Human and Social Capital Complementarities in the Presence of Credit Market Imperfections

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Abstract

This paper focuses on the individual level social capital in easing the credit market constraint which facilitates the accumulation of costly human capital. Human capital in turn affects individual income and the level of bequest, which reduces income inequality. It is shown that investment in social capital has a negative relationship with the interest rate and so the initial inherited bequest of every individual affects the output and investment in the short-run as well as in the long-run. Also, the paper shows that cross-country differences in such macroeconomic activities are due to the non-monetary cost of social exclusion from mobility which affects the long-run equilibrium.

0.1 Introduction

The significance of educational credentials for an individual's job market success is a well-established fact in labour economics. These market returns which are realized in future attract individuals to accumulate human capital today. It is due to human capital's direct effects on productivity (Lucas, 1988; Romer, 1989; Dinda, 2008) as well as indirect effect through spillovers (Nelson & Phelps, 1966; Becker & Mulligan, 1997). Thus, economic growth and income differences can be explained by differences in the levels of education (Galor & Zeirra, 1993). Also, indirect effect of human capital via social capital reduces income inequality (Glaeser, et al., 2002). This paper analyzes the role of individual level social capital in easing the credit market constraints which facilitate the accumulation of human capital. Human capital eventually affects individual income and the level of bequest, which reduces income inequality.

In underdeveloped areas, like Ethiopia, lower literacy rate is due to demand and supply factors including lack of knowledge about education's economic benefits, credit constraints and the non-availability of academic centres. In a study, it was found that parents' education is most important for children's early enrollment in school, especially mothers' education, who then have a bargaining power when it comes to children's future (Weir, 2000). Empirical evidence confirms that there exists a direct correlation between years of schooling and economic growth (Barro & Sala-i-Martin, 2004).

A screw driver being the physical capital or education being the human capital increase the productivity of individual, likewise social connections in terms of values and who knows who aids in augmenting the productivity of individuals (Imandoust, 2011). Unlike human capital which is accumulated solely, social capital is acquired between at least two people. It requires repetitive interaction with the expectation of mutual benefits being received in future. Various strands of literature focus on social capital affecting economic growth which will be discussed as follows (Putnam, 1993; Chou, 2005).

Economic literature has described social capital with multiple facets. General definition of social capital as quoted by Staveren and Knorringa (2007) is that "relations matter". In its broad form, social capital generates a social network based on trust and understanding which creates incentives for everyone to achieve a common goal efficiently. Without this shared trust, higher costs will otherwise be incurred by everyone in the society in order to verify each other (Coleman, 1990; Dinda, 2008). People who are born within a network benefit from it. Others have to invest time, effort and money to realize returns in future. Potential benefits of social capital under discussion will be for material goods and services (children's health care and education), information flow (credibility of the borrowers), trust formation (access of credit), lowering transaction costs (reduced interest rates) and complementing other capitals (human capital). Secondary benefits include moral support (for psychological happiness).

In economic history, social capital has been viewed in following manner. Coleman (1988) has stated social capital to be a public good, being underinvested but benefiting the members within that network. Putnam (1993) has used the variable in terms of membership in formal groups where northern Italy succeeded over southern Italy because of its strong association with other members of the society and civic democracy. There exists empirical evidence for social capital's positive correlation with growth which is important for our study. Knack and Keefer's (1997) findings for 29 market economies for the period 1980-1992 show that social capital measured via TRUST variable is positively correlated to growth. The variable was measured in terms of average annual growth per capita income. Glaeser et al. (2000) delineates social capital at an individual level, community level and also at macro level. In another dimension, two important features of social capital as pointed out by Dufhues et al. (2012) are: the strength of the network and the distance between a lender and borrower as to how well connected they are socially.

Several studies show the impact of social capital on development projects since it requires mutual effort from every member of the society. There are evidences where social capital resulted in those outcomes which were beneficial for people living in low-income areas. It includes Madagascar's agricultural exchange (Fafchamps & Minten, 2002), Indonesian aqua based projects (Isham & Kahkonen, 2002), Dhaka's solid waste management control (see Paragel et al., 2002), and Rajhastan's water conservation methods (Krishna & Uphoff, 2002). This confirms that social capital accumulation is profitable at least in the developing regions.

In a developed nation where parents are more aware of the economic benefits of education, only primary education doesn't make a difference due to a competitive environment. Thus, social capital accumulation has benefited the developed nations and not just the least developing countries. The growth channel, however, differs. For instance, in developed countries various firms have benefited from social collaboration with each other in terms of sharing resources, communicating the knowledge of innovation and above all risk sharing. The type of social capital explained is known as the "New Economy" of 1990s (Chou, 2006). It enables the firms to maintain competitiveness in the market by sharing profits and also by building a relation of trust through reciprocating positive actions.

In literature, social capital has also been associated with the risk managing strategy (Oyen, 2002). This is relevant to our study because individuals are encouraged to accumulate social capital so that they can build credibility and lenders can charge reduced interest rate to the low-income borrowers. Since humans want to associate themselves with each other in some way, it can help in their economic well-being by reducing uncertainty (Mueller, 1989). As mentioned before, social capital can help in overcoming crisis. A farmer can get aid from his landlord in times of crop failure or if he is suffering from a prolonged illness. These micro-level social relations actually help in allowing an individual to deal with uncertainty in other ways such as turning to the relatives or friends for financial help in times of a job loss.

Social capital is viewed with reference to pareto improvement in the society, such as through social interaction leading to an improved flow of information. It occurs when individuals do not have to incur costs to verify each other (Putnam, 1993). Occupations which require social skills, their returns to social capital investment are relatively higher, hence profitable to invest in it. At the economy level, it affects through the political channels by improving the public policies as discussed by Glaeser et al. (2002). Knack (1948) states that it facilitates credit at the micro-level (individuals have to spend less money from being exploited). Thus, the most pertinent benefit is regarding the financial development which is the focus of this paper.

