t}) + \beta_t \ln(c_{2t}) \tag{1}$$

where c_{1t} and c_{2t} denote consumption in period 1 and 2, respectively. β_t is the generation-specific discount factor. As we explain in subsequent sections, it depends on the average level of initial/inherited human capital of generation born in period t.

0.3 Technologies

We assume a four production technologies economy along the lines of Ehrlich and Lui (1999) and Wadho (2014). It involves the production of i) human capital, ii) social capital (unproductive), iii) final good by the unskilled sector, and iv) final good by the skilled sector. Accumulation of human capital (knowledge) is the driver of growth in this model. Acquisition of knowledge in the first period enables agents to produce more output in the second period and hence earn more in the latter part of their life. Unproductive social capital on the other hand, enables them to make use of the social networks, links and contacts to: i) avoid/evade[1] government intervention, and ii) appropriate away the rents that are created as a result of government intervention in the economy. Since social capital does not facilitate production, either directly or indirectly, and since it facilitates rent-seeking, we call it 'unproductive'. These two capitals markedly differ with respect to the timing of the realisation of returns. Human capital that involves investment in early period of life yields returns only in the latter part of life. Whereas returns from unproductive social capital are immediately realised. Every agent is endowed with 1 unit of time in every time period. In the first time period when agents are young, it involves three competing uses of this time, i.e. accumulation of human capital, unproductive social capital, and working. Let h_{it} and q_{it} be the time spent by agent i of generation t in the accumulation of human capital and unproductive social capital, respectively, then $(1 - h_{it} - q_{it})$ is the time spent working in the unskilled sector. In the second period, each agent spends her entire time working in the skilled sector.

0.3.1 Human Capital

We envisage human capital accumulation technology similar to Lucas (1988), Ehrlich and Lui (1999), and Wadho (2014). Human capital is generated by:

$$H_{i2t} = AH_{i1t}h_{it} \tag{2}$$

where H_{i1t} denotes the inherited human capital by agent i of generation t. It is equivalent to her ancestor's second period stock of human capital, H_{i2t-1}. h_{it} denotes time invested by agent i in the accumulation of human capital, and $A > 0$, which represents the productivity of human capital production technology.

Putting it intuitively, an agent in her youth is as knowledgeable as her parent since she is transferred this knowledge by her parent. She then builds up her stock of knowledge by acquiring education and therefore, by the virtue of getting educated, when she grows old, she is more

[1] Using 'avoidance' we imply escaping government intervention legally, through exploitation of loop-holes in the law, or illegally. 'Evasion' specifically refers to the use of illegal means to escape from government intervention. Therefore, from here onwards, we resort to the broader notion of 'avoidance' when referring to the act of rent-seeking by the means of escaping from government intervention.

knowledagble than her parent. The quality of knowledge received by an agent is determined by the productivity of education sector.

0.3.2 Unproductive Social Capital

We assume that all agents are potentially dishonest and they can opt to indulge in (illegal) rent-seeking activity. They consciously invest their time in building up social networks, links, and contacts which enable them to achieve two ends, i.e. i) to escape from government intervention, and ii) to appropriate part of the rents created in the economy due to government intervention.

Although it might be tempting to think that the sort of social networks and contacts modelled here are those specifically involving government officials and bureaucrats. We envisage a rather broader context here where apart from government servants, agents can also develop these links and contacts with certain 'pressure groups/lobbies' to achieve the same ends of avoiding government intervention and appropriating away government revenue. These pressure groups can take various forms, for instance, media and journalistic organisations, religious groups, political parties, and other such organised groups and collective bargaining organisations which have an influence over government affairs by the means of force, coercion, manipulation, and even in some cases, consent. The last of these forms of influence is likely to be used when agents have links and contacts within government agencies and the bureaucracy.

An assumption which is, however, quite clear is that the concept of social capital in this set up is implemented with its negative connotations in mind, that is, as a socially unproductive activity. By indulging in this particular form of social networking, an agent: i) spends less time working for the production of the final good in period 1, and also ii) spends less time receiving education when young, and therefore as a result, produces less of the final good in the second period due to inadequate second period skill set.

The use of unproductive social capital for rent-seeking differs in two major respects from human capital. Firstly, unlike human capital, that is realised in the second time period, social capital is accumulated and realised in the same time period. The reason for formation of social capital in the period of investment is that developing acquaintances (which later develop into ‘friendships[2]’) and building links is a relatively quick process when we compare it to acquiring education, which at best takes more than a decade to reach a particular level of attainment (i.e. high school, undergraduate, graduate, post-graduate, etc). Secondly, the rewards to human capital accumulation are realised only in the latter half of the life, whereas the returns to unproductive social capital accumulation are realised instantaneously. Once again it is not difficult to imagine why returns to social capital can be realised quickly than returns to human capital. An individual can seek assistance of her ‘friend’ almost as soon as she has invested time in building up this social capital and therefore, we can claim that social capital yields returns immediately. However, on the other hand, returns to human capital are realised only after we have reached a particular level of educational attainment.

The production technology of unproductive social capital is, however, symmetric to that of human capital. Every young agent can access social networks developed by her parent, can build on these contacts and links by taking away time from production and education, and as a result of her strengthened social network, can (in both periods of her life): i) to escape from government intervention, and ii) to appropriate part of the rents created in the economy due to government intervention. The production function for unproductive social capital is as follows:

$$Q_{i2t} = Q_{i1t} = BQ_{i0t}q_{it} \tag{3}$$

where Q_{i0t} denotes the inherited stock of unproductive social capital of agent i from generation t, q_{it} denotes her time investment in the accumulation of unproductive social capital, $B > 0$ is the productivity parameter, and since returns to this capital are realised in the period of investment, therefore, Q_{i1t} denotes the first period stock of unproductive social capital. Furthermore, it is assumed that an agent may accumulate this capital only once in her lifetime, therefore, in the absence of depreciation, the second period stock of this capital, Q_{i2t}, will remain at its first period level[3].

[2] Such ‘friendships’ are purely transactional in nature in which individuals develop contacts only for the purpose of extracting certain benefits, exhibiting opportunist behaviour.

[3] It is also similar to the break-even investment in social capital where second period investment is exactly equal to the depreciation of existing capital in the form of losing old contacts and networks.

0.3.3 Final Goods Production

The final good is produced using two different technologies. Every agent works as an entrepreneur in both unskilled and skilled sectors using her own labour to produce the final good. A one-for-one relationship is assumed between hours worked by an unskilled agent and the amount of final good she produces. On the other hand, one-for-one relationship is assumed between the effective labour provided by a skilled agent and the amount of final good she produces.

Unskilled sector

The output produced by the unskilled sector is given by:

$$Y_t^u = \sum_{i=1}^{n} y_{it}^u = \sum_{i=1}^{n} (1 - h_{it} - q_{it}) \tag{4}$$

where Y_t^u denotes the aggregate output of the unskilled sector produced by agents from generation t. It is the sum of output produced by each of the n young agents working in the unskilled sector, where output produced by the i^{th} agent is given by y_{it}^u. The amount of output an i^{th} agent produces in period 1 is, in turn, equal to the number of hours she spends working, $(1 - h_{it} - q_{it})$.

Skilled Sector

The output produced by the skilled sector is given by:

$$Y_t^s = \sum_{i=1}^{n} y_{it}^s = \sum_{i=1}^{n} \gamma H_{i2t} \tag{5}$$

where Y_t^s denotes the aggregate output of the skilled sector produced by agents belonging to generation t. It is the sum of output produced by each of the n old agents working in the skilled sector, where output produced by the i^{th} agent is given by y_{it}^s. The amount of output an i^{th} agent produces in period 2 is, in turn, given by γH_{i2t}. Where $\gamma > 1$ denotes the productivity of the skilled sector and H_{i2t} is the effective labour supplied by the i^{th} agent in period 2. It is noteworthy that since γ is assumed to be greater than unity, therefore the wage (per unit of effective labour) paid by the skilled sector is strictly greater than the unitary wage paid by the unskilled sector.

The total output of the economy at time τ is thus the sum of the aggregate skilled sector output produced by old agents living at time τ and the aggregate unskilled sector output produced by young agents living at time τ, mathematically:

$$Y_\tau = Y_\tau^s + Y_\tau^u \tag{6}$$

Note over here the distinction between generation index, t and time index, τ. While old agents living at any particular time τ will be from generation $t-1$, young agents living at the same point in time will be from generation t.

0.4 Government Intervention and Rent-seeking

The presence of government in the economy is modelled along the lines of Ehrlich and Lui (1999) in that all the transactions in the economy are subject to government intervention, or alternatively, the government takes away a certain fraction, θ of agents' income each period. Unlike Barro (1990), the government is assumed not facilitate final good's production in any such way. But instead, the government redistributes, as public consumption good, its receipts from each sector equally among the agents working in that particular sector[4], and therefore runs a balanced budget.

In the absence of rent-seeking, government revenue at time τ from its intervention in the skilled sector results in total receipts of θY_τ^s. Assuming that old agents from generation $t-1$ work in the skilled sector at time τ, this then becomes θY_{t-1}^s. Similarly, government revenue at time τ from its intervention in the unskilled sector is θY_τ^u. It is equivalent to θY_t^u since young agents from generation t work in the unskilled sector at time τ. The total government revenue at time τ, in the absence of rent-seeking, thus becomes:

$$G_\tau = \theta Y_\tau = \theta \left(Y_\tau^s + Y_\tau^u \right) = \theta Y_{t-1}^s + \theta Y_t^u \tag{7}$$

Where $0 \leq \theta \leq 1$. With the aim of running balanced budget, the government redistributes its receipts (in the form of public consumption good) from the skilled sector equally among all n agents from generation $t-1$ working in the skilled sector at time τ. Similarly, receipts from the unskilled sector are equally redistributed among all n agents from generation t working in the unskilled sector at time τ. The total amount of public consumption good provided by the government thus becomes:

$$R_\tau = n \left(\frac{\theta Y_{t-1}^s}{n} \right) + n \left(\frac{\theta Y_t^u}{n} \right) = \theta Y_{t-1}^s + \theta Y_t^u = G_\tau \tag{8}$$

Therefore, the government revenue, G_τ at any time τ equals government's provision of the public consumption good, R_τ and thus the government runs a balanced budget.

[4] Since two different generations work in the unskilled and the skilled sector at any time τ, therefore it is reasonable to assume that the government does not carry-out intergenerational redistribution of income.

It is important to notice that in the absence of rent-seeking, the presence of a ‘redistributive’ government in this particular economy will not affect incentives and optimal allocations of agents. The reason being that agents within each generation are homogenous along with government’s policy of sector-specific redistribution ensures that agents will receive the same fraction of their income as public consumption good that is initially taken away by the government. Therefore government intervention and subsequent redistribution along the lines of the above discussion will leave agents’ payoffs unaffected.

It is worth noting that we deliberately abstain from the use of the term ‘taxation’ in our discourse throughout and instead rely on the much broader notion of ‘government intervention’. This distinction is necessitated by the fact that we have modelled government intervention in a way that it seems remarkably similar to the treatment of taxes in most theoretic economic models. However, in this model, the role of government is neither that of facilitating final goods production, along the lines of Barro (1990) nor is that of ensuring provision of education, as modelled by Glomm and Ravikumar (1992).

Instead, it has been assumed that the government redistributes its receipts from the intervention to agents in the form of the consumption good. It is equivalent to assuming that the government takes away some fraction of agents’ income in order to provide them with a public consumption good which is produced on a one-for-one basis using receipts from government intervention as the only input. This is why the government production technology for producing this consumption good was not revealed in the discussion above since the term ‘redistribution’ in itself implied that the receipts from intervention were returned to agents on ‘as is’ basis.

To elaborate this further, we relate to the ‘one-good economy’ assumption often encountered in the growth literature. The assumption under discussion is that the government intervenes in the economy by taking away some fraction of agents’ income (measured in units of the final good) and then it provides them with the same fraction worth of the final good (in the absence of rent-seeking). While taxation is one way in which the government can intervene in the economy, it is however not the only one. Government intervention in an economy can manifest itself in the form of the government providing agents with utilities and services such as education, healthcare, communication, national defence, etc. In the case of a command economy, the size of government is almost equal to one which implies that the government decides as to how much each agent would consume, regardless of her productivity. Therefore, the greater is the size of the government, the lesser control each agent has over her income and resultantly on her consumption. It must also be noted over here that since inequality dynamics with regards to different government structures are not within the realm of our discussion, therefore we have kept the model simple by assuming that agents within each generation are homogenous.

The concept of 'rent-seeking' manifests itself in two forms in this economy. Firstly, government intervention in the economy creates an incentive for agents to spend their time in building social capital which may enable them to reduce the fraction of their income taken away by the government. Secondly, agents have an incentive to invest time in building up social capital since with the help of it, they can appropriate away part of receipts resulting from government intervention in the economy. A distinction must be made between these two forms of rent-seeking in the chronology of their occurrence in that rent-seeking by avoidance is followed by rent-seeking by appropriation. It is also assumed that an agent who opts to indulge in rent-seeking would commit to both forms of rent-seeking activities and it is not possible for her to opt out of one. Furthermore, it is interesting to note that despite there being redistribution by the government, agents still may prefer appropriation over it in the hope of commanding a greater share of government revenue than they would if they remain honest. And this will particularly be true if agents fear dishonesty on part of their peers, which may result in them being deprived of their due share of government redistribution, and hence leading to the particular form of 'coordination failure' exhibited in this setting.

Since rent-seekers is illegal, rent-seekers run the risk of getting caught in the second period. Every rent-seeker faces the probability, z, of being caught. When caught her entire second period earnings are confiscated by the government. The reason why the entire second period income may be taken away from a rent-seeker is that the government may impose a fine or a penalty as large as agents' entire second period income to deter agents from rent-seeking. Also, when caught, an agent may be imprisoned for a considerable amount of time, disabling her from work. Furthermore, once an agent is identified as a rent-seeker, then she may lose her job not to be employed any further. z reflects the quality of law enforcement institutions since better quality law enforcement would entail a greater level of vigilance and thus limited avenues of escape for rent-seekers. These law enforcement institutions reflect the ‘ex-post’ institutional constraints which may take the form of policing and legislative organs of the state which spring into action after the illegal/criminal activity of rent-seeking is carried out. It is also reasonable to assume that an agent will be held accountable for rent-seeking only in the latter part of her life since in the earlier part of it, she works in the unskilled sector where the scale of rent-seeking by either evasion or appropriation is very small. Therefore, the probability of government taking legal action against this less significant form of rent-seeking is assumed to be negligible. For simplicity, we assume that the confiscated earnings of rent-seekers are not subject to redistribution (and therefore to appropriation), i.e. these are dissipated.

To sum it up, government intervention in an economy, where agents have an incentive to cheat, will affect payoffs and optimal allocations of agents. Hence this cannot be treated as a trivial matter since the size of government, which is measured by θ, amongst other factors, will affect the decision of an agent to cheat or to remain honest.

0.4.1 Rent-seeking by avoidance/evasion

The economic rent that is created as a result of government intervention in the economy is two-fold. When the government decides to take away a certain fraction of their income, then agents have an incentive to spend their time trying to avoid/evade the government. Such an exercise qualifies as a rent-seeking activity since agents are using their limited time endowment just for the purpose of escaping government intervention, which is an unproductive activity. So, when an agent opts to cheat, she may be able to escape government intervention, either partly, or completely, depending on the relative strength of her social capital and the lack of administrative controls by the government, represented by α. These administrative controls by the government are a form of ‘ex-ante’ institutional constraints by the government unlike the quality of law enforcement institutions, z, which were ex-post institutional constraints. α in the present context refers to the competence of civil servants, their independence from being swayed away by pressure groups, lobbies, and political parties. It also refers to “the credibility of the government’s commitment to policies”. In our case θ is the policy variable which entails the government taking away a pre-defined proportion of agents' income for the purpose of provision of public consumption good. α in this case can be interpreted as a measure of credibility of government's commitment to its policy since a higher α would imply higher administrative controls by the government preventing leakages in the form of rent-seeking and therefore keeping government's credibility in tact to provide the public consumption good in return for its receipts from market intervention (see Glaeser et al., 2004). Therefore, In the context of this model, α acts as a deterrent to rent-seeking 'before' an agent indulges in such an activity. z, however, serves a as a tool to penalise an agent 'after' she has succeeded in committing the act of rent-seeking.

The fraction of income that is subject to government intervention varies from one agent to another and this is true of agents working in the skilled as well as the unskilled sector. The expression for the extent of government intervention, which an i^{th} agent's income will be subject to is given by:

$$\theta_{ikt} = \left\{ \begin{matrix} \theta & \text{if } q_{it} = 0 \\ \theta \left[1 - d_t \left(\frac{Q_{ikt}}{\bar{Q}_{kt}} - \alpha \right) \right] & \text{if } q_{it} > 0 \end{matrix} \right\} \tag{9}$$

where $k = 1, 2$ and $0 \leq \alpha \leq 1$, and $0 \leq d_t \leq 1$. The expression above depicts that if an agent opts to be honest (i.e. $q_{it} = 0$) then the fraction of her income that will be subject to government intervention will be equal to the size of government. However, if she opts to cheat (i.e. $q_{it} > 0$), and using her social capital attempts to avoid/evade government intervention, then the fraction of her income subject to government intervention will vary. She will be successful in preventing the government from taking away some part of the fraction θ of her income if the relative strength of her social capital to that of the average of agents from her generation $\left(\text{i.e.} \frac{Q_{ikt}}{\bar{Q}_{kt}}\right)$ is greater than the strength of government's administrative controls (i.e. α). However, if the converse is true, then she may relinquish a higher fraction of her income than she would have in the case of her remaining honest. This indicates that if government administrative controls are adequate enough, then this particular form of rent-seeking can be discouraged since the government will punish rent-seekers by taking away a larger fraction of their income than θ. Furthermore, the effect of either of these cases is accentuated by the proportion of dishonest agents in the economy (i.e. d_t). An agent commanding over relatively much stronger social networks (strong enough to render government administrative controls ineffective) will be benefited by the strategic complementarity effect stemming from d_t. However, if her social networks are not strong enough, then a higher proportion of dishonest agents in the economy will prove detrimental for her, and the fraction of her income subject to government intervention will increase. Thus, the relative 'social' standing of an agent amidst her peers and the strength of government administrative controls mutually determine, as to whether or not rent-seeking by an agent will be profitable.

0.4.2 Rent-seeking by appropriation

The second form of rent-seeking is rent-seeking by appropriation. After government intervention in the economy, agents may have an incentive to appropriate part of government revenue despite the fact that the government will redistribute these receipts in the form of public consumption good anyhow. The reason for such behaviour on part of agents is the lack of mutual trust and chances to have a greater share of rents. Since all agents are potentially dishonest, the fear that her peers may indulge in rent-seeking and thus reduce the pool of redistribution, makes an agent resort to rent-seeking in order to ensure that she is not deprived of her share of the 'redistribution pie'.

The share of rents that an individual rent-seeker is going to obtain depends on two factors. Firstly, it depends on the total fraction of government revenue which is subject to appropriation. This fraction varies with the proportion of rent-seekers in the economy, d_t and the strength of government administrative controls, α. The expression for total pool of government revenue which is subject to appropriation is as follows:

$$P_t = d_t m_t = d_t \left[1 - \alpha \left(1 - d_t\right)\right] \tag{10}$$

here, $m_t = 1 - \alpha\left(1 - d_t\right)$ indicates that if the proportion of rent-seekers in the economy, d_t, is high, then government administrative controls will be rendered ineffective. The multiplicative

d_t term, on the other hand, indicates that when the proportion of rent-seekers in the economy is high, then a larger fraction of government revenue will be subject to appropriation. Although, a higher proportion of rent-seekers, in both of these cases, in effect makes the size of the redistribution pie subject to rent-seeking larger, yet, in the former case it does so indirectly through the weakening of government administrative controls. Whereas in the latter case, it directly increases the fraction of government revenue subject to appropriation. Therefore, d_t and m_t are two elements of our model which reinforce the impact of the proportion of dishonest agents in the economy on each other and thus affecting the fraction of government revenue subject to appropriation. Also, it must be noted that the expression for the fraction of government revenue which cannot be appropriated by rent-seekers is given by $1 - P_t$. This follows from the fact that $0 \leq P_t \leq 1$.

The second factor determines the share of rents that a dishonest agent will receive, υ_{it}. Inspired by Wadho (2014), it is expressed as follows:

$$\upsilon_{ikt} = \frac{Q_{ikt}}{\sum_{i=1}^{n} Q_{ikt}} \tag{11}$$

where $k = 1, 2$. The term in the denominator of the expression above is different from the one which appeared in the denominator of the expression for rent-seeking by evasion. In the present context, the aggregate strength of social networks of agents from generation t appears in the denominator. In the previous case, however, the average strength of social capital of agents from generation t was used in the denominator.

The reason for this distinction is quite straightforward. In the current scenario, the question is as to what share of the 'total' pie of rents will be received by a rent-seeker. Therefore, the 'total' social capital of agents from generation t is used to determine the share of rents received by each agent. In the previous scenario, the concern was to determine the 'relative' social standing of an agent amidst her peers. Therefore, social capital of an agent was compared to the 'average' of social capital of agents from her generation in order to determine how strong were her social networks in relation to that of the (hypothetical) average agent.

0.5 Agents' Income and Consumption

Based on the detailed description of the economy given above, we can split the income of an agent into three components, at the very most. The first component is the income an agent earns by working for the production of the final good. The second component of an agent's income is the share of public consumption good that she may receive as redistribution. And lastly, if an agent opts to cheat, then the share of rents received by her would also form a part of her income.

We must make a distinction over here between 'productive' and 'unproductive' components of income earned by agents. The only productive component of an agent's income is what she earns from working for the production of the final good. Share of public consumption good and receipts from appropriation, are both, unproductive components of an agent's income since both of these represent, in effect, a mere redistribution of income, which in the former case is legal and in the latter case is illegal.

Furthermore, we assume that financial markets are inexistent in this economy and also that agents have no bequest motive. Therefore due to the absence of savings and bequests, agents consume their entire income in each period. The expression for income of, and henceforth consumption by agents in period 1 is as follows:

$$I_{i1t} = c_{i1t} = (1-\theta_{i1t})y^u_{it} + (1-P_t)\frac{\sum_{j=1}^{n}\theta_{j1t}y^u_{jt}}{n} + \phi_{it}P_t\upsilon_{i1t}\sum_{j=1}^{n}\theta_{j1t}y^u_{jt} \tag{12}$$

where y^u_{it} is the i^{th} agent's period 1 income, θ_{i1t} is the fraction of her period 1 income that is subject to government intervention, P_t is the fraction of government revenue subject to appropriation, υ_{i1t} is the share of rents that the i^{th} agent will receive if she opts to be a rent-seeker. And lastly, ϕ_{it} is a variable used to indicate that whether the i^{th} agent from generation t is a rent-seeker or not. It is expressed as:

$$\phi_{it} = \begin{Bmatrix} 0 & \text{if } q_{it} = 0 \\ 1 & \text{if } q_{it} > 0 \end{Bmatrix} \tag{13}$$

Similarly, the expression for second period income and consumption of agents is as follows:

$$I_{i2t} = c_{i2t} = (1 - \phi_{it} z) \left[(1 - \theta_{i2t}) y_{it}^s + (1 - P_t) \frac{\sum_{j=1}^{n} \theta_{j2t} y_{jt}^s}{n} + \phi_{it} P_t \upsilon_{i2t} \sum_{j=1}^{n} \theta_{j2t} y_{jt}^s \right] \tag{14}$$

The expressions given above for the first and the second period income and consumption of agents are similar in a number of ways. The first component (from left) involving y_{it}, in both cases, is the productive component of income, i.e. net income earned by working for the production of the final good. The next component is the share of public consumption good, and finally, the third and the last component is the share of rents. The additional term $(1 - \phi_{it} z)$ multiplying the second period income/consumption is the probability that a rent-seeker will escape accountability for her actions. We assume that an agent's entire second period income is confiscated by the government if she is caught seeking rent, therefore the set of possibilities is exhausted by multiplying $\phi_{it} z$ with 'zero'.

0.6 Agents' Decision Problem

An agent first decides whether or not to indulge in rent-seeking, and then based on that, she decides how much time she will dedicate in period 1 to each of the three activities of acquiring education, working in the unskilled sector, and accumulation of social capital. If she opts out of rent-seeking, then her choices in period 1 are limited to acquiring education and working in the unskilled sector. In period 2, however, every agent inelastically spends the entire time working in the skilled sector and therefore has no time allocation decision to make.

The solution to agents' decision problem is obtained through backwards induction. We first determine agents' optimal time allocation in scenarios when they are all honest and when all of them are rent-seekers. Beginning with the high growth (no rent-seeking) equilibrium, we solve for agents' optimal time investment in the accumulation of human capital, h_t, when they are honest. Then, we consider the low growth (rent-seeking) equilibrium in which we find agents' optimal time allocation between acquiring education, h_t, in the accumulation of social capital, q_t, and working when all of them are rent-seekers.

The second stage involves the comparison of agents' utilities under the two equilibria and finding the range of θ in which each of these equilibria exist. At this stage, we let an agent deviate from the equilibrium outcome in each of the two cases. In doing so, we define the range of θ for which the high growth equilibrium exists, implying that it is optimal for all of the agents to remain honest. Similarly, we define the range of θ for which the low growth equilibrium exists, implying that it is optimal for all agents to indulge in rent-seeking. By solving agents' decision problem in the manner discussed above, we are actually defining sub-game perfect nash equilibria for our economy in terms of the size of government parameter, θ.

0.6.1 High Growth (No Rent-seeking) Equilibrium

To begin with, we find the optimal time allocation by agents between acquiring education and working in the unskilled sector in period 1, assuming that all of them have opted to remain honest, i.e. $d_t = 0$. We call this the 'high growth equilibrium' since none of the agents is indulging in the unproductive activity of rent-seeking, implying that $\phi_{it} = 0$, $q_{it} = 0 \; \forall \; i$. In addition to that, the government takes away the fraction θ of each agent's income. The fraction of government revenue available for provision as public consumption good , $1-P_t$, in the absence of rent-seeking becomes:

$$1 - P_t = 1 \tag{15}$$

Using eq (12) and eq(15), the expression for the i^{th} agent's consumption in period 1 becomes:

$$c_{i1t} = (1-\theta)y_{it}^{u} + \frac{\sum_{j=1}^{n} \theta_{j1t} y_{jt}^{u}}{n} \tag{16}$$

Similarly using eq (14) and eq (15), the expression for consumption in period 2 by the i^{th} agent is given by:

$$c_{i2t} = (1-\theta)y_{it}^{s} + \frac{\sum_{j=1}^{n} \theta_{j2t} y_{jt}^{s}}{n} \tag{17}$$

Her maximisation problem thus becomes:

$$\max_{c_{i1t},\, c_{i2t},\, h_{it}} U_{it} = \ln(c_{i1t}) + \beta_t \ln(c_{i2t}) \tag{18}$$

subject to:

$$c_{i1t} = (1-\theta)y_{it}^u + \frac{\sum_{j=1}^{n} \theta_{j1t} y_{jt}^u}{n}$$

$$c_{i2t} = (1-\theta)y_{it}^s + \frac{\sum_{j=1}^{n} \theta_{j2t} y_{jt}^s}{n}$$

$$y_{it}^u = (1-h_{it})$$

$$y_{it}^s = \gamma H_{i2t}$$

$$H_{i2t} = AH_{i1t}h_{it}$$

$$0 \leq h_{it} \leq 1$$

where each agent takes the total unskilled(skilled) sector output when young(old) and therefore the total amount of public consumption good to be provided by the government in both periods as given. The first-order condition of this maximisation problem for h_{it} is as follows:

$$\frac{c_{i2t}}{c_{i1t}} = \gamma\beta_t A H_{i1t} \tag{19}$$

Using the expressions for c_{i1t} and c_{i2t} from the list of constraints given above and invoking the condition that all agents are homogeneous in equilibrium (implying that $h_t = h_{it}$, $H_{2t} = H_{i2t}$) , we obtain the following expression for time investment by agents in the accumulation of human capital:

$$h_t^{HG} = \frac{\beta_t}{1+\beta_t} \tag{20}$$

Using eq (2), it can be observed that in the high growth equilibrium, the growth rate of human capital and therefore of output is:

$$1 + g_t^{HG} = \frac{\beta_t A}{1+\beta_t} \tag{21}$$

From the above expression, it is apparent that the economy will grow at a faster rate when agents are more patient (i.e. β_t is high) and when the productivity of the education sector is high (i.e. A is high). This is in line with Lucas (1988) where productivity of education technology and patience positively affect economic growth. As we will see in subsequent sections that β_t is endogenous and it depends on the educational investment of the previous generation, the level of human capital and the rate of growth is going to be history dependent as in Azariadis and Drazen (1990). Although here it is β_t that is endogenous as compared to there's where A was endogenous.