The monetary benefits of social capital described above build credibility via trust factor which helps in overcoming the problem of financial constraints for those people who have lower incomes. Dufhues et al. (2012) explains the credit problems of developing countries that many profitable deals are not executed either at all or are restricted due to higher transaction costs. He also states a solution to overcome the lack of information problem, that is, the accumulation of social capital. These findings depict that social ties work better in developing countries where there are lack of property rights, poorly developed financial markets and unreliable contract enforceability. In this way, less educated people with lack of financial assets can rely on informal credit markets for a safe future due to the benefits attached with social capital accumulation (Knack & Keefer, 1997).

The important aspect of social capital which requires further discussion is its significant impact on the financial development (Chou, 2005). The main idea is that for any financial transaction without a formal documentation, we need another factor such as trust for its enforcement. Trust is the key element as it reduces the cost of transaction by increasing the level of information sharing; accelerating the rate of physical capital accumulation; increasing the effectiveness of human capital and lastly it affects economic growth and development positively (Knack & Keefer 1997; Dearmon & Grier, 2009). Empirical data collected on Italy shows that the indicators of social capital have a favourable impact on country's financial development (Guiso et.al.,2000; Helliwell & Putnam, 1995).

These activities require the economic agents to be dependent upon future actions of each other. Thus, future transactions can be executed at a lower cost if trust is already maintained. Agents do not need to divert additional resources on cross checking the borrowers. Such credit constraints prevalent in the developing countries can be overcome when individuals start participating in credit lending groups. Lenders then want to lend more to those borrowers who are better connected in the community even if the productivity of every borrower is the same (Banerjee, 2001). Dufhues (2014) run an empirical study for Northern rural Thailand whose findings state a clear negative correlation between denied access to credit and the vertical links in the community. However, the elites were able to access bigger amounts of loans due to a higher influential power. On the whole, literature purports that social capital is positively correlated to access to credit. It reinforces our viewpoint that social capital is a medium to achieve bigger goals .

We focus more on the trust intensive contracts attached with social capital which affect the development of financial market more. This exchange is dependent upon the enforceability of contracts by legal institutions but also on how much the financier will trust his financee. Therefore, such social capital accumulation can be beneficial when legal bodies are weak or amongst the less educated class. Lower educated people are the target group since they are in greater need to initiate the development of social capital. So, if the level of social capital is relatively high in the society, chances are that households may not be denied credit. This is due to the greater availability of credit instruments for everyone. With transparent information and trust, economic activity will also be positively affected (Guiso et al., 2004).

To come to think of the origin of trust, we should note that it can be based on culture, inherited from parents, from religious teachings, among people of similar castes or from legal institutions who inculcate such behavior in their citizens. If one is surrounded by trust worthy people, the level of trust in the society rises as well (Alesina & Ferrara, 2000). Element of trust is only developed once an individual has the opportunity to cheat on the other person. If everyone starts discounting their future utility highly then nobody will invest in the social capital. They will invest more time in verifying each other's activities; hence, incur more cost without the development of trust. Therefore, to gain the desired benefits, trust needs to be formed in the society (Zack & Knack, 1998). There are empirical evidences for trust and growth's positive correlation in a study by Dincer and Uslaner (2007).

Although there are different significant growth mechanisms of social capital such as improvement in material goods (health) and financial development (improved credibility of the borrowers) already being discussed, another important channel is when it aids the accumulation of other productive capitals such as human capital. This strand of literature explains interpersonal complementarities between human and social capital (Gleaser et al., 2001). Coleman (1994) was the first one to talk about social capital which influences society's human capital. When children's parents are educated, this provides them with an intellectual environment of learning. Becker (1993) has insisted on family ties which influence human capital ultimately.

Similarly, there are non-monetary benefits attached to social capital accumulation. Social connections inculcate a sense of security and happiness amongst individuals. They know that similar gratitude will be reciprocated in future. In this way, social capital can help solve the free-rider problem with everyone's cooperation (La porta et al., 1997). If a group of trust worthy people pool in money to hire a security guard to gain protection from the diseconomies of theft in their neighborhood, then everyone can gain from the controlled criminal behavior. Therefore, trust also has connections with the growth of an economy as mentioned in a study of Italy for the time region 1950-1999 (Putnam, 1995). The same relationship is also found by La porta et al. (1997) in another paper.

With enormous discussion on the economic benefits attached with human and social capital, we need to see how economic literature defines the relationship between the two. Human capital and social capital can either be competing against each other or serving the purpose of complements. In terms of substitute to each other, social capital by-passes the need to have human capital if one possesses a strong social network. It happens in a situation where everybody is competing for the same job designation but one applicant is preferred over a better qualified one only on the basis of superior social connections. In terms of complements, social capital accumulation helps in developing trust. When human capital is acquired, the interaction which takes place with teachers and peers allows an unintentional accumulation of social capital. We should note that human capital returns are realized in the future and serve as a long-term effort where as social capital returns are realized in the short-term.

Empirical evidence proves that there is a significant positive correlation between education and social capital (Glaeser et al., 2002). It is common that people who invest in one type of capital, which requires interaction with peers and teachers, also invest in other capitals, like social capital. This is because all patient individuals invest in a variety of capitals. However, there are evidences in literature which does not support this argument due to time constraints faced by every individual (Putnam, 2000).

Social capital is associated with health in some studies which posits a relationship with income. With improved medication, individuals are able to work for longer hours, hence earn more income (Kawachi, I et al., 1997). The relationship of income and social capital works two-way in this example. When referring to social skills of individuals, those businesses which are based on regular clientele need customer relationship to maintain their regular cash inflows. This infers that people who are in social occupations like an event manager will gain more by acquiring more social capital (Glaeser et al., 2001). In another context, Coleman (1988) has stressed upon the complementarity of social capital with human capital. This implies that with adequate income when higher education is acquired, individuals learn values of social cooperation which further builds their social network. This relationship with income is implicit in this context.

Many studies stress on the network building for a well-connected society which invests in social capital. These ties are only beneficial and show positive results if the network is wider. It can be explained with the help of a situation where a large number of low-income and high-income individuals consist of a society. If low-income individuals plan to borrow money from the highly-endowed individuals, there will be greater number of options to do so; otherwise a smaller society cannot help solve this problem. In that way, many low-income individuals will be relying on a small group of high-income individuals. Therefore, for social capital accumulation to be effective and diffuse efficiently, a higher-density network is preferred (Coleman, 1988; Woolock & Narayan, 2000).

Besides benefits, social capital comes with its costs. Individuals benefit within networks but they may exhibit negative externalities towards other members of the society. For instance, a large amount of social capital possession can bring about negative aspects like nepotism and lobbying (Dufhues et al., 2012) and patron-client relationship (see Szerter and Woolcock, 2004). This can be explained through an example where a used car sales person can sell lemons in the market due to his ability to convince people or through better connections. His individual social capital generates a negative externality in the community which benefits him alone. Another example is of mafias who work for their personal motives but impose uneven costs on the society as observed by Olson (1982).

Marx has pointed out that the lack of dense network amongst the French peasants was the prime reason that they were unable to abolish capitalism in the nineteenth century. Another important example from history implying the negative effects of social capital was entailing welfare losses for the other party as occurred in 1930s when Nazi party in Germany was using power against the Jewish population. When cooperation is achieved by trust and social ties, it manifests costs on other members of the society. Helliwell (1996) finds a significant negative correlation of productivity growth and group membership for seventeen OECD countries.

It has also been discussed in literature that societies that are divided in terms of language, ethnicity, and religious fractionalization or due to political polarization cannot attain maximum utility from social capital accumulation (Chou, 2006). It is because they will show loyalty only in small groups which may not be beneficial for the society at large in times of economic shocks.

Easterly and Levine (1997) have worked on the cross-country data to show that ethnic diversity affects financial growth adversely. Therefore, social capital does not always show a positive correlation with growth. Knack and Keefer (1997) also find that those countries which are less polarized in terms of ethnic diversity, trust and civic cooperation prevailed over there successfully.

Other limitations of social capital also need discussion. Not just in schools, people who work also gain social capital with everyday interaction but it starts diminishing as soon as someone leaves their job. Individuals accumulating human capital usually get higher utility from formal schooling, learning different languages or just by interacting with peers. Such skills developed overtime help in communication with others to form a friendly bond but it requires continuous maintenance. Comparably, one needs to keep investing in social capital or mobility can have adverse effects on it (Glaeser et al., 2002). Therefore, Glaeser et al. (2002) purports that with the expectation to move, social capital declines because it is difficult to keep a contact with peers when living far away. Their findings for the economic model based on an individual's optimal social capital accumulation state that there is negative correlation between mobility and social capital. They take homeownership to be the most relevant variable stating one's expectation to move or not.

Those individuals who are closely connected to a centre have higher mobility cost compared to those who are far away from the centre. By centre, we are implying a dense network of family and friends who have invested their time in building this relationship over time. The relationship is similar to what Glaeser et al. (2001) and Festinger et al. (1950) find in their studies that physical distance determine social connections. Greater this distance, social interaction between participants will be deterred. Hence, a negative relation exists between migration and social capital accumulation.

When lenders lend money, fear of absconding with money or problems of debt evasion always exists. When lenders are unaware of borrowers' credibility, this situation is known as moral hazard. In the job market, employees give signals to the employers about their ability through acquiring particular educational credentials as explained by Spence (1973) in his "job marketing signaling" theory. This helps as a sorting device and reduces uncertainty. Therefore, when one leaves the job, the social capital accumulated horizontally or vertically during the job starts diminishing as Becker (1964) mentions in his paper. Comparably, when individuals are living in a society, they form social capital by investing in time and money and without its maintenance, it starts eroding.

Another cost related to social capital is the non-monetary cost or the psychological cost of social exclusion. This type of cost is again borne when one leaves the society or membership from a group. It occurs in the form of unhappiness caused by moving to a new place, by forming new links with unknown individuals, being unable to pay back debts or it can be related to the different geographical location from the previous residence. The non-monetary cost holds significance for our paper since this cost covers those people who have been penalized and don't have access to credit due to their past debt repayment performance. Thus, due to higher degree of social connections in group borrowing, individuals fear the cost of social exclusion the most. Past experience from literature has shown that often financial indebtedness causes this kind of social exclusion (Drakeford et al., 2001).

In literature, social capital is defined as community oriented so the measurement has been aggregate mostly. There are limitations to social capital measurement; for instance, like Grameen bank's popular feature was the joint liability but we abolish this concept and focus on individual liability only because if one of the group members is always unable to pay back, others suffer a loss. Community's decisions of social capital cannot be generalized for everyone as it hinders the framework in which there can be reasoning for social capital investment. Also, when using surveys to measure the variable trust, there can be response bias, sampling error or even difficulty in translating answers.

There has been criticism in economic literature on quantifying social capital. Some studies have used the GSS (General social survey) method which measures trust by asking respondents the following question, "*Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people.*" Therefore, we emulate Bourdieu's (1983) viewpoint of social capital, as he calls it to be an influential resource of an individual which then enables him to have access to other fruitful resources.

Now from literature references, we will discuss some problems related to micro-finance and see how our model tries to fill these gaps. Basic economics teaches an important concept of diminishing marginal returns to capital. It says that those investors who have less capital will have higher returns to investment compared to those who have larger amounts of initial capital. Imagine a person selling fresh fruit on a cart is given a refrigerator to store his leftovers compared to a refrigerator bought in an already well-facilitated utility store. To those who believe that capital should naturally flow from the rich to the poor entrepreneurs will find the idea of micro lending surprising. The answer to this puzzle is simply risk. Lenders face adverse selection which is lack of information regarding the borrowers' credentials. This is why risky borrowers are charged higher interest rates in order to compensate for the additional probability of nonpayment which eventually siphon off the safe borrowers.