0.6.2 Low Growth (Rent-seeking) Equilibrium

Now, consider the case when all of the agents opt to be rent-seekers, i.e. $d_t = 1$. This equilibrium is regarded as the 'low growth equilibrium' since every agent indulges in the unproductive activity of rent-seeking. This implies that $\phi_{it} = 1$ and $q_{it} > 0 \ \forall \ i$. The fraction of government revenue subject to appropriation, as given by eq(10), thus becomes:

$$P_t = 1\left[1 - \alpha\left(1 - 1\right)\right] = 1 \tag{22}$$

This implies that all of the government revenue is going to be appropriated and therefore the government will be unable to provide the public consumption good.

Using eq (12) and eq(22), the expression for the i^{th} agent's consumption in period 1 becomes:

$$c_{i1t} = (1 - \theta_{i1t})y_{it}^u + \upsilon_{i1t}\sum_{j=1}^{n}\theta_{j1t}y_{jt}^u \tag{23}$$

Similarly, using eq (14) and eq (22) the expression for consumption in period 2 by the i^{th} agent is given by:

$$c_{i2t} = (1 - z)\left[(1 - \theta_{i2t})y_{it}^s + \upsilon_{i2t}\sum_{j=1}^{n}\theta_{j2t}y_{jt}^s\right] \tag{24}$$

Her maximisation problem thus becomes:

$$\max_{c_{i1t},\, c_{i2t},\, h_{it},\, q_{it}} U_{it} = \ln(c_{i1t}) + \beta_t \ln(c_{i2t}) \tag{25}$$

subject to:

$$c_{i1t} = (1-\theta_{i1t})y_{it}^u + \upsilon_{i1t}\sum_{j=1}^{n}\theta_{j1t}y_{jt}^u$$

$$c_{i2t} = (1-z)\left[(1-\theta_{i2t})y_{it}^s + \upsilon_{i2t}\sum_{j=1}^{n}\theta_{j2t}y_{jt}^s\right]$$

$$y_{it}^u = (1-h_{it}-q_{it})$$

$$y_{it}^s = \gamma H_{i2t}$$

$$H_{i2t} = AH_{i1t}h_{it}$$

$$Q_{it} = Q_{i2t} = Q_{i1t} = BQ_{i0t}q_{it}$$

$$\theta_{it} = \theta_{i2t} = \theta_{i1t} = \theta\left[1-\left(\frac{Q_{i1t}}{\bar{Q}_{1t}} - \alpha\right)\right]$$

$$\upsilon_{it} = \upsilon_{i2t} = \upsilon_{i1t} = \frac{Q_{i1t}}{\sum_{i=1}^{n} Q_{i1t}}$$

$$0 \le h_{it} \le 1$$

$$0 \le q_{it} \le 1$$

where each agent takes the total unskilled(skilled) sector output when young(old) and therefore the total amount of public consumption good to be provided by the government in both periods as given. Also the levels of aggregate and average social capital of the society in both periods is taken as given by the agents. The first-order conditions of this maximisation problem for h_{it} and q_{it}, respectively, are as follows:

$$h_{it} = \frac{\beta_t}{1+\beta_t}\left[(1-q_{it}) + \frac{\sum_{j=1}^{n}\theta_{jt}\left(1-h_{jt}-q_{jt}\right)}{1-\theta_{it}}\left(\frac{Q_{it}}{\sum\limits_{i=1}^{n} Q_{it}}\right)\right] - \frac{1}{1+\beta_t}\frac{\sum_{j=1}^{n}\theta_{jt}H_{j1t}h_{jt}}{\left(1-\theta_{it}\right)H_{i1t}}\left(\frac{Q_{it}}{\sum\limits_{i=1}^{n} Q_{it}}\right) \tag{26}$$

$$q_{it} = \beta_t(1-z)\frac{c_{i1t}}{c_{i2t}}\left[\gamma H_{i2t} + \frac{\bar{Q}_t}{\theta\sum\limits_{i=1}^{n} Q_{it}}\sum_{j=1}^{n}\theta_{jt}y_{jt}^{s}\right] + (1-h_{it}) + \frac{\bar{Q}_t}{\theta\sum\limits_{i=1}^{n} Q_{it}}\sum_{j=1}^{n}\theta_{jt}y_{jt}^{u} - \frac{\bar{Q}_t}{\theta B Q_{i0t}}(1-\theta_{it}) \tag{27}$$

We can clearly observe from the first-order condition for h_{it} given above that time investment by an agent in the accumulation of human capital is a negative function of her time investment in the accumulation of social capital, highlighting the trade-off she faces of allocating her time in period 1 between these two competing activities. According to this, an agent opting to invest more time in the accumulation of social capital does so at the expense of less time investment in human capital accumulation and less time spent working in period 1. In addition to that, due to lower level of time investment in the accumulation of human capital, an agent earns less income from the production of the final good in period 2. Thus, an agent's decision to indulge in rent-seeking reduces her incentive to accumulate human capital by lowering her returns to acquisition of education.

Using these first-order conditions and the expressions for c_{i1t},c_{i2t}, θ_{it} from the list of constraints given above and also by invoking the condition that all agents are homogeneous in equilibrium (implying that $h_t = h_{it}$, $q_t = q_{it}$, $H_{2t} = H_{i2t}$, $Q_{1t} = Q_{i1t}$, and so forth), we obtain the following expressions for time investment by agents in the accumulation of social and human capital, respectively:

$$q_t^{LG} = \frac{\theta(1+\alpha)}{1+\theta} \tag{28}$$

$$h_t^{LG} = \frac{\beta_t}{1+\beta_t}\left(\frac{1-\alpha\theta}{1+\theta}\right) \tag{29}$$

Due to delay in realisation of its returns, the equilibrium level of time investment by agents in the accumulation of human capital, in the presence of rent-seeking, is a positive function of their level of patience, β_t and a negative function of the size of government intervention, θ. On the contrary, since social capital yields returns in the period of investment, the equilibrium level of time investment by agents in the accumulation of social capital, when all of them opt to be rent-seekers, is unaffected by their level of patience, and is a positive function of the size of government. At first glance, the positive relationship between the strength of government administrative controls, α and the optimal level of time investment by agents in the accumulation of social capital seems counter-intuitive. However, since we have already assumed that it is optimal for agents to indulge in rent-seeking, thus they will spend more time (in equilibrium) in the accumulation of social capital in the case when government administrative controls are strong, so that they may reduce the effectiveness of these controls and thereby raise returns to their rent-seeking activity. This result follows from our earlier discussion of the rent-seeking technology, which showed that the strength of government administrative controls is contingent on the rent-seeking behaviour of agents.

In addition to that, from eq (28) above, we can observe that it is never optimal for rent-seekers to invest their entire first period unitary time endowment in the accumulation of social capital, since $q_t^{LG} < 1$ because $\alpha\theta < 1$. It is not optimal for agents to devote their entire time for the accumulation of social capital because rents are effectively sourced from their own income, therefore, agents cannot completely opt out of working for the production of the final good, since it would imply no rents accruing to them at equilibrium.

Using eq (3), it can be observed that in the low growth equilibrium, the growth rate of human capital and therefore of output will be:

$$1 + g_t^{LG} = \frac{\beta_t A}{1 + \beta_t} \left(\frac{1 - \alpha\theta}{1 + \theta} \right) \tag{30}$$

Given this, it is straightforward to observe that $g_t^{LG} < g_t^{HG}$ since $\frac{1-\alpha\theta}{1+\theta} < 1$. Higher patience, β_t, creates an incentive for agents to accumulate the "future oriented" human capital and it therefore results in an increase in the rate of economic growth. Furthermore, when agents have decided to seek rent, then an increase in the size of government, θ, increases the pool of government revenue that can be appropriated. As a result, it increases agents' incentive to invest time in the accumulation of social capital by taking time away from production and the accumulation of human capital, reducing the rate of economic growth. Also, when they are rent-seekers, agents respond to the strengthening of government administrative controls, α, by increasing their allocation of time for the accumulation of social capital. It is done in order to weaken the strength of these controls put in place by the government and to appropriate away a larger fraction of government revenue. Once again since agents devote less time to the accumulation of human capital, the rate of economic growth is reduced. A higher size of the government, θ, and a higher strength of government administrative controls, α, thus encourage rent-seekers to devote more time for the accumulation of social capital which enables them to appropriate away a larger fraction of government revenue. Since agents' time endowment is fixed, more time devoted to the accumulation of social capital implies less investment of time in the accumulation of human capital and therefore a reduction in the rate of growth. Therefore, economies in which agents opt to indulge in rent-seeking are characterised by low rate of growth as compared to economies in which agents opt to remain honest. In the following section, we will see how the size of government plays a key role in affecting agents' payoffs and ultimately their decision to remain honest or to indulge in rent-seeking.

0.6.3 Agents' decision to seek rents

As was explained earlier, the initial decision each agent has to make is whether she should seek rent or that she should remain honest. Once this decision is taken, an agent then decides how much time to allocate between final good's production, accumulation of human capital, and accumulation of social capital. In the previous section, we solved for agents' optimal time allocation decision between these three activities, based on the assumption that an agent had already decided to take either of the two paths. In this section, we use the backward induction approach, and by using agents' optimal choices from the previous section, determine the range of values for θ for which either of the two equilibria would exist. In other words, we will compare the utility of an agent when she acts like the rest of her peers in either of the two cases discussed above with the case when her optimal choices differ from that of the rest of her peers. Given the equilibria in the previous section, there are two possible scenarios depending on whether others invest time $q_t = 0$ or $q_t > 0$ in the accumulation of social capital. Moreover, since rents are generated due to government intervention, an individual's decision to be rent-seeker would crucially depend on the extent of government intervention in the economy, θ. Before divulging any further, it must be noted that the size of population of each generation is large enough implying that $\frac{1}{n} \approx 0$.

When the rest of the agents opt to remain honest (i.e. $q_t = 0$ and $h_t = h^{HG}$)

To begin with, we determine the range of values of θ for which the high growth equilibrium exists. In order to do that, we compare the utility of an agent when she opts to remain honest with her utility when she decides to indulge in rent-seeking when all others are honest. The utility of the i^{th} agent when she opts to remain honest when all others are honest is given by:

$$U^h_{iht} = \ln(1 - h^{HG}_t) + \beta_t \ln(\gamma A H_{1t} h^{HG}_t) \tag{31}$$

The above expression follows directly from the optimality problem set up for the high growth equilibrium, since all agents have opted to remain honest.

Now, consider the case when the i^{th} agent deviates by indulging in rent-seeking while all others remain honest, implying that the proportion of rent-seekers is $d_t = \frac{1}{n}$. The fraction of government revenue subject to appropriation, as given by eq(10), in this case becomes:

$$P_t = \left[\frac{n - (1 - \alpha)}{n}\right] \tag{32}$$

Using eq (12) and eq(32), the expression for rent-seeker's consumption in period 1 becomes:

$$c_{i1t} = (1 - \theta_{i1t}) y^u_{it} + \left[\frac{n - (1 - \alpha)}{n}\right] \frac{(n - 1)\theta(1 - h^{HG}_t)}{n} + \left(\frac{1 - \alpha}{n}\right) \upsilon_{i1t}(n - 1)\theta(1 - h^{HG}_t)$$

Similarly, using eq (14) and eq (32) her consumption in period 2 is given by:

$$c_{i2t} = (1-z)\left[(1-\theta_{i2t})y^s_{it} + \left[\frac{n-(1-\alpha)}{n}\right]\frac{(n-1)\theta\gamma AH_{1t}h_t^{HG}}{n} + \left(\frac{1-\alpha}{n}\right)\upsilon_{i1t}(n-1)\theta\gamma AH_{1t}h_t^{HG}\right] \tag{33}$$

The agent's maximisation problem thus becomes:

$$\max_{c_{i1t},\, c_{i2t},\, h_{it},\, q_{it}} U_{it} = \ln(c_{i1t}) + \beta_t \ln(c_{i2t}) \tag{34}$$

subject to:

$$c_{i1t} = (1-\theta_{i1t})y^u_{it} + \left[\frac{n-(1-\alpha)}{n}\right]\frac{(n-1)\theta(1-h_t^{HG})}{n} + \left(\frac{1-\alpha}{n}\right)\upsilon_{i1t}(n-1)\theta(1-h_t^{HG})$$

$$c_{i2t} = (1-z)\left[(1-\theta_{i2t})y^s_{it} + \left[\frac{n-(1-\alpha)}{n}\right]\frac{(n-1)\theta\gamma AH_{1t}h_t^{HG}}{n} + \left(\frac{1-\alpha}{n}\right)\upsilon_{i1t}(n-1)\theta\gamma AH_{1t}h_t^{HG}\right]$$

$$y^u_{it} = (1-h_{it}-q_{it})$$

$$y^s_{it} = \gamma H_{i2t}$$

$$H_{i2t} = AH_{i1t}h_{it}$$

$$Q_{it} = Q_{i2t} = Q_{i1t} = BQ_{i0t}q_{it}$$

$$\theta_{it} = \theta_{i2t} = \theta_{i1t} = \theta\left[1 - \left(\frac{Q_{i1t}}{\bar{Q}_{1t}} - \alpha\right)\right]$$

$$\upsilon_{it} = \upsilon_{i2t} = \upsilon_{i1t} = \frac{Q_{i1t}}{\sum_{i=1}^{n} Q_{i1t}}$$

$$0 \le h_{it} \le 1$$

$$0 \le q_{it} \le 1$$

The first-order conditions yield the following optimal values of time-investment in human and social capital, respectively, by the rent-seeker when all others are honest:

$$h^h_{rt} = \frac{\beta_t}{1+\beta_t}\left(\frac{1-\theta\,(1-\alpha)}{1+\theta}\right) \tag{35}$$

$$q_{rt}^{h} = \frac{\theta(2-\alpha)}{1+\theta} \tag{36}$$

The utility of the i^{th} agent who is a rent-seeker while all others are honest is therefore given by:

$$U_{irt}^{h} = \ln\left[\left(1 - h_{rt}^{h} - q_{rt}^{h}\right) + (2-\alpha)\theta(1-h^{HG})\right] + \beta_t \ln\left[(1-z)\left(\gamma A H_{1t} h_{rt}^{h} + (2-\alpha)\theta\gamma A H_{1t} h_t^{HG}\right)\right] \tag{37}$$

Proposition 1 $\forall\theta \leq \bar{\theta}$, *there exists a high growth equilibrium such that no one is a rent-seeker.*

Proof. See Appendix A. ■

When the extent of government intervention in the economy is $\bar{\theta}$ or lower, then returns to rent-seeking are small enough to encourage agents to accumulate social capital and therefore none of the agents opts to do so. As a result, when $\theta \leq \bar{\theta}$ then the economy is in the high-growth equilibrium which is characterised by no rent-seeking and a higher stock of equilibrium human capital and where:

$$\bar{\theta} = \frac{1 - \mu + \sqrt{(1-\mu)^2 + 4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu} \tag{38}$$

also where $\mu = (1-z)^{\frac{\beta_t}{1+\beta_t}}$

On the other hand, when $\theta > \bar{\theta}$, then it always pays the i^{th} agent to become a rent-seeker despite the fact that all of the other agents are honest. Extent of government intervention more than $\bar{\theta}$ encourages the i^{th} agent to seek rent since her payoff from rent-seeking is more than her foregone income from working for the production of final good even when the probability of losing the entire second period income if caught is incorporated. Therefore, the high-growth equilibrium does not exist when the size of government, θ is in excess of $\bar{\theta}$. In addition to this, the threshold level $\bar{\theta}$ is endogenous and interestingly, it depends on patience, β_t, strength of government administrative controls, α, and quality of law enforcement institutions, z. It means that not only $\bar{\theta}$ is not only affected by society's preferences, but being perhaps the most important policy variable itself, it also is affected by other policy variables α and z which reflect ex-ante and ex-post institutional constraints, respectively. We can see that $\frac{\partial\bar{\theta}}{\partial\beta_t}$, $\frac{\partial\bar{\theta}}{\partial z}$, and $\frac{\partial\bar{\theta}}{\partial\alpha}$ are all positive[5]. This implies that the range of government intervention where high growth equilibrium exists increases with patience that allows less discounting of returns to human capital, and with both ex-ante and ex-post institutional constraints that make rent-seeking less profitable. Interestingly, when there is no cost of rent-seeking, i.e. $z = 0$, then $\bar{\theta} = 0$ and high growth equilibrium does not exist. This is very intuitive as without cost of rent-seeking, returns of being a rent-seeker would always exceed returns of being honest. And in the other extreme when the agent is certain of being caught in the second period for her act of indulging in rent-seeking, i.e. $z = 1$, then $\bar{\theta} = \infty$ and the high growth equilibrium exists for all values of $\bar{\theta}$.

When the rest of the agents opt to seek rent (i.e. $q_t = q^{LG}$ and $h_t = h^{LG}$)

The utility of an agent when she opts to be a rent-seeker when all others are also rent-seekers is given by:

$$U^r_{irt} = \ln(1 - h^{LG}_t - q^{LG}_t) + \beta_t \ln((1 - z)\gamma A H_{1t} h^{LG}_t) \tag{39}$$

The above expression follows directly from the optimisation problem set up for the low growth equilibrium, since all agents have decided to act as rent-seekers.

Now, we consider the case when the agent deviates by remaining honest when all others are rent-seekers, implying that $d_t = \frac{n-1}{n}$. It can be shown that when she deviates from the low growth equilibrium by remaining honest, she invests $h_{it} = h^{HG}$ in the accumulation of human capital[6]:

[5] For proof, see Appendix A.
[6] For Proof, see Appendix B.

$$h_{ht}^{r} = h^{HG} = \frac{\beta_t}{1+\beta_t} \tag{40}$$

However, in the present scenario, where rent-seeking by agents is pervasive, an honest agent will be deprived of her share of the public consumption good and therefore, her lifetime utility will be strictly less than that found in the high growth case. The expression for it is as follows:

$$U_{iht}^{r} = \ln((1-\theta)(1-h_t^{HG})) + \beta_t \ln((1-\theta)\gamma A H_{1t} h_t^{HG}) \tag{41}$$

Proposition 2 $\forall \theta \geq \underline{\theta}$, *there exists a low growth equilibrium such that everyone is a rent-seeker.*

Proof. See Appendix B. ■

When the extent of government intervention in the economy is $\underline{\theta}$ or more, then returns to rent-seeking are more than agents' foregone income from working for the production of final good even when the probability of losing the entire second period income if caught is incorporated and therefore all agents opt to accumulate social capital. Thus, when $\theta \geq \underline{\theta}$ then the economy is in the low-growth equilibrium in which everyone is a rent-seeker and where:

$$\underline{\theta} = \frac{\alpha\mu + \sqrt{(\alpha\mu)^2 + 4(1-\mu)}}{2} \tag{42}$$

recall that $\mu = (1-z)^{\frac{\beta_t}{1+\beta_t}}$

Whereas when $\theta < \underline{\theta}$, then it always pays an agent to remain honest despite the fact that all others are rent-seekers. Extent of government intervention less than $\underline{\theta}$ encourages the agent to stay honest because her payoff from rent-seeking (taking into account the probability of her losing the entire second period income if caught) is less than her foregone income from working for the production of the final good. Therefore, the low-growth equilibrium does not exist when the size of government, θ is below $\underline{\theta}$. Moreover, the threshold level $\underline{\theta}$ is endogenous and like the high-growth threshold level of $\bar{\theta}$, it depends on patience, β_t, strength of government administrative controls, α, and quality of law enforcement institutions, z. We can see that $\frac{\partial \underline{\theta}}{\partial \beta_t}$, $\frac{\partial \underline{\theta}}{\partial \alpha}$, and $\frac{\partial \underline{\theta}}{\partial z}$ are all positive[7]. This implies that the range of government intervention where low growth equilibrium exists decreases with patience that allows less discounting of returns to human capital, and with both ex-ante and ex-post institutional constraints that make rent-seeking less profitable. Interestingly, when there is no ex-post cost of rent-seeking, i.e. $z = 0$, then $\underline{\theta} = \alpha$ and low growth equilibrium exists for $\theta \geq \alpha$. Intuitively, in the case when there is no ex-post cost of rent-seeking, then in order for rent-seeking to be profitable, the extent of government intervention in the economy (and therefore size of rents available) must be large enough to cover the ex-ante cost of rent-seeking, α. Therefore, we get the condition on θ that it must be as large as α for agents to be rent-seekers when there is no ex-post cost of rent-seeking. On the other hand, when the agent is certain of being caught in the second period for her act of indulging in rent-seeking, i.e. $z = 1$, then $\underline{\theta} = 1$ and the low growth equilibrium does not exist.

[7] For proof, see Appendix B.

0.7 Patience thresholds and equilibria

The results of the previous section reveal that how the extent of government intervention in the economy, θ, plays a crucial role in altering agents' incentives and therefore in the determination of the growth regime in which a country operates. We have shown that when the extent of government intervention in the economy satisfies $\theta \geq \underline{\theta}$, then given the considerably large size of the rents they can earn, all of the agents opt to be rent-seekers and therefore the economy is in the low growth equilibrium with low investment in human capital accumulation by successive generations. Similarly, we showed that when the extent of government intervention in the economy satisfies $\theta \leq \bar{\theta}$, which indicates that the size of rents available is considerably smaller, then all of the agents opt to be honest and as a result the economy is in the high growth equilibrium with high investment in human capital accumulation by successive generations.

However, it will be incorrect to attribute existence and persistence of high economic growth solely to economies characterised by low extent of government intervention. Agell et al. (1997) show using data on 23 OECD countries for the period 1970-90 that government expenditures and taxes (as a share of GDP) have a negative impact on growth, however this relationship is not robust when factors such as initial GDP and demography are included in the regression. Similarly Saunders (1988) shows that the impact of total government expenditure on growth is sensitive to the choice of countries and the range of time for which data is available and therefore there does not exist any determinate relationship between government size and growth. Autocratic regimes and dictatorships are a vivid illustration of large government size, since in such regimes government has a significant control over the economic activity. Glaeser et al. (2004) show that South Korea and North Korea had comparable average scores of 1.71 and 2.16 for the political institutional measure of 'executive constraints' during the period after the Korean war till 1980s; implying that both countries were effectively dictatorships. However, as it turned out, the South Korean dictators proved to be 'good for growth' as opposed to their North Korean counterparts. They argue that the actual drivers behind the growth experienced by relatively 'autocratic' economies such as South Korea were the accumulation of physical and human capital.

A question then arises that what makes agents prefer the accumulation of human capital over rent-seeking in economies where government intervention is pervasive and how can agents fight the temptation of rent-seeking when the size of rents they can earn is far bigger due to presence of a considerably large government? A plausible answer to this question, in the light of Azariadis and Drazen (1990) is that the productivity of the human capital technology exhibits threshold effects stemming from an externality arising from the inherited stock of human capital which makes investment in human capital more profitable than rent-seeking beyond a certain threshold level of inherited human capital. Therefore, economies characterised by a large government size may still experience high growth due to higher productivity of human capital technology which increases the payoff to the accumulation of human capital. However, it is more plausible to assume that non-market factors (such as preferences) may be responsible for a higher valuation of returns to human capital in such economies instead of factors that affect the market rate of return to education. The ex-communist economies of Soviet Union are an apt illustration of countries where government intervention is pervasive. In the case of these economies, wages were held fixed at a pre-determined level by the government instead of each worker being paid according to her productivity. Chase (1998) using dataset for Communist and post-communist Czech Republic shows that returns to education for Czech men increased significantly from 2.4% in 1984 (communist era) to 5.2% in 1993 (post-communism). This almost doubling of returns to education within the period of less than a decade reflects that the government determined wage rate did not pay workers according to their productivity and thus market factors cannot be a possible channel affecting returns to education in economies where government size is large.

Preferences, on the other hand, are a key non-market factor which may explain why even when government intervention is pervasive, agents may have a greater incentive to accumulate a 'future oriented' capital, such as human capital, instead of accumulating social capital, despite the fact that the latter yields returns immediately and that a relatively large size of government may translate into more rents being available. Societies which are inherently more patient prefer to accumulate human capital which has a delayed return profile over rent-seeking, notwithstanding larger potential rents on offer which can be extracted much quickly than realisation of returns to human capital. Therefore, more patient societies, due to greater accumulation of human capital, may experience high growth regardless of government size.

We model patience, or in other words the generation specific discount factor, β_t in light of Dohmen et al. (2010) and Hryshko et al. (2011) in that β_t exhibits threshold effects in terms of the average initial stock of human capital. This specification ensures that we capture the elements of across and within generation influence of human capital (education) on preferences in our model. The former objective is accomplished since we define patience in terms of the 'average' level of initial human capital and the latter is ensured by the fact that inital human capital of agents from generation t is equivalent to their 'inherited' human capital. In addition to that, since agents take the average initial level of human capital as given, therefore investment in patience is modelled as an indeliberate act on part of every individual agent. We show that beyond a certain threshold of average initial human capital, agents are characterised by very high level of patience where it is not optimal for agents to indulge in rent-seeking, regardless of the extent of government intervention in the economy. Therefore, in this case, agents will always opt to be honest, implying greater accumulation of human capital by successive generations and high rate of economic growth. Similarly, we show that below some very low threshold level of average initial human capital, agents are characterised by very low level of patience where it is not optimal for agents to accumulate human capital, irrespective of the size of government. As a result, in this case, agents will always opt to be rent-seekers, implying less accumulation of human capital by successive generations and low rate of economic growth. In addition to that, we also show that corresponding to intermediate levels of average initial human capital, there are intermediate levels of patience which imply the existence of multiple equilibria. Furthermore, we show that since agents do not internalise the subsequent impact of their decision to accumulate human capital on the level of patience, therefore, government policy of increasing ex-ante and ex-post institutional controls can ensure that economies with low level of education (and thus low level of patience) can still opt to invest more in the accumulation of human capital and therefore experience a high rate of economic growth, even when the extent of government intervention is large. Our results, indicating a non-monotonic relationship between government size and economic growth, are in line with empirical evidence which is unable to establish any consensus on the direction of relationship between these two variables.

The level of patience of agents belonging to generation t can be expressed in terms of their average initial stock of human capital, H_{1t}, as follows:

$$\beta_t = \beta\left(\frac{\sum_{i=1}^{n} H_{i1t}}{n}\right) = \beta\left(H_{1t}\right) = \max\left[\underline{\beta}_0\ ,\ \beta_0 H_{1t}^{\lambda}\right] \tag{43}$$

where $\beta_0 H_{1t}^{\lambda} > \underline{\beta}_0$ for any $H_{1t} > 0$. Also, we assume that patience exhibits non-increasing returns to average initial level of human capital, implying that $0 \leq \lambda \leq 1$. It must be noted that when we configure our model's equilibrium regimes with regards to the average initial level of human capital, we ignore boundaries of $\theta = 0$ and $\theta = 1$, since in the former case which implies absence of government, agents have no incentive to seek rent (because there isn't any!). Whereas in the latter case, agents have no incentive of accumulate human capital since their earnings are determined by the government and not by market forces. Instead of these boundaries, we consider limiting cases of $\theta = \varepsilon \to 0$ and $\theta = \omega \to 1$ in order to obtain meaningful results. We now discuss various equilibrium configurations implied by different threshold levels of average initial human capital.