Banks which have catered to micro-lending in past provide limited sanctions against borrowers who can abscond with money. Other times, the requirement of well-reputed guarantors may exclude a group of well-connected potential borrowers from the market. The most relevant example of creating trust in the poor society is of the Grameen Bank of Bangladesh through social collateral. The kind of group lending which harness social collateral has had a chequered past. The idea was to bypass the obstacle of lending finance to the poor in society who cannot provide collateral. The ability of the poor to pay back credit through trust in a group eventually helps the others to benefit from the already established trust in the society. Small and medium farmers benefited the most from credit lending of the Grameen Bank who had to rely on family and friends in times of crisis (Dowla, 2006). Credit without collateral reduces the risk for the borrower and in an indirect way the cost is reduced as well. Lenders benefit only when they are able to reduce the monitoring costs of checking the reliability of their clients. Hence, investment in social capital can be a win-win situation for borrowers as well as lenders.

In past, there have been attempts by government to provide subsidies (popular during 1950s to 1980s) to the poor by putting interest rate caps as it was done in Philippines in 1981. The additional demand for loans pressurized the government to ignore the low-income groups and provide capital to some politically chosen groups only. Such government subsidies have their limitations as they push the informal lenders out of the market and highly discourage the individuals to save for future. Also, the market interest rate which serves as a rationing mechanism no longer holds in this situation. It is because the interest rate is kept very low than the market interest rate and productive agents can no longer fund their interests. Rather government is forced to provide loans to politically chosen groups (non-productive at times).

The prime focus in economics has always been human capital through education, financial capital in the form of savings and physical capital in the form of homeownership. This paper puts emphasis on social participation so that people are prepared in advance to handle trying times rather than seeking government help for corrective measures. The more people interact with peers and friends, chances are that they will manage to borrow money at a rate lower than the market rate of interest. Aghion et al. (2010) confirmed in his paper that government regulation has a negative correlation with social capital accumulation. When trust is low, people themselves want government regulation despite it being corrupt.

ROSCAs (Rotating Savings and Credit Associations) is another popular method discussed in literature when discussing micro-financing. It is just an efficient method of saving amongst family and friends. For this to work, patience is required. Usually people value the money given today than what is received tomorrow. It means for the 'early pot motive' to work, individuals are forced to save till they receive the full payment. Therefore, it doesn't allow any flexibility in savings accumulation even if a person is able to save more today than in future. There can be management issues if there are a lot of members with lengthening the life of ROSCA as well. Also, if all the bidders are seeking the pot at the time of crisis then the exercise is futile.

Considering the problems related to micro-financing discussed above, some important questions which need to be answered are: how can people gain access and realize benefits from social capital accumulation? How does social capital enhance the value of other fruitful resources such as human capital and financial capital? Will social capital allow the low-income groups of the society to borrow at a lower rate than the higher market rate? Which effective policy designs can aid in spreading the benefits from social interaction? This paper will try to find answers to these important questions through the model being built.

To cater to the prevailing problem of risk which is restrained through the development of trust and investment in social capital accumulation, we build an Overlapping Generations Model (OLG) where individuals live for two time periods. When young they maximize their utility by consumption, saving bequest for the next generation and by investing in social capital. The threshold of bequest enables one to make three types of decisions; that is, to invest in costly human capital, to borrow and invest in human capital or to remain unskilled throughout their lives with no borrowings at all. We have modelled social capital in a way that those individuals who invest in it are able to borrow at a lower rate than the market rate and this additional money allows them to invest in their well-being. However, there is no government involved which provides subsidies due to the issues already discussed before. Our model settings are based on Galor and Zeira (1993) and Glaeser, Laibson and Sacredote (2002) where we can explore the theoretical linkage between an individual's initial inheritance and human capital through social capital accumulation.

In this model, income is exhausted upon three components; consumption, bequest and social capital. First two have been discussed in the model of Galor and Zeirra (1993) where as individual social capital has been discussed in the model of Glaeser et al. (2001). Social capital jointly is not discussed along with the first two in any model up to our knowledge. With additional income generated through borrowed money, we expect the timing and composition of income spent to vary. Proportion of income spent on consumption will be categorized as non-productive whereas the proportion of income spent on social capital is productive with bequest being utilized as savings by the next generation. Higher consumption leads to an improved standard of living for the low-income groups of the society. They can spend on infrastructure, modern sanitation & water facilities or on desirable food products (Dasgupta & Maler, 1994).

This paper adds to the existing theoretical work in two significant ways. First, it develops an explicit relationship of social capital with income unlike implicit relationship described in literature. Secondly, it shows that for interest rates to vary for the low-income borrowers, social capital is essential to accumulate as individual aspect is being considered rather than aggregate. The model's results show that the interest rate is dependent upon social capital; therefore, higher social capital allows individuals to borrow at a rate that is lower compared to what is offered in the market. Also, our model assumes that borrowers' cost is dependent upon the mobility cost of individuals. Those who have sufficient social capital will try not to migrate since their movement will affect those relationships and borrowing cost will eventually increase since monitoring can become difficult by the lenders.

Moneylenders have always been an essential part of financial landscape. Therefore, it is important to classify the type of moneylenders our model is focusing upon. It includes anyone and everyone who is able to lend money to a person whose inherited bequest cannot cover the cost of costly human capital expenses. Thus, borrowed money in this model is assumed to be spending on acquiring education only to become skilled ultimately. This borrowing can be one-time or continued with one's financial needs. Individuals can benefit from additional financial resources and secure their future by building bequest. Whereas the relationship with age is such that if your peers die when you are old there may be nobody to look after you in your trying times since you have no additional resources. This also implies that social capital incurs mobility costs. At times, occupational opportunities compel people to migrate but they can carry out a benefit-cost analysis to make an informed decision.