Proposition 3 *$\forall H_{1t}$ such that $H_{1t} \geq \bar{\bar{H}} \Longrightarrow \beta_t \geq \bar{\bar{\beta}}$, there is a unique high growth equilibrium for all $\theta \leq \omega \to 1$ and there is no low growth equilibrium*

Proof. See Appendix C. ■

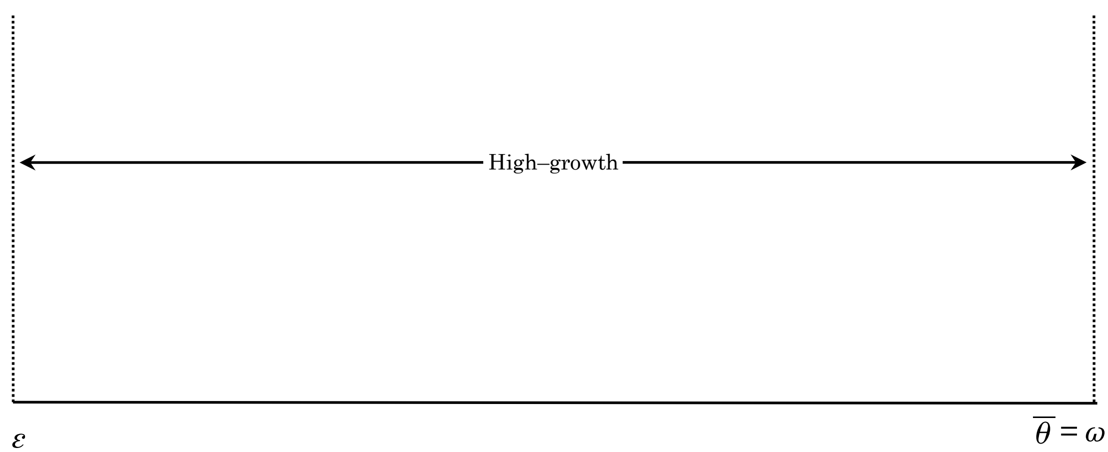

FIGURE 1

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When the average level of initial human capital is greater or equal to $\overline{\overline{H}}$, then all agents exhibit high level of patience, $\overline{\overline{\beta}}$, and high growth equilibrium exists for all levels of government intervention, θ, and that the low growth equilibrium does not exist at all. This implies that societies where average level of education is sufficiently high, implying that they are considerably patient, can achieve the high growth equilibrium regardless of the extent of government intervention in the economy and the possible size of rents that can be extracted. Where:

$$\overline{\overline{H}} = \left(\frac{\ln\left(\frac{1-\alpha\omega}{1-\omega^2}\right)}{\beta_0 \ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right]} \right)^{\frac{1}{\lambda}} \tag{44}$$

It is also interesting to note that $\overline{\overline{H}}$ is endogenous and is affected by policy variables α and z which reflect ex-ante and ex-post institutional constraints, respectively. $\overline{\overline{H}}$ is reduced by an increase in α as well as z[8]. This implies that societies where government administrative controls, α, are high enough and societies where legal institutions, z, are strong enough, can achieve the high growth equilibrium, regardless of the size of government, even when they have a relatively low stock of initial human capital (which in turn implies a relatively low level of patience). Thus, we find that institutional factors are responsible for altering a society's preferences as a whole which in turn affect agents' payoffs from the accumulation of human and social capital. Better institutional constraints ensure that a particular generation of individuals will devote more time to accumulation of human capital and as a result its subsequent generation will find investment in human capital more attractive due to higher market returns to human capital implied by a higher initial stock of human capital, but more importantly, because of higher non-market returns to human capital implied by a higher level of patience in the society.

Proposition 4 *$\forall H_{1t}$ such that $H_{1t} \leq \underline{\underline{H}} \Longrightarrow \beta_t \leq \underline{\underline{\beta}}$, there is a unique low growth equilibrium for all $\theta \geq \varepsilon \to 0$ and there is no high growth equilibrium..*

Proof. See Appendix D. ■

[8] For Proof, see Appendix C.

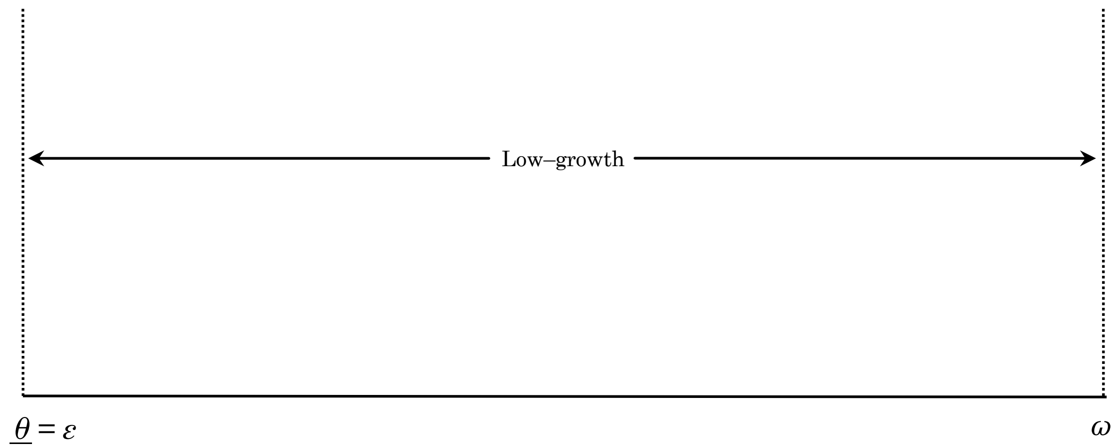

FIGURE 2

When the average level of initial human capital is less than or equal to $\underset{=}{H}$, then all agents exhibit low level of patience, $\underset{=}{\beta}$, and low growth equilibrium exists for all levels of government intervention, θ, and that the high growth equilibrium does not exist at all. This implies that societies where average level of education is sufficiently low, implying that they are considerably impatient, can be trapped in the low growth equilibrium even when the extent of government intervention in the economy and the possible size of rents that can be extracted is not relatively large. Where:

$$\underset{=}{H} = \left(\frac{\ln\left(\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon}\right)}{\beta_0 \ln\left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]}\right]} \right)^{\frac{1}{\lambda}} \tag{45}$$

Once again we note that the threshold level of average initial human capital, $\underset{=}{H}$ in this case, is endogenous and is affected by ex-ante and ex-post institutional constraints, α and z, respectively. $\underset{=}{H}$ is reduced by an increase in α as well as z[9]. This implies that societies where government administrative controls, α, are high enough and societies where legal institutions, z, are strong enough, can still manage to avoid this persistent low growth equilibrium, regardless of the size of government and even when they have a relatively low stock of initial human capital

[9] For Proof, see Appendix D.

(which in turn implies a relatively low level of patience). Once again, we show that ex-ante and ex-post institutional constraints are responsible for altering a society's preferences as a whole. These preferences then affect agents' incentive to accumulate human and social capital and therefore determine the growth regime in which an economy operates.

So far, we have considered extreme values of average initial human capital, H_{1t}, which imply existence of unique equilibria for the entire range of government size, θ. However, we are yet to determine the equilibrium configuration for intermediate levels of average initial human capital, ranging between $\underline{\underline{H}} < H_{1t} < \overline{\overline{H}}$. We now show that for all intermediate levels of average initial human capital, there exist multiple equilibria with the range of values of θ for which the high growth equilibrium exists increasing with the increase in average level of initial human capital. Similarly, the range of values of θ for which the low growth equilibrium exists decreases wtih an increase in H_{1t}. The existence of multiple equilibria implies that there exists a non-monotonic relationship between government size and economic growth, as indicated by empirical evidence.

Proposition 5 *$\forall H_{1t}$ such that $\underline{\underline{H}} < H_{1t} < \overline{\overline{H}} \Longrightarrow \underline{\underline{\beta}} < \beta_t < \overline{\overline{\beta}}$, there are multiple equilibria for all θ such that $\theta \leq \bar{\theta}$ and $\theta \geq \bar{\theta}$.*

Proof. See Appendices E, F, and G. ■

We now show that within this equilibrium configuration there are three cases which are possible. These cases involve a progressively increasing range of values of θ for which the high growth exists and it increases with an increase in the average level of initial human capital.

CASE I:

$\forall H_{1t}$ such that $\underline{\underline{H}} < H_{1t} \leq \underline{H} \Longrightarrow \underline{\underline{\beta}} < \beta_t \leq \underline{\beta}$, there are multiple equilibria for all θ which satisfy $\theta \leq \bar{\theta}$. And there is a unique low growth equilibrium for all $\theta > \bar{\theta}$[10].

[10] For Proof, See Appendix E

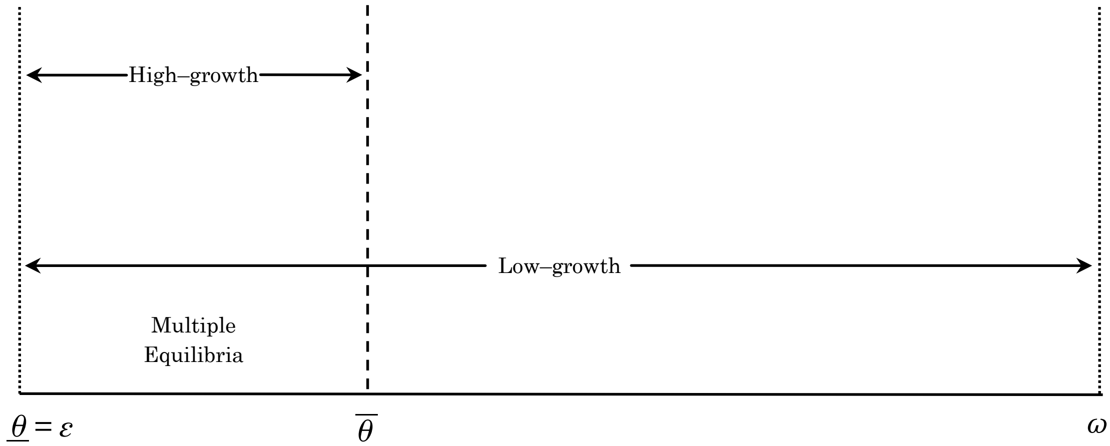

FIGURE 3

This equilibrium configuration implies that when the average initial level of human capital of agents is larger than $\underline{\underline{H}}$ but no more than $\underline{H}$, then the economy can beat the persistent low growth trap to operate in the high growth regime for sufficiently small government size, given by $\theta \leq \overline{\theta}$. However, since the low growth equilibrium still exists for all range of values of θ, the existence of high growth equilibrium for $\theta \leq \overline{\theta}$ does not imply that it is unique and even when $\theta \leq \overline{\theta}$ an economy may still find itself in the low growth equilibrium. It can also be observed that when the size of government exceeds $\overline{\theta}$ then only a unique low growth equilibrium exists implying that agents will always find it profitable to indulge in rent-seeking. Where:

$$\underline{H} = \left(\frac{\ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\beta_0 \ln\left[\frac{1-\varepsilon^2}{(1-z)[1-\alpha\varepsilon]}\right]} \right)^{\frac{1}{\lambda}} \tag{46}$$

Comparative statics indicate that the threshold level of average initial human capital, $\underline{H}$ in this case, is reduced by an increase in ex-ante and ex-post institutional constraints, α and z, respectively [11], which is consistent with our results for the previous thresholds.

CASE II:

[11] For Proof, see Appendix E.

$\forall H_{1t}$ such that $\underline{H} < H_{1t} \leq \bar{H} \Longrightarrow \underline{\beta} < \beta_t \leq \bar{\beta}$, there is a unique high growth equilibrium for all θ which satisfy $\theta < \underline{\theta}$; There are multiple equilibria for all θ which satisfy $\underline{\theta} \leq \theta \leq \bar{\theta}$; There is a unique low growth equilibrium for all θ which satisfy $\theta > \bar{\theta}$.[12]

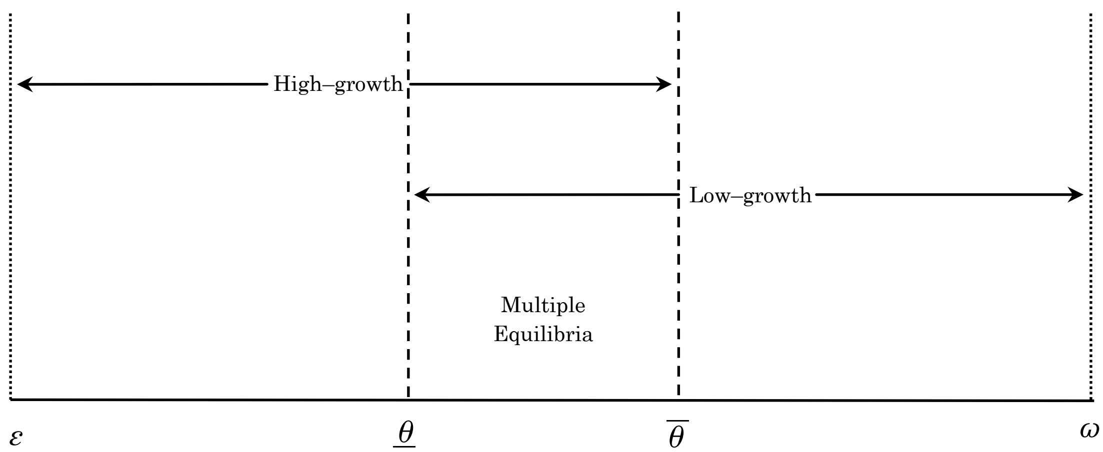

FIGURE 4

This equilibrium configuration implies that when the average initial level of human capital of agents is larger than $\underline{H}$ but no more than $\bar{H}$, then the economy can beat the persistent low growth trap to operate in the high growth regime for sufficiently small government size, given by $\theta < \underline{\theta}$. Unlike the previous case, the high growth equilibrium is unique for all sizes of government less than $\underline{\theta}$. This implies that when the size of government is sufficiently small, then there is no incentive for agents to seek rents and therefore the economy is guaranteed to operate in the high growth regime whenever the average level of initial human capital is in the range $\underline{H} < \bar{H}_{1t} \leq \bar{H}$. For an intermediate range of government size given by $\underline{\theta} \leq \theta \leq \bar{\theta}$, we observe that there exist multiple equilibria and the economy may operate in either the high

[12] For Proof, See Appendix F

growth or the low growth regime. Finally, we observe that when the size of government is sufficiently large, as indicated by $\theta > \bar{\theta}$, then there exists a unique low growth equilibrium which implies that agents will always opt to be rent-seekers. Where:

$$\bar{H} = \left(\frac{\ln\left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega}\right)}{\beta_0 \ln\left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]}\right]} \right)^{\frac{1}{\lambda}} \tag{47}$$

Comparative statics indicate that the threshold level of average initial human capital, $\bar{H}$ in the present case, is reduced by an increase in ex-ante and ex-post institutional constraints, α and z, respectively [13], which is consistent with our results for the previous thresholds.