Therefore, our model results state that various inherited bequest levels of individuals will categorize them in ranges which allow them to make optimal decisions about investment in social capital or to borrow money. Inherited bequest below the costly human capital implies that that those individuals find it optimal not to borrow money or to invest in education at all. Inherited bequest below costly education but higher than what the unskilled individuals inherit find it optimal to borrow money to become skilled. They are charged a lower interest rate compared to the market rate if they keep investing in social capital. The final range is of individuals who can finance their entire education without borrowing, this group then becomes the lenders of the society.

The rest of the paper is organized as follows: The next section gives the description of the economy being modelled with specifying an individual's behaviour and the incentive compatibility constraint that they face. We have described various components of one's income and how budget is optimally allocated among consumption, bequest and social capital. After that we discuss how social capital accumulation lowers interest rates compared to the market interest rates. We then solve for various threshold levels of bequest and define the region where agents are charged a lower interest rate with social capital accumulation. We have also performed the comparative static analysis on long-run equilibrium to see which economies are benefited the most in future. In the end, we will conclude.

0.2 Description of the Economy

0.2.1 Benchmark Model

It is assumed in this model that a small open economy produces a single product only. It is upon an individual's discretion to utilize it for consumption or for further investment. The good's production is carried out through two technologies.

The first one uses an unskilled labour which is defined as:

$$Y_t^n = w_n \, . \, L_t^n \qquad (1)$$

where Y_t^n is the unskilled output, L_t^n unskilled labour and w_n is the unkilled wage rate or the marginal productivity of labour. Also, $w_n > 0$

The second one uses skilled labour as well as capital and is defined as:

$$Y_t^s = f(L_t^s, K_t) \qquad (2)$$

where Y_t^s is the skilled output, f is a concave function with constant returns to scale, L_t^s is skilled labour and K_t is capital being used in the production of this product.

Further we assume that like human capital accumulation is decided in the first time period likewise investment in capital is made a period before and for model simplification it doesn't depreciate overtime. Wages in this sector are kept constant at w_s and they are dependent upon the ratio of capital- labour which is kept constant as well at x. If more individuals join the skilled labour then capital is automatically adjusted to keep this ratio the same. Lastly, we assume that the labour and goods market described above follow the structure of perfectly competitive firms.

Our framework for analysis on the effect of inherited bequest on one's human capital acquisition and social capital accumulation is on Galor and Zeirra (1993 & 2012). Their paper solely considers the effect of inequality on an individual's decision to become skilled or unskilled via fixed cost of human capital acquisition under likely circumstances of an imperfect credit market. The stance that they follow is regarding the interest rate which is higher for borrowers compared to the lenders due to the unavailability of perfect information regarding the borrowers. The type of division between the skilled and the unskilled labour has short-run as well as long-run consequences. This causes an adverse effect on the macroeconomic activity due to the shortage of skilled labour in the economy. Also, while the intergenerational effects persist, inequality prevails in the long-run affecting the economic prosperity of a country. This model takes shape in a different way where social capital investment lowers one's borrowing rate eventually to the world's interest rate. It occurs after reaching a certain threshold level of individual social capital beyond which everyone pays a risk-free interest rate that is the world interest rate.

0.2.2 Individuals

There is an Overlapping Generation economy of two period lived agents with inter-generational altruism. In time period 1, individual is young and in time period 2, individual is old. Parents care about their children and they leave a certain amount of bequest, b_{t+1}, for their children according to their resources. We assume that population growth is constant with one parent and one child which creates a link between two generations. Individuals within each generation are homogenous in terms of their preferences and innate abilities and heterogeneous in terms of initial bequest level which they receive from their parents. Every agent is endowed with a unitary time in every period. When young, he/she allocates his/her time between receiving education, working and accumulating social capital. Old agents spend their entire time working (either as skilled or unskilled depending upon their first time period decisions). When young agents do not acquire education they work as unskilled labour as they get old. Only if costly human capital is accumulated, they work as skilled labour when old. It all depends on their initial conditions and the market forces which lead to the division of individuals.

0.2.3 Preferences and Budget Constraint

We assume that preferences and abilities of agents are identical for time period t. Agents allocate their income towards; domestic consumption for adulthood, intergenerational funds in the form of bequest for their children and for productive social capital which has defined returns. These preferences are described in log-linear utility function as:

$$U_{i,t+1} = \alpha\log(c_{t+1}) + \beta\log(b_{t+1}) + (1-\alpha-\beta)\log R(\hat{S}).\ S_{i,t+1} \quad (3)$$

where $\alpha \in (0,1),\ \beta \in (0,1)$

Equation (3) shows the log utility of an individual for a time period, where c_{t+1} stands for consumption in the second time period, b_{t+1} is the level of inherited bequest which they carry from their parents and $R(\hat{S}).S_t$ [1] is the return on social capital which everyone receives from investing in it where $R(\hat{S})$is a differentiable function with aggregate per capita social capital.α and β are the weights assigned to consumption and $(1-\alpha-\beta)$ is the weight assigned to social capital of each individual. Individual chooses optimal investment in social capital, its level of consumption and the bequest that maximizes utility in *(3).*

The budget constraint of an individual from generation t in time period $t+1$ is:

$$y_{t+1} \geq c_{t+1} + b_{t+1} + \gamma i S_{t+1} \quad (4)$$

where $\gamma \in (0,1)$ *and it depends on index i*

y_{t+1} is the income of an individual in the next time period or when they become adults

[1]This function, log $R(\hat{S}).\ S_{i,t+1}$ is same as of Glaeser, E. et.al (2002). An economic approach to social capital. *The Economic Journal*, *112*(483), F437-F458.

From equation *(4)* we see that income of individuals, y_{t+1}, in the next time period which is when they become adults is constrained by the household consumption, the bequest for their offspring and the cost of social capital. We model individual's investment in social capital as spending time with family and friends (for example helping them in times of crisis, paying visit to them or just by calling them). Therefore, we also assume that the time cost of accumulating social capital is proportional to one's income as stated in the paper of Glaeser et al. (2002). Their model suggests that the opportunity cost of time increases for those who earn higher wages. This implies that their unit of time spent on social interaction besides work may cost them more than a person whose is unskilled and has a lower opportunity cost of time. Skilled people earning higher wages value their time more as they can be more productive than unskilled people given the same unit of time. Thus, individuals bear γw_s and γw_u which are the costs of skilled and unskilled workers respectively.

0.2.4 Optimization

Individuals maximize their utility function in equation *(3)* subject to the budget constraint in equation *(4)*. Thus,

$$\max_{c,\, b,\, S_i} \quad U_{i,t+1} = \alpha \log(c_{t+1}) + \beta \log(b_{t+1}) + (1-\alpha-\beta) \log R(\hat{S}).\ S_{i,t+1}$$

subject to:

$$y_{t+1} = c_{t+1} + b_{t+1} + \gamma_i\, S_{t+1}$$

By setting up a lagrange, we find the first-order conditions to be:[2]

$$\frac{\partial L}{\partial c} = \frac{\alpha}{c_{t+1}} = \lambda \qquad (i)$$

$$\frac{\partial L}{\partial b} = \frac{\beta}{b_{t+1}} = \lambda \qquad (ii)$$

$$\frac{\partial L}{\partial S} = \frac{1-\alpha-\beta}{S_{t+1}} = \lambda \qquad (iii)$$

$$\frac{\partial L}{\partial \lambda} = y_{t+1} = c_{t+1} + b_{t+1} + \gamma_i S_{t+1} \quad (iv)$$

Solving the first-order conditions, we find the optimal values:

$$c_{t+1}{}^{*} = \alpha y_{t+1} \tag{5}$$

$$b_{t+1}{}^{*} = \beta y_{t+1} \tag{6}$$

$$S_{t+1}{}^{*} = \frac{(1-\alpha-\beta)y_{t+1}}{\gamma_i} \tag{7}$$

By substituting in for *(γi)* optimal social capital for skilled and unskilled is defined according to their wage rate as:

$$S_i^u = \frac{(1-\alpha-\beta)y_{t+1}}{\gamma w_u} \tag{7.1}$$

$$S_i^s = \frac{(1-\alpha-\beta)y_{t+1}}{\gamma w_s} \tag{7.2}$$

From their income, a fixed fraction of α is allocated to household consumption, β fraction is allocated for intergenerational transfers while the remaining fraction *(1-α-β)* of income per respective cost (proportional to one's income) is allocated to optimal social capital accumulation. By substituting in for the optimal values from equation *(5), (6)* & *(7),* we find an indirect utility function, V_t [2]:

$$V = \alpha\log(\alpha) + \alpha\log(y_{t+1}) + \beta\log(\beta) + \beta\log(y_{t+1}) + (1-\alpha-\beta)\log R(\hat{S}) + (1-\alpha-\beta)\log(1-\alpha-\beta) + (1-\alpha-\beta)\log y_{t+1} - (1-\alpha-\beta)\log\gamma$$

$$V_t = \log y_{t+1} - (1-\alpha-\beta)\log\gamma_i + \varepsilon \tag{8}$$

Where $\varepsilon = \alpha\log\alpha + \beta\log\beta + (1-\alpha-\beta)\log(1-\alpha-\beta) + (1-\alpha-\beta)\log R(\hat{S})$

[2] For detailed working, see Appendix A

0.3 Credit Markets

The credit market for individual borrowers is such that the lending rate is higher than the borrowing rate due to the imperfect information available to lenders regarding the borrowers' credibility. To cater to this uncertainty, lenders need to monitor the borrowers if they are trust-worthy and don't abscond with money in future. Therefore, lenders' monitoring cost need to be at least positive to make sure that those borrowers don't default. This additional tracking cost needs to be covered by the lender and they are only willing to lend money at a rate that is greater than the risk-free interest rate, r.

$$i = r + z.f(S_i) \qquad (9)$$

Where i is the per unit interest rate which lender's charge. It is a sum of the risk-free per unit interest rate, r, along with the monitoring cost, z. monitoring cost is a multiplicative function with $f(S_i)$. $f(Si)$or $z=f(\frac{1}{s_i})$ this is a linear negative function. If an individual has a higher social capital, he has a higher credibility and lender incurs less resources to verify such a borrower, hence a negative relation. So the optimal interest rate at which a borrower is lent loan is equal to the risk free interest rate along with the additional monitoring cost which a lender incurs

We propose that individual lender's monitoring cost varies with the social capital of each individual. Whenever social agreement takes place among parties; individuals make sure to repay their debts in order to maintain their reputation (Stiglitz, 1991). We assume that those borrowers who are closer to centre have high social capital. Often the term 'assortive mating' is used to refer to the idea that similar kind of people form groups. In this case, individuals with high social capital are well-connected to give better signal to lenders about their credibility. Therefore, their mobility cost will also be high compared to those who live far away from the centre. Thus, lenders are better able to monitor such individuals. Eventually, this decreases lenders' monitoring cost for those who possess higher social capital.

We take into account another observation from the book of Aghion and Morduch (2005), which says that the interest rates which lenders charges also depends on the amount of borrowings. Larger transactions incur smaller administrative costs. This indicates that lenders find it feasible to give out larger amounts of money at one time rather than loaning out plenty of smaller transactions. Also, their research on informal moneylending concludes that banks do not carry that much information about the borrowers. Relatives, friends or neighbours are a good source of enforcing contracts since they know more about borrowers' credibility through their already built social capital. Hence, those with higher social capital will be charged a smaller interest rate as shown in the model below.

Had they been firms instead of individuals, monitoring cost would have been unnecessary since it is costly for firms to move. In this model, it is assumed that all individuals reside within a circle. Those who are closer to the centre have a higher level of social capital. Thus, cost of mobility for them is higher compared to those who are living far away from the centre. Thus, this cost is dependent upon the social capital of each individual. Therefore, those borrowers who have relatively higher social capital, their monitoring cost will be lower. These costs may consist of travelling expenditures, public relations or plain psychological costs (losing happiness of environment from moving away). In order to discourage borrowers from evading debt repayments, lenders keep z as high as possible.