CASE III:

$\forall H_{1t}$ such that $\bar{H} < H_{1t} < \bar{\bar{H}} \Longrightarrow \tilde{\beta} < \beta_t < \bar{\bar{\beta}}$, there is a unique high growth equilibrium for all $\theta < \underline{\theta}$. And there are multiple equilibria for all $\theta \geq \underline{\theta}$.

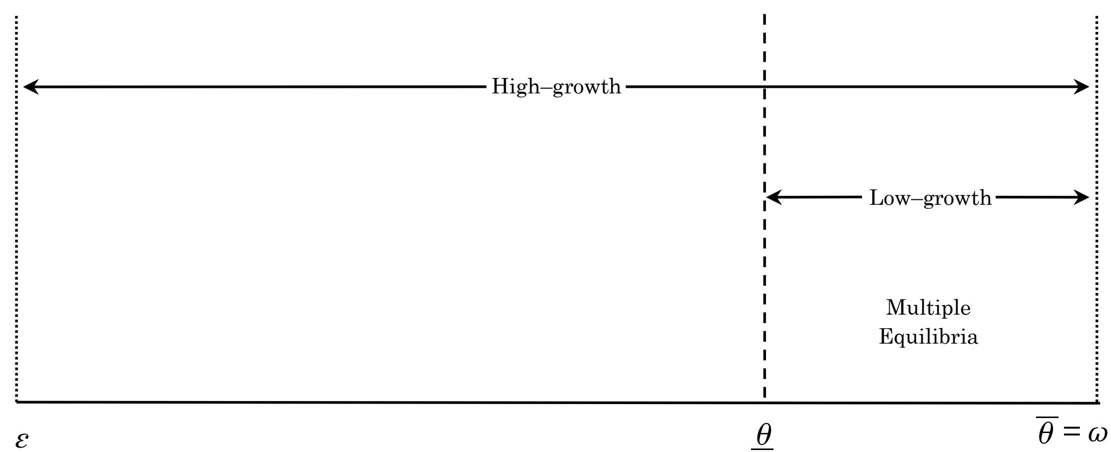

FIGURE 5

[13] For Proof, see Appendix F.

This equilibrium configuration implies that when the average initial level of human capital of agents is in the range $\bar{H} < \bar{H}_{1t} < \bar{\bar{H}}$, then the economy will always operate in the high growth regime for all sizes of government less than $\underline{\theta}$. This implies that for an intermediately high level of average initial human capital and the extent of government intervention in the economy which is not too large, agents will always opt to be honest and that there is a unique high growth equilibrium. But when the size of government exceeds $\underline{\theta}$, then agents may opt to become rent-seekers. However, since the high growth equilibrium still exists for all range of values of θ, the existence of low growth equilibrium for $\theta \geq \underline{\theta}$ does not imply that it is unique and even when $\theta \geq \underline{\theta}$ an economy may still manage to operate in the high growth equilibrium.

0.8 Comparative Statics

Now, we revisit the results obtained from our discussion so far and have another look at the characteristics of the equilibria of our model. Table 1 provides a summary of time investment in the accumulation of human and social capitals, growth rate, and aggregate output under both the high growth, as well as the low growth regime. We can see that the size of the government, θ, plays a crucial role in determining the existence of these two equilibria. A higher size of the government increases agents' incentive to seek rent and thus they invest more time in the accumulation of social capital. This is depicted by a direct relationship between q^{LG} and θ. Also, since agents' time endowment is limited, therefore by investing more time in the accumulation of social capital, agents have less time remaining for production and the accumulation of human capital in period. Therefore, a larger extent of government intervention in the economy reduces time investment by agents in the accumulation of human capital. Furthermore, since human capital is the engine of growth in our model, therefore a reduction in the accumulation of human capital retards the rate of economic growth. Moreover, we can observe that since $1-h^{HG} = \frac{\beta_t}{1+\beta_t}$ is greater than $1-h^{LG}-q^{LG} = \frac{\beta_t}{1+\beta_t}\left(\frac{1-\alpha\theta}{1+\theta}\right)$, therefore the aggregate first period output will be strictly greater in the case of high growth equilibrium and it is straightforward to see that the aggregate second period output will also be greater in the high growth case since $h^{HG} > h^{LG}$. Hence, the aggregate output (of both periods) in the high growth equilibrium will be strictly greater than the aggregate output in the low growth equilibrium.

In addition to having a bearing on the existence of the two equilibria, the extent of government intervention also affects the aggregate output indirectly in a couple of ways. Firstly, it negatively affects output through investment in social capital. A greater extent of government intervention in the economy increases time investment in social capital and due to fixed endowment of time, this implies that agents spend less time in the accumulation of human capital as well as for working for the production of the final good in period 1. Thus, due to an increase in the extent of government intervention in the economy, less of the final good is produced by the agents from generation t working in the unskilled sector which results in lower aggregate output. In addition to this, less time investment by agents in the accumulation of human capital results in inadequate second period skill-set of agents which implies that the quality of agents' 'effective labour' is poor and therefore the second period aggregate output is also low since the skilled sector produces less of final good. And as a result, the rate of growth of output is also reduced.

	High-growth regime	Low-growth regime
Size of Government, θ	$\theta \leq \bar{\theta}$	$\theta \geq \underline{\theta}$
Human capital, h_t	$h^{HG} = \frac{\beta_t}{1+\beta_t}$	$h^{LG} = \frac{\beta_t}{1+\beta_t}\left(\frac{1-\alpha\theta}{1+\theta}\right)$
Social capital, q_t	$q^{HG} = 0$	$q^{LG} = \frac{\theta(1+\alpha)}{1+\theta}$
Growth rate (of human capital)	$1 + g^{HG} = \frac{\beta_t A}{1+\beta_t}$	$1 + g^{LG} = \frac{\beta_t A}{1+\beta_t}\left(\frac{1-\alpha\theta}{1+\theta}\right)$
Aggregate Output	$Y_t^{HG} = n(1 - h^{HG}) + n(\gamma A H_{1t} h^{HG})$	$Y_t^{LG} = n(1 - h_t^{LG} - q_t^{LG}) + n(1 - z)(\gamma A H_{1t} h^{LG})$

COMPARATIVE STATICS TABLE

0.9 Conclusion

Existing empirical evidence is unable to prove the existence of a significant relationship between the extent of government intervention in an economy and its rate of economic growth. One strand of literature suggests that government intervention may result in rent-seeking, reducing production and retarding growth. Some economists argue that countries which are characterised a high level of intervention by the government (implying large potential rents) can still manage to experience high rate of economic growth when they accumulate productive capitals such has physical and human capital. It is however implausible to assume that market returns to accumulation of productive capitals in such economies are high since when government intervention is pervasive, it is less likely that individuals will be paid according to their marginal product. A recent body of literature, however, has shifted the focus towards non-markets factors which affect agents' incentive to accumulate various forms of capital. These factors include, amongst others, individuals' preferences, beliefs and values.

We model an overlapping generations economy comprising of identical individuals living for two periods who face the trade-off between investing in a 'future oriented' capital, i.e. human capital and a 'contemporaneous' capital which is manifested in the form of (unproductive) social capital. Accumulation to human capital yields return in the latter part of individuals' lives since it affects the income earned by these agents when they work in the skilled sector. On the other hand, the social capital enables agents to indulge in rent-seeking as soon as it is accumulated to develop contacts and links with certain pressure groups and lobbies in order to avoid and escape from government intervention in the economy and to divert away government revenue.

Without incorporating endogenous patience into our model, the preliminary analysis shows that a larger extent of government intervention in the economy encourages agents to accumulate the unproductive social capital since a larger size of the government translates into more rents which reduces agents' time investment in the accumulation of human capital, resulting in lower growth. Similarly, when the extent of government intervention is low enough, agents do not indulge in rent seeking since returns to human capital accumulation are greater than the available share of rents. Also, an increase in ex-ante and ex-post measures of government administrative controls increases the range of values of government size for which the high growth equilibrium exists and decreases the range of value of size of government for which the low growth equilibrium exists implying that individuals living in countries where government administrative and law enforcement institutions are strong are less likely to invest in the accumulation of unproductive social capital since higher costs to rent seeking dilute returns to the accumulation of this capital and therefore such economies experience high growth. These results are consistent with existing literature which argues that even countries that relatively less developed can experience high rate of economic growth if they build 'appropriate institutions' which help in fostering economic growth (see Gerschenkon, 1962). Similarly, Tanzi and Davoodi (1998) also argue that when some critical 'auditing' and 'controlling' institutions are weak, leading to weak institutional controls, which increases the chances of misappropriation of government resources.

These preliminary results however fail to answer the question, just like the empirical literature, that how is it possible for economies where government intervention is pervasive to experience high growth despite the fact that the size of rents on offer is considerably large. We then endogenise agents' patience by expressing it in terms of the average level of initial human capital of agents belonging to that particular generation. We assume that agents' patience exhibits threshold effects in terms of the average initial stock of human capital. This specification ensures that we capture the elements of across and within generation influence of human capital (education) on preferences in our model. The former objective is accomplished since we define patience in terms of the 'average' level of initial human capital and the latter is ensured by the fact that initial human capital of agents from any generation is equivalent to their 'inherited' human capital. In addition to that, since agents take the average initial level of human capital as given, therefore investment in patience is modelled as an indeliberate act on part of every individual agent. We show that beyond a certain threshold of average initial human capital, agents are characterised by very high level of patience where it is not optimal for agents to indulge in rent-seeking, regardless of the extent of government intervention in the economy. Therefore, in this case, agents will always opt to be honest, implying greater accumulation of human capital by successive generations and high rate of economic growth. Similarly, we show that below some very low threshold level of average initial human capital, agents are characterised by very low level of patience where it is not optimal for agents to accumulate human capital, irrespective of the size of government. As a result, in this case, agents will always opt to be rent-seekers, implying less accumulation of human capital by successive generations and low rate of economic growth. In addition to that, we also show that corresponding to intermediate levels of average initial human capital, there are intermediate levels of patience which imply the existence of multiple equilibria where low growth and high growth equilibria co-exist for different range of values of government size. Furthermore, we show that since agents do not internalise the subsequent impact of their decision to accumulate human capital on the level of patience, therefore, government policy of increasing ex-ante and ex-post institutional controls can ensure that economies with low level of education (and thus low level of patience) can still opt to invest more in the accumulation of human capital and therefore experience a high rate of economic growth, even when the extent of government intervention is large. Our results, indicating a non-monotonic relationship between government size and economic growth, are in line with empirical evidence which is unable to establish any consensus on the direction of relationship between these two variables.

0.10 Appendix A

In this Appendix, we give a detailed exposition of the proof for the existence of the high growth equilibrium. We then perform comparative static analysis of $\bar{\theta}$ with respect to β_t, z, and α.

The high growth equilibrium exists when an agent's utility of remaining honest is greater than her utility of being a rent-seeker when all others are honest.

The utility of an agent when she is honest (when everyone else is honest) is given by:

$$U_{iht}^h = \ln(1 - h_t^{HG}) + \beta_t \ln(\gamma A H_{1t} h_t^{HG})$$

where $h_t^{HG} = \frac{\beta_t}{1+\beta_t}$

The utility of the agent when she is a rent-seeker (when everyone else is honest) is given by:

$$U_{irt}^h = \ln\left[\left(1 - h_{rt}^h - q_{rt}^h\right) + (2-\alpha)\theta(1 - h^{HG})\right] + \beta_t \ln\left[(1-z)\left(\gamma A H_{1t} h_{rt}^h + (2-\alpha)\theta\gamma A H_{1t} h_t^{HG}\right)\right]$$

where $h_{rt}^h = \frac{\beta_t}{1+\beta_t}\left(\frac{1-\theta(1-\alpha)}{1+\theta}\right)$ and $q_{rt}^h = \frac{\theta(2-\alpha)}{1+\theta}$

Given the agent's utility in these two scenarios, for the high growth equilibrium to exist, we require:

$$U_{iht}^h(\gamma, A, H_{i1t}, \beta_t) \geq U_{irt}^h(\gamma, A, H_{i1t}, \beta_t, \theta, \alpha, z)$$

$$\ln(1-h_t^{HG})+\beta_t\ln(\gamma AH_{1t}h_t^{HG})\geq$$
$$\ln\left[\left(1-h_{rt}^h-q_{rt}^h\right)+(2-\alpha)\theta(1-h^{HG})\right]+\beta_t\ln\left[(1-z)\left(\gamma AH_{1t}h_{rt}^h+(2-\alpha)\theta\gamma AH_{1t}h_t^{HG}\right)\right]$$
$$\ln\left(\frac{1}{1+\beta_t}\right)+\beta_t\ln\left(\frac{\beta_t\gamma AH_{1t}}{1+\beta_t}\right)\geq$$
$$\ln\left[\frac{1}{1+\beta_t}\left(\frac{1-\theta\,(1-\alpha)}{1+\theta}\right)+\frac{(2-\alpha)\theta}{1+\beta_t}\right]+\beta_t\ln\left[(1-z)\left(\frac{\beta_t\gamma AH_{1t}}{1+\beta_t}\left(\frac{1-\theta\,(1-\alpha)}{1+\theta}\right)+\frac{\beta_t\gamma AH_{1t}}{1+\beta_t}(2-\alpha)\theta\right)\right]$$
$$\ln\left(\frac{1}{1+\beta_t}\right)+\beta_t\ln\left(\frac{\beta_t\gamma AH_{1t}}{1+\beta_t}\right)\geq$$
$$\ln\left(\frac{1+\theta+(2-\alpha)\theta^2}{(1+\beta_t)(1+\theta)}\right)+\beta_t\ln\left[\frac{\beta_t\gamma AH_{1t}(1-z)}{1+\beta_t}\left(\frac{1+\theta+(2-\alpha)\theta^2}{1+\theta}\right)\right]$$
$$\ln\left(\frac{1+\theta}{1+\theta+(2-\alpha)\theta^2}\right)-\frac{\beta_t}{1+\beta_t}\ln(1-z)\geq 0$$

Solving the above for θ results in two real roots which are:

$$\theta\leq\frac{1-\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu}\text{ and }\theta\geq\frac{1-\mu-\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu}$$

where $\mu=(1-z)^{\frac{\beta_t}{1+\beta_t}}$

Also, we can notice that the latter root $\left(\text{i.e. }\theta\geq\frac{1-\mu-\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu}\right)$ negative since $\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}$ >$1-\mu$ and we already know that $\theta\geq 0$, therefore, the condition given by this root on θ that it must be at least as large as the negative expression $\frac{1-\mu-\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu}$, is fulfilled by assumption that $0\leq\theta\leq 1$, that is the size of government is between zero and one. Thus, this root gives us a trivial condition in terms of θ and we therefore ignore it.