The incentive compatibility constraint described in equation *(10)* shows that as the borrowed amount increases, monitoring and non-monitoring cost of evasion both rise and hence, the corresponding tracking cost borne by the lender rises as well.

$$d(1+i)=\beta_{m}..zf(S_i) + \beta_{nm} f(S_i) \qquad (10)$$

Where β_m and β_{nm} are the monitoring and non-monitoring costs of evasion respectively and *d(1+i)* is the interest charged on the amount borrowed. Also, *d=(b-h)*. This incentive compatibility shows that the individual will be indifferent if the total interest paid on borrowed amount is equal to the total cost of default in terms of monetary and non-monetary cost. β_m is a negative function of social capital because the lenders need to put in less effort and money in order to verify the credibility of the borrower. $\beta_{nm} = f(S_i)$ is a linear positive function because borrowers who have a higher social capital, they incur greater psychological cost of social exclusion.

When an individual leaves a network and moves away, he faces a mobility cost in terms of spending more money to keep in touch with friends and relatives. Also, he may have to incur greater traveling cost to maintain his presence in case he is a member of a prominent society or just for keeping good relations. Non-monitoring costs are also a function of one's social capital since movement from one place to another can cause psychological disturbance or cause a feeling of social exclusion. Individuals with higher social capital incur higher costs of each type which is mobility cost as well as the psychological cost. On the contrary, monitoring them becomes easier.

By solving for the incentive compatibility constraint by using eqn *(9)* and *(10),* we can find i_d:

$$i= \frac{d+r\beta_m - \beta_{nm}.Si}{(\beta_m - d)} \qquad (11)$$

$$1+i= \frac{\beta_m[1+r] - \beta_{nm}.Si}{(\beta_m - d)} \qquad (12)$$

The comparative static for $\frac{\partial(1+i)}{\partial Si}$ shows a negative relationship[3]. Equation *(11)* implies that interest rate that lender charges to individual borrowers decreases with individual social capital accumulation. However, this interest rate never becomes equal to the risk-free interest rate.

Another cost which individuals incur to become skilled is on human capital. Education is costly and its cost, *h*, is a fixed amount consisting of tuition fee, administrative cost and the books which need to be bought. In the real world, this cost is divided by giving weight to each class of labour associated with the process of human capital acquisition. For instance, the weight given to the skilled teachers is higher compared to the unskilled janitors working in the school.

Thus, it is defined as:

$$h \cong \lambda w_s + (1-\lambda) w_u$$

where $h > 0$ and $0 \leq \lambda \leq 1$

However, for model simplification, we use the combined cost of human capital as, *h*. This cost is significant in terms of the borrowing needed by an individual. If an individual inherits bequest which is sufficient enough to cover costly human capital acquisition then no money needs to be borrowed. If the case is contrary then money is borrowed to accumulate human capital.

[3] For detailed working, see Appendix B

0.4 Income of individuals

In time period 1, individuals acquire education and work in time period 2 receiving the wages of skilled labour or they can work as unskilled labour in both time periods 1 and 2. It is dependent upon the inherited bequest or/and if they invest in social capital accumulation.

If the level of inherited bequest is very low compared to the cost of education then the agents work as unskilled labour in both the periods. If this bequest is higher but not high enough to cover the fixed cost of human capital, then the individuals allocate their time in productive social capital in order to borrow funds at a lower interest rate. For those agents whose inherited bequest is high enough to cover human capital cost, they channel those resources towards acquiring education and they do not invest any time in social capital accumulation as the results will show. These agents can acquire education in time period 1 and join labour force as skilled labour in time period 2.

0.4.1 Income of an Unskilled Worker

In time period 1, when an individual is a child, if he opts to work, his compensations will be that of an unskilled worker's wage rate, w_u. At the end of time period 1, an individual receives bequest from his parents, b_t. Individuals save to consume in time period 2. Thus, when adulthood is reached income consists of childhood savings $(w_u + b_t)$, capital gains on savings $(w_u + b_t)r$, along with the current wage, w_u which they receive in time period 2. Therefore, wealth of an unskilled individual in $t+1$ will be:

$$y_{t+1}^{u} = b_t(1+r) + w_u(2+r) \cong y_{t+1}^{u}(b_t) \qquad (13)$$

0.4.2 Income of a Skilled Worker

In time period 1, when an individual is a child, if he opts to acquire education, he can then work as a skilled worker in time period 2 or when he reaches adulthood. His compensations will be that of a skilled worker's wage rate, w_s. At the end of period 1, this individual receives bequest, b_t, from his parents. The level of bequest determines one's wealth for *t+1*.

If the bequest is sufficient to cover human capital cost, *h*, that is when $(b_t-h) > 0$, the additional funds are saved for time period 2. Therefore, individual can afford to finance costly human capital and can lend the savings to make capital gains on them. Thus, income in *t+1* comprises of wage income, w_s, capital gains on savings, $(b_t-h)r$, along with the savings (b_t-h) themselves.

If the case is contrary that is when $(b_t-h) < 0$, the additional funds are borrowed at an interest rate, *i*. In time period 2, individual has to repay the loan amount with interest amount to the lender as they are unable to finance the entire cost of human capital. Thus, income in *t+1* comprises of wage income w_s, net of additional borrowings and interest charged on them, $(b_t-h)(1+i)$. Therefore, wealth of a skilled worker in *t+1* depends on the levels of b_t that they receive:

$$y_{t+1}^{s} = (b_t - h)(1+r) + w_s \qquad b_t \geq h \tag{14}$$

$$y_{t+1}^{s} = (b_t - h)(1+i) + w_s \qquad b_t \leq h \tag{15}$$

0.5 Agents' Decision Problem

Agents make a choice in the first time period whether to accumulate human capital or not based on the initial inheritance level. We make assumptions to simplify the subsequent analysis.