Hence, the former root $\left(\text{i.e. }\theta\leq\bar{\theta}=\frac{1-\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu}\right)$ is meaningful and gives us a non-trivial condition in terms of the size of government, θ, for which the high growth equilibrium exists.

Now, we perform comparative static analysis of $\bar{\theta}$ with respect to β_t, z, and α.

It must be noted that

$$\frac{\partial(1-z)^{\frac{\beta_t}{1+\beta_t}}}{\partial\beta_t} = \frac{(1-z)^{\frac{\beta_t}{1+\beta_t}}\ln(1-z)}{(1+\beta_t)^2} < 0 \text{ since } \ln(1-z) < 0$$

and also that

$$\frac{\partial(1-z)^{\frac{\beta_t}{1+\beta_t}}}{\partial z} = -\beta_t\frac{(1-z)^{\frac{\beta_t}{1+\beta_t}}}{(1+\beta_t)(1-z)} < 0$$

We find that

$$\frac{\partial\bar{\theta}}{\partial\mu} = \frac{1+3\mu-2\alpha\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{-2(2-\alpha)\mu^2\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}} < 0$$

Where the denominator is < 0, and for $\frac{\partial\bar{\theta}}{\partial\mu} < 0$, we require the numerator to be positive. So, since $1+3\mu-2\alpha\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)} \geq 0$ reduces to $\mu^2 \geq 0$ and $4(2-\alpha)^2 \geq 0$, which always hold, we thus get $\frac{\partial\bar{\theta}}{\partial\mu} < 0$

And we therefore conclude that

$$\frac{\partial\bar{\theta}}{\partial\beta_t} = \frac{\partial\bar{\theta}}{\partial\mu}\frac{\partial\mu}{\partial\beta_t} = (-)\times(-) = +$$

and that

$$\frac{\partial\bar{\theta}}{\partial z} = \frac{\partial\bar{\theta}}{\partial\mu}\frac{\partial\mu}{\partial z} = (-)\times(-) = +$$

Moving on, we find that

$$\frac{\partial\bar{\theta}}{\partial\alpha} = \frac{(1-\mu)\left[1+3\mu-2\alpha\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}\right]}{2(2-\alpha)^2\mu\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}} > 0$$

0.11 Appendix B

In this Appendix, we give a detailed exposition of the proof for the existence of the low growth equilibrium. We then perform comparative static analysis of $\underline{\theta}$ with respect to β_t, z, and α.

The low growth equilibrium exists when an agent's utility of being a rent-seeker is greater than her utility of being honest when all others are rent-seekers.

The utility of the an agent when she is a rent-seeker (when all others are rent-seekers) is given by:

$$U^r_{irt} = \ln(1 - h^{LG}_t - q^{LG}_t) + \beta_t \ln((1-z)\gamma A H_{1t} h^{LG}_t)$$

where $h^{LG}_t = \frac{\beta_t}{1+\beta_t}\left(\frac{1-\alpha\theta}{1+\theta}\right)$ and $q^{LG}_t = \frac{\theta(1+\alpha)}{1+\theta}$

Now, consider the case when the agent deviates by remaining honest when all others are rent-seekers, implying that $d_t = \frac{n-1}{n}$. The fraction of government revenue subject to appropriation, as given by eq(10), in this case becomes:

$$P_t = \frac{(n-1)(n-\alpha)}{n^2}$$

Using eq (12) the expression for the agent's consumption in period 1 becomes:

$$c_{i1t} = (1-\theta)y^u_{it} + \left[\frac{n(1+\alpha)-\alpha}{n^2}\right]\left[\frac{(n-1)\alpha\theta(1-h^{LG}_t - q^{LG}_t) + \theta(1-h_{it})}{n}\right]$$

Since the size of population of each generation is large enough $\left(\text{i.e. } \frac{1}{n} \approx 0\right)$ and also noting that $\theta(1-h_{it}) \leq 0$, the above expression can be simplified to:

$$c_{i1t} = (1-\theta)y^u_{it}$$

Similarly, using eq (14) the expression for the agent's consumption in period 2 is given by:

$$c_{i2t} = (1-\theta)y^s_{it} + \left[\frac{n^2-(n-1)(n-\alpha)}{n^2}\right]\left[\frac{(n-1)\alpha\theta\gamma A H_{1t} h^{LG}_t + \theta\gamma A H_{1t} h_{it}}{n}\right]$$

This can also be simplified to obtain:

$$c_{i2t} = (1-\theta)y_{it}^{s}$$

The agent's maximisation problem thus becomes:

$$\max_{c_{i1t},\, c_{i2t},\, h_{it}} U_{it} = \ln(c_{i1t}) + \beta_t \ln(c_{i2t})$$

subject to

$$c_{i1t} = (1-\theta)y_{it}^{u}$$
$$c_{i2t} = (1-\theta)y_{it}^{s}$$
$$y_{it}^{u} = (1-h_{it})$$
$$y_{it}^{s} = \gamma H_{i2t}$$
$$H_{i2t} = AH_{i1t}h_{it}$$
$$0 \leq h_{it} \leq 1$$

the first-order condition yields the following optimal value of time-investment in the accumulation of human capital by the honest agent when all the rest of $(n-1)$ agents have opted to act as rent-seekers:

$$h_{ht}^{r} = h_{t}^{HG} = \frac{\beta_t}{1+\beta_t}$$

Thus, the utility of the agent when she remains honest when all others are rent-seekers is obtained to be:

$$U_{iht}^{r} = \ln((1-\theta)(1-h_{t}^{HG})) + \beta_t \ln((1-\theta)\gamma AH_{1t}h_{t}^{HG})$$

Given the agent's utility in the two scenarios discussed above, for the low growth equilibrium to exist, we require:

$$U^r_{irt}(\gamma, A, H_{i1t}, \beta_t, \theta, \alpha, z) \geq U^r_{iht}(\gamma, A, H_{i1t}, \beta_t, \theta)$$
$$\ln(1 - h^{LG}_t - q^{LG}_t) + \beta_t \ln((1 - z)\gamma A H_{1t} h^{LG}_t) \geq \ln((1 - \theta)(1 - h^{HG}_t)) + \beta_t \ln((1 - \theta)\gamma A H_{1t} h^{HG}_t)$$
$$\ln\left(\frac{1}{1 + \beta_t}\left(\frac{1 - \alpha\theta}{1 + \theta}\right)\right) + \beta_t \ln\left(\frac{\beta_t \gamma A H_{1t}(1 - z)}{1 + \beta_t}\left(\frac{1 - \alpha\theta}{1 + \theta}\right)\right) \geq \ln\left(\frac{1 - \theta}{1 + \beta_t}\right) + \beta_t \ln\left(\frac{\beta_t \gamma A H_{1t}(1 - \theta)}{1 + \beta_t}\right)$$
$$\ln\left(\frac{1 - \theta^2}{1 - \alpha\theta}\right) - \frac{\beta_t}{1 + \beta_t}\ln(1 - z) \leq 0$$

Solving the above for θ results in two real roots which are:

$$\theta \leq \frac{\alpha\mu - \sqrt{(\alpha\mu)^2 + 4(1 - \mu)}}{2} \text{ and } \theta \geq \frac{\alpha\mu + \sqrt{(\alpha\mu)^2 + 4(1 - \mu)}}{2}$$

where $\mu = (1 - z)^{\frac{\beta_t}{1+\beta_t}}$

We can notice that the former root $\left(\text{i.e. } \theta \leq \frac{\alpha\mu - \sqrt{(\alpha\mu)^2 + 4(1-\mu)}}{2}\right)$ negative since $\sqrt{(\alpha\mu)^2 + 4(1 - \mu)} > \alpha\mu$, and since size of government, θ, can never be negative, therefore we ignore this negative root.

Thus, the latter root $\left(\text{i.e. } \theta \geq \underline{\theta} = \frac{\alpha\mu + \sqrt{(\alpha\mu)^2 + 4(1-\mu)}}{2}\right)$ is meaningful and gives us a non-trivial condition in terms of the size of government, θ, for which the low growth equilibrium exists.

Now we perform comparative static analysis of $\underline{\theta}$ with respect to β_t, z, and α.

From our discussion in Appendix A, we already know that

$$\frac{\partial(1 - z)^{\frac{\beta_t}{1+\beta_t}}}{\partial \beta_t} < 0$$

and also that

$$\frac{\partial(1-z)^{\frac{\beta_t}{1+\beta_t}}}{\partial z} < 0$$

We find that

$$\frac{\partial\underline{\theta}}{\partial\mu} = \frac{-2+\alpha^2\mu+\alpha\sqrt{(\alpha\mu)^2+4(1-\mu)}}{2\sqrt{(\alpha\mu)^2+4(1-\mu)}} < 0$$

Where the denominator is > 0, and for $\frac{\partial\underline{\theta}}{\partial\mu} < 0$, we require the numerator to be negative. So, since $-2+\alpha^2\mu+\alpha\sqrt{(\alpha\mu)^2+4(1-\mu)} \leq 0$ reduces to $4(1-\alpha^2) \geq 0$, which always holds, we thus get $\frac{\partial\underline{\theta}}{\partial\mu} < 0$

Therefore we can conclude that

$$\frac{\partial\underline{\theta}}{\partial\beta_t} = \frac{\partial\underline{\theta}}{\partial\mu}\frac{\partial\mu}{\partial\beta_t} = (-)\times(-) = +$$

and that

$$\frac{\partial\underline{\theta}}{\partial z} = \frac{\partial\underline{\theta}}{\partial\mu}\frac{\partial\mu}{\partial z} = (-)\times(-) = +$$

Moving on, we find that

$$\frac{\partial\underline{\theta}}{\partial\alpha} = \frac{\mu\left[\alpha\mu+\sqrt{(\alpha\mu)^2+4(1-\mu)}\right]}{2\sqrt{(\alpha\mu)^2+4(1-\mu)}} > 0$$

0.12 Appendix C

In this appendix, we derive the threshold $\overline{\overline{H}}$ of average initial human capital which implies that the high growth equilibrium exists for all $\theta \leq \omega \to 1$ and low growth equilibrium does not exist at all.

By solving

$$\frac{\alpha\mu + \sqrt{(\alpha\mu)^2 + 4(1-\mu)}}{2} \geq \omega$$

we get

$$\mu \leq \frac{1-\omega^2}{1-\alpha\omega}$$
$$(1-z)^{\frac{\beta_t}{1+\beta_t}} \leq \frac{1-\omega^2}{1-\alpha\omega}$$

Solving $(1-z)^{\frac{\beta_t}{1+\beta_t}} \leq \frac{1-\omega^2}{1-\alpha\omega}$ for H_{1t}, yields the following threshold $\overline{\overline{H}}$

$$H_{1t} \geq \overline{\overline{H}} = \left(\frac{\ln\left(\frac{1-\alpha\omega}{1-\omega^2}\right)}{\beta_0 \ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right]} \right)^{\frac{1}{\lambda}}$$

The corresponding expression for β_t is as follows

$$\beta_t \geq \overline{\overline{\beta}} = \frac{\ln\left(\frac{1-\alpha\omega}{1-\omega^2}\right)}{\ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right]}$$

The test for uniqueness of high growth equilibrium for all $H_{1t} \geq \overline{\overline{H}}$ is given in Appendix G where we determine the ranking of each of the thresholds of average initial level of human capital. In there, we prove that the ranking of $\overline{\overline{H}}$ is such that whenever $H_{1t} \geq \overline{\overline{H}}$, high growth equilibrium exists for all $\theta \leq \omega \to 1$ and that it is unique.

Now, we perform comparative static analysis of $\overline{\overline{H}}$ with respect to z and α.

Using eq (43) and expressing H_{1t} in terms of β_t, we show that H_{1t} is an increasing function of β_t

$$\frac{\partial H_{1t}}{\partial \beta_t} = \frac{1}{\lambda \beta_0} \left(\frac{\beta_t}{\beta_0} \right)^{\frac{1-\lambda}{\lambda}} > 0$$

And using the expression for $\overline{\overline{\beta}}$ derived above, we show that $\overline{\overline{\beta}}$ is a decreasing function of z

$$\frac{\partial \overline{\overline{\beta}}}{\partial z} = \frac{-1}{(1-z)} \left[\frac{\ln\left(\frac{1-\alpha\omega}{1-\omega^2}\right)}{\ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right]^2} \right] < 0$$

Therefore

$$\frac{\partial \overline{\overline{H}}}{\partial z} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \overline{\overline{\beta}}}{\partial z} = (+) \times (-) = -$$

and similarly, we show that $\overline{\overline{\beta}}$ is a decreasing function of α

$$\frac{\partial \overline{\overline{\beta}}}{\partial \alpha} = \frac{-\omega}{1-\alpha\omega} \left[\frac{\ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right] + \ln\left(\frac{1-\alpha\omega}{1-\omega^2}\right)}{\ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right]^2} \right] < 0$$

Which implies

$$\frac{\partial \overline{\overline{H}}}{\partial \alpha} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \overline{\overline{\beta}}}{\partial \alpha} = (+) \times (-) = -$$

0.13 Appendix D

In this appendix, we derive the threshold $\underset{=}{H}$ of average initial human capital which implies that the low growth equilibrium exists for all $\theta \geq \varepsilon \to 0$ and high growth equilibrium does not exist at all.

By solving

$$\frac{1-\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu} \leq \varepsilon$$

we get

$$\mu \geq \frac{1+\varepsilon}{1+\varepsilon+(2-\alpha)\varepsilon^2}$$
$$(1-z)^{\frac{\beta_t}{1+\beta_t}} \geq \frac{1+\varepsilon}{1+\varepsilon+(2-\alpha)\varepsilon^2}$$

It is apparent that for all $0 \leq \alpha \leq 1$, $\frac{1+\varepsilon}{1+\varepsilon+(2-\alpha)\varepsilon^2} \leq 0$

Solving $(1-z)^{\frac{\beta_t}{1+\beta_t}} \geq \frac{1+\varepsilon}{1+\varepsilon+(2-\alpha)\varepsilon^2}$ for H_{1t}, yields the following threshold $\underset{=}{H}$

$$H_{1t} \leq \underset{=}{H} = \left(\frac{\ln\left(\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon}\right)}{\beta_0 \ln\left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]}\right]} \right)^{\frac{1}{\lambda}}$$

The corresponding expression for β_t is as follows

$$\beta_t \leq \underset{=}{\beta} = \frac{\ln\left(\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon}\right)}{\ln\left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]}\right]}$$

Once again, it straightforward to observe that $\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon} \geq 1$. Using this, we can show that $\underset{=}{\beta} \geq 0$ for any $z \geq 0$ when $\varepsilon \to 0$.

The test for uniqueness of low growth equilibrium for all $H_{1t} \leq \underset{=}{H}$ is given in Appendix G where we determine the ranking of each of the thresholds of average initial level of human capital. In there, we prove that the ranking of $\underset{=}{H}$ is such that whenever $H_{1t} \leq \underset{=}{H}$, low growth equilibrium exists for all $\theta \geq \varepsilon \to 0$ and that it is unique.

Now, we perform comparative static analysis of $\underset{=}{H}$ with respect to z and α.

From our derivation in Appendix C, we know that

$$\frac{\partial H_{1t}}{\partial \beta_t} = \frac{1}{\lambda \beta_0} \left(\frac{\beta_t}{\beta_0} \right)^{\frac{1-\lambda}{\lambda}} > 0$$

And using the expression for $\underset{=}{\beta}$ derived above, we show that $\underset{=}{\beta}$ is a decreasing function of z

$$\frac{\partial \underset{=}{\beta}}{\partial z} = \frac{-1}{(1-z)} \left[\frac{\ln \left(\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon} \right)}{\ln \left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]} \right]^2} \right] < 0$$

Therefore

$$\frac{\partial \underset{=}{H}}{\partial z} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \underset{=}{\beta}}{\partial z} = (+) \times (-) = -$$

and similarly, we show that $\underset{=}{\beta}$ is a decreasing function of α

$$\frac{\partial \underset{=}{\beta}}{\partial \alpha} = \frac{-\varepsilon^2}{1+\varepsilon+(2-\alpha)\varepsilon^2} \left[\frac{\ln \left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]} \right] + \ln \left(\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon} \right)}{\ln \left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]} \right]^2} \right] < 0$$

Which implies

$$\frac{\partial \underset{=}{H}}{\partial \alpha} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \underset{=}{\beta}}{\partial \alpha} = (+) \times (-) = -$$

0.14 Appendix E

In this appendix, we derive the threshold $\underline{H}$ of average initial human capital which implies that there exist multiple equilibria for all $\theta \leq \bar{\theta}$ and that a unique low growth equilibrium exists for all $\theta > \bar{\theta}$.

By solving

$$\frac{\alpha\mu + \sqrt{(\alpha\mu)^2 + 4(1-\mu)}}{2} \leq \varepsilon$$

we get

$$\mu \geq \frac{1-\varepsilon^2}{1-\alpha\varepsilon}$$
$$(1-z)^{\frac{\beta_t}{1+\beta_t}} \geq \frac{1-\varepsilon^2}{1-\alpha\varepsilon}$$

Solving $(1-z)^{\frac{\beta_t}{1+\beta_t}} \geq \frac{1-\varepsilon^2}{1-\alpha\varepsilon}$ for H_{1t}, yields the following threshold $\underline{H}$

$$H_{1t} \leq \underline{H} = \left(\frac{\ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\beta_0 \ln\left[\frac{1-\varepsilon^2}{(1-z)[1-\alpha\varepsilon]}\right]} \right)^{\frac{1}{\lambda}}$$

The expression for β_t is as follows

$$\beta_t \leq \underline{\beta} = \frac{\ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\ln\left[\frac{1-\varepsilon^2}{(1-z)[1-\alpha\varepsilon]}\right]}$$

The proof for ranking of $\underline{H}$ implying that $\underline{\underline{H}} \leq \underline{H} \leq \bar{H}$ is given in Appendix G.

Now, we perform comparative static analysis of $\underline{H}$ with respect to z and α.

From our derivation in Appendix C, we know that

$$\frac{\partial H_{1t}}{\partial \beta_t} = \frac{1}{\lambda\beta_0}\left(\frac{\beta_t}{\beta_0}\right)^{\frac{1-\lambda}{\lambda}} > 0$$

And using the expression for $\underline{\beta}$ derived above, we show that $\underline{\beta}$ is a decreasing function of z

$$\frac{\partial \underline{\beta}}{\partial z} = \frac{-1}{(1-z)}\left[\frac{\ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\ln\left[\frac{1-\varepsilon^2}{(1-z)(1-\alpha\varepsilon)}\right]^2}\right] < 0$$

Therefore

$$\frac{\partial \underline{H}}{\partial z} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \underline{\beta}}{\partial z} = (+) \times (-) = -$$

and similarly, we show that $\underline{\beta}$ is a decreasing function of α

$$\frac{\partial \underline{\beta}}{\partial \alpha} = \frac{-\varepsilon}{1-\alpha\varepsilon}\left[\frac{\ln\left[\frac{1-\varepsilon^2}{(1-z)(1-\alpha\varepsilon)}\right] + \ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\ln\left[\frac{1-\varepsilon^2}{(1-z)(1-\alpha\varepsilon)}\right]^2}\right] < 0$$

Which implies

$$\frac{\partial \underline{H}}{\partial \alpha} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \underline{\beta}}{\partial \alpha} = (+) \times (-) = -$$

0.15 Appendix F

In this appendix, we derive the threshold $\bar{H}$ of average initial human capital which implies that there exists a unique high growth equilibrium for all $\theta < \underline{\theta}$ and that there exist multiple equilibria for $\underline{\theta} \leq \theta \leq \bar{\theta}$. It also implies that a unique low growth equilibrium exists for all $\theta > \bar{\theta}$.

By solving

$$\frac{1-\mu+\sqrt{(1-\mu)^2+4(2-\alpha)\mu(1-\mu)}}{2(2-\alpha)\mu} \leq \omega$$

we get

$$\mu \geq \frac{1+\omega}{1+\omega+(2-\alpha)\,\omega^2}$$
$$(1-z)^{\frac{\beta_t}{1+\beta_t}} \geq \frac{1+\omega}{1+\omega+(2-\alpha)\,\omega^2}$$

Solving $(1-z)^{\frac{\beta_t}{1+\beta_t}} \geq \frac{1+\omega}{1+\omega+(2-\alpha)\omega^2}$ for H_{1t}, yields the following threshold $\bar{H}$

$$H_{1t} \leq \bar{H} = \left(\frac{\ln\left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega}\right)}{\beta_0 \ln\left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]}\right]} \right)^{\frac{1}{\lambda}}$$

The resulting threshold of β_t, is as follows

$$\beta_t \leq \bar{\beta} = \frac{\ln\left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega}\right)}{\ln\left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]}\right]}$$

The proof for ranking of $\bar{H}$ implying that $\underline{H} \leq \bar{H} \leq \bar{\bar{H}}$ is given in Appendix G.

Now, we perform comparative static analysis of $\bar{H}$ with respect to z and α.

From our derivation in Appendix C, we know that

$$\frac{\partial H_{1t}}{\partial \beta_t} = \frac{1}{\lambda \beta_0} \left(\frac{\beta_t}{\beta_0} \right)^{\frac{1-\lambda}{\lambda}} > 0$$

And using the expression for $\bar{\beta}$ derived above, we show that $\bar{\beta}$ is a decreasing function of z

$$\frac{\partial \bar{\beta}}{\partial z} = \frac{-1}{(1-z)} \left[\frac{\ln \left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega} \right)}{\ln \left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]} \right]^2} \right] < 0$$

Therefore

$$\frac{\partial \bar{H}}{\partial z} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \bar{\beta}}{\partial z} = (+) \times (-) = -$$

and similarly, we show that $\bar{\beta}$ is a decreasing function of α

$$\frac{\partial \bar{\beta}}{\partial \alpha} = \frac{-\omega^2}{1+\omega+(2-\alpha)\,\omega^2} \left[\frac{\ln \left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]} \right] + \ln \left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega} \right)}{\ln \left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]} \right]^2} \right] < 0$$

Which implies

$$\frac{\partial \bar{H}}{\partial \alpha} = \frac{\partial H_{1t}}{\partial \beta_t} \times \frac{\partial \bar{\beta}}{\partial \alpha} = (+) \times (-) = -$$

0.16 Appendix G

Our analysis of equilibrium configurations determined by various thresholds of average initial human capital (and therefore of patience) is based on the following ordering of these thresholds:

$$\underset{=}{H} \leq \underset{-}{H} \leq \overset{-}{H} \leq \overset{=}{H}$$

which corresponds to

$$\underset{=}{\beta} \leq \underset{-}{\beta} \leq \overset{-}{\beta} \leq \overset{=}{\beta}$$

We now prove the consistency of ranking of thresholds

To begin with, we prove that $\underset{-}{\beta} \geq \underset{=}{\beta}$ which is equivalent to proving that $\underset{-}{H} \geq \underset{=}{H}$. This requires

$$\frac{\ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\ln\left[\frac{1-\varepsilon^2}{(1-z)[1-\alpha\varepsilon]}\right]} \geq \frac{\ln\left(\frac{1+\varepsilon+(2-\alpha)\varepsilon^2}{1+\varepsilon}\right)}{\ln\left[\frac{1+\varepsilon}{(1-z)[1+\varepsilon+(2-\alpha)\varepsilon^2]}\right]}$$

which results in

$$\alpha \geq \frac{-\varepsilon(1-2\varepsilon)}{1-\varepsilon(1-\varepsilon)} = \alpha_1$$

We can see that when $\varepsilon \to 0$ it implies that $\alpha \geq \alpha_1 \to 0$ and since we already know that $0 \leq \alpha \leq 1$, therefore this condition will always be fulfilled for any $\varepsilon \to 0$ and we therefore prove that $\underset{-}{\beta} \geq \underset{=}{\beta}$ and that $\underset{-}{H} \geq \underset{=}{H}$.

Moving on, we now prove that $\overset{-}{\beta} \geq \underset{-}{\beta}$ which is equivalent to proving that $\overset{-}{H} \geq \underset{-}{H}$. This requires

$$\frac{\ln\left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega}\right)}{\ln\left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]}\right]} \geq \frac{\ln\left(\frac{1-\alpha\varepsilon}{1-\varepsilon^2}\right)}{\ln\left[\frac{1-\varepsilon^2}{(1-z)[1-\alpha\varepsilon]}\right]}$$

which results in

$$\alpha \leq \frac{2\omega^2(1-\varepsilon^2)-\varepsilon^2(1+\omega)}{\omega^2(1-\varepsilon^2)-\varepsilon(1+\omega)} = \alpha_2$$

since $\varepsilon < 1$, this implies that $\varepsilon^2(1+\omega) < \varepsilon(1+\omega)$. And therefore, we can conclude that the numerator in the above condition will always exceed the denominator implying that

$$\alpha \leq 1$$

Since we already know that $0 \leq \alpha \leq 1$, therefore this condition will always be fulfilled for any we therefore prove that $\bar{\beta} \geq \underline{\beta}$ and that $\bar{H} \geq \underline{H}$.

Finally, we prove that $\bar{\bar{\beta}} \geq \bar{\beta}$ which is equivalent to proving that $\bar{\bar{H}} \geq \bar{H}$. This requires

$$\frac{\ln\left(\frac{1-\alpha\omega}{1-\omega^2}\right)}{\ln\left[\frac{1-\omega^2}{(1-z)(1-\alpha\omega)}\right]} \geq \frac{\ln\left(\frac{1+\omega+(2-\alpha)\omega^2}{1+\omega}\right)}{\ln\left[\frac{1+\omega}{(1-z)[1+\omega+(2-\alpha)\omega^2]}\right]}$$

which results in

$$\alpha \leq \frac{\omega(2\omega-1)}{1-\omega(1-\omega)} = \alpha_3$$

We can see that when $\omega \to 1$ it implies that $\alpha \leq \alpha_3 \to 1$ and since we already know that $0 \leq \alpha \leq 1$, therefore this condition will always be fulfilled for any $\omega \to 1$ and we therefore prove that $\bar{\bar{\beta}} \geq \bar{\beta}$ and that $\bar{\bar{H}} \geq \bar{H}$.

0.17 Appendix H

Provided below is the glossary of various parameters used in our paper:

n number of agents belonging to each generation

d_t proportion of dishonest agents belonging to generation t

β_t generation specific discount factor

α ex-ante institutional controls representing government administrative controls

z ex-post institutional controls representing strength of law enforcement

θ government size depicting extent of government intervention in the economy

P_t pool of government revenue subject to appropriation

A productivity of human capital technology

h_{it} amount of time invested in human capital accumulation by agent i from generation t

H_{i1t} inherited (initial) human capital of agent i from generation t

H_{i2t} accumulated (second period) human capital of agent i from generation t

H_{1t} average initial human capital of generation t

H_{2t} average accumulated human capital of generation t

B productivity of social capital technology

Q_{i0t} inherited (initial) social capital of agent i from generation t

q_{it} amount of time invested in social capital accumulation by agent i from generation t

Q_{i1t} accumulated (first period) social capital of agent i from generation t

Q_{i2t} accumulated (second period) social capital of agent i from generation t

$\bar{Q}_{0t}$ average initial social capital of generation t

$\bar{Q}_{1t}$ average accumulated (first period) social capital of generation t

$\bar{Q}_{2t}$ average accumulated (second period) social capital of generation t

y_{it}^u unskilled output produced by entrepreneur i from generation t

Y_t^u aggregate unskilled sector output produced by generation t

y_{it}^s skilled output produced by entrepreneur i from generation t

γ productivity of skilled sector production technology

Y_t^s aggregate skilled sector output produced by generation t

υ_{i1t}	share of period 1 appropriated rents of agent i from generation t
υ_{i2t}	share of period 2 appropriated rents of agent i from generation t
$\underline{\beta}_0$	minimum bound for agent's patience

0.18 References

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