Assumption 1

Individuals accumulate human capital only if the utility of being skilled (b > h) is greater than that of being unskilled.

$$V_s \geq V_u$$

$$log[(b_t - h)(1+r) + w_s] + log(1-\alpha-\beta)\log R(\hat{S}) - (1-\alpha-\beta)log\gamma\, w_s \quad \geq$$

$$log[b_t(1+r) + w_u(2+r)] + (1-\alpha-\beta)\log R(\hat{S}) - (1-\alpha-\beta)log\gamma\, w_u$$

$$\frac{(b-h)(1+r)+w_s}{b(1+r)+w_u(2+\mathrm{r})} \geq \left(\frac{w_s}{w_u}\right)^{1-\alpha-\beta} \qquad (16)$$

Equation *(16)*[4] implies that if the optimal ratio of a skilled individual's income to an unskilled individual's income is greater than the ratio of their wages, they will invest in human capital and become skilled adults. This also implies that those individuals whose ratio of skilled income to unskilled income is less than the ratio of their wages, they will not acquire human capital and work as unskilled labour throughout their lives.

The third group of individuals can borrow money to invest in human capital. Therefore, the interest charged to them can decrease if they simultaneously invest in social capital as well. Individuals accumulate social capital only if the utility of being skilled (b < h) and borrowing at *(1+i),* is greater than the utility of being unskilled.

[4] For detailed working, see Appendix C

$$V_S^* \geq V_u$$

$$log[(b_t - h)(1+i) + w_s\,] - (1\text{-}\alpha\text{-}\beta)log\gamma\, w_s \quad \geq \; log[b_t(1+r) + w_u(2+r)\,] - (1\text{-}\alpha\text{-}\beta)log\gamma\, w_u$$

Simplifying the expression, we get:

$$S^* \geq S^{un}(\frac{w_u}{w_s})^{\alpha+\beta}$$

$$b_1 \;\geq$$

$$\frac{-[\gamma w_u\{\beta_m(1+r)-w_s\}-(\frac{w_u}{w_s})^{\alpha+\beta}\{h(1+r)-w_u(2+r)\}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\,\gamma w_s\beta_m]}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s-(1-\alpha-\beta)\beta_{nm}\,]}$$

$$\frac{-\sqrt{\gamma^2 w_u{}^2\{\beta_m(1+r)-w_s\}^2+(\frac{w_u}{w_s})^{\alpha+\beta^2}h^2(1+r)^2\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+\cdots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s-(1-\alpha-\beta)\beta_{nm}\,]}$$

$$\frac{\sqrt{(\frac{w_u}{w_s})^{\alpha+\beta^2}w_u{}^2(2+r)^2\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\gamma^2 w_s{}^2\beta_m{}^2-2\gamma w_u\{\beta_m(1+r)-w_s\}\ldots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s-(1-\alpha-\beta)\beta_{nm}\,]}$$

$$\frac{\sqrt{.h(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}+2\gamma w_u\{\beta_m(1+r)-w_s\}\{w_u(2+r)\}(\frac{w_u}{w_s})^{\alpha+\beta}\ldots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s-(1-\alpha-\beta)\beta_{nm}\,]}$$

$$\frac{\sqrt{.\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-2\gamma w_u\{\beta_m(1+r)-w_s\}(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\,\gamma w_s\beta_m-2(\frac{w_u}{w_s})^{\alpha+\beta^2}\ldots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s-(1-\alpha-\beta)\beta_{nm}\,]}$$

$$\frac{\sqrt{.\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2h(1+r)w_u(2+r)+2(\frac{w_u}{w_s})^{\alpha+\beta^2}h(1+r)^2\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}\ldots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s-(1-\alpha-\beta)\beta_{nm}\,]}$$

$$\frac{\sqrt{.\gamma w_s\beta_m - 2w_u(2+r)(\frac{w_u}{w_s})^{\alpha+\beta^2}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}(1+r)\gamma w_s\beta_m \ldots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{-4(1+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}[-h\gamma w_u\{\beta_m(1+r) - w_s\} + \gamma w_u w_s\beta_m \ldots}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{-w_u(2+r)h\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} - w_u(2+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}\gamma w_s\beta_m]}}{2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

(17)

Equation *(17)* shows a threshold level[5], *f*, above which all individuals invest in social capital to ease their credit constraint and invest in human capital. This means indivisible education is limited to those individuals who can afford it completely or can borrow money by reducing their interest rate to become skilled in future.

Since the initial bequest level is the determinant of an individual's future occupation, we assume that, I_t, it the distribution of inheritance of all the individuals who are born in the first time period, *t*.

$$\int_0^\infty dI_t(l_t) = L_t \qquad (18)$$

[5]For detailed working, see Appendix D

This distribution of inheritance decides the number of skilled and unskilled individuals that will be in labour force of a respective economy such that:

$$L_t^s = \int_f^{\infty} dI_t(l_t) \tag{19}$$

is the skilled labour and

$$L_t^{us} = \int_0^{f} dI_t(l_t) \tag{20}$$

is the unskilled labour

0.6 Social capital Accumulation

Once all individuals know that it is beneficial to invest in social capital, the second stage is to find the optimal investment in social capital. From equation *(7),* we find the general form of optimal investment in social capital.

Therefore, we find the optimal investment by plugging in the value of *(1+i)* from equation *(12):*

$$S^{*} = \frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m} \qquad (21)$$

Social capital increases with a higher bequest level and the second derivative being positive[6] means that social capital for those who borrow to become skilled increases in a convex manner.

We can also find the optimal investment in social capital for an unskilled and skilled individual from equation *(7.1 and 7.2):*

$$S^{un} = \frac{(1-\alpha-\beta)[b(1+r)+w_u(2+r)]}{\gamma w_u} \qquad (22)$$

$$S^{sk} = \frac{(1-\alpha-\beta)[(b-h)(1+r)+w_s]}{\gamma w_s} \qquad (23)$$

[6]For detailed working, see Appendix E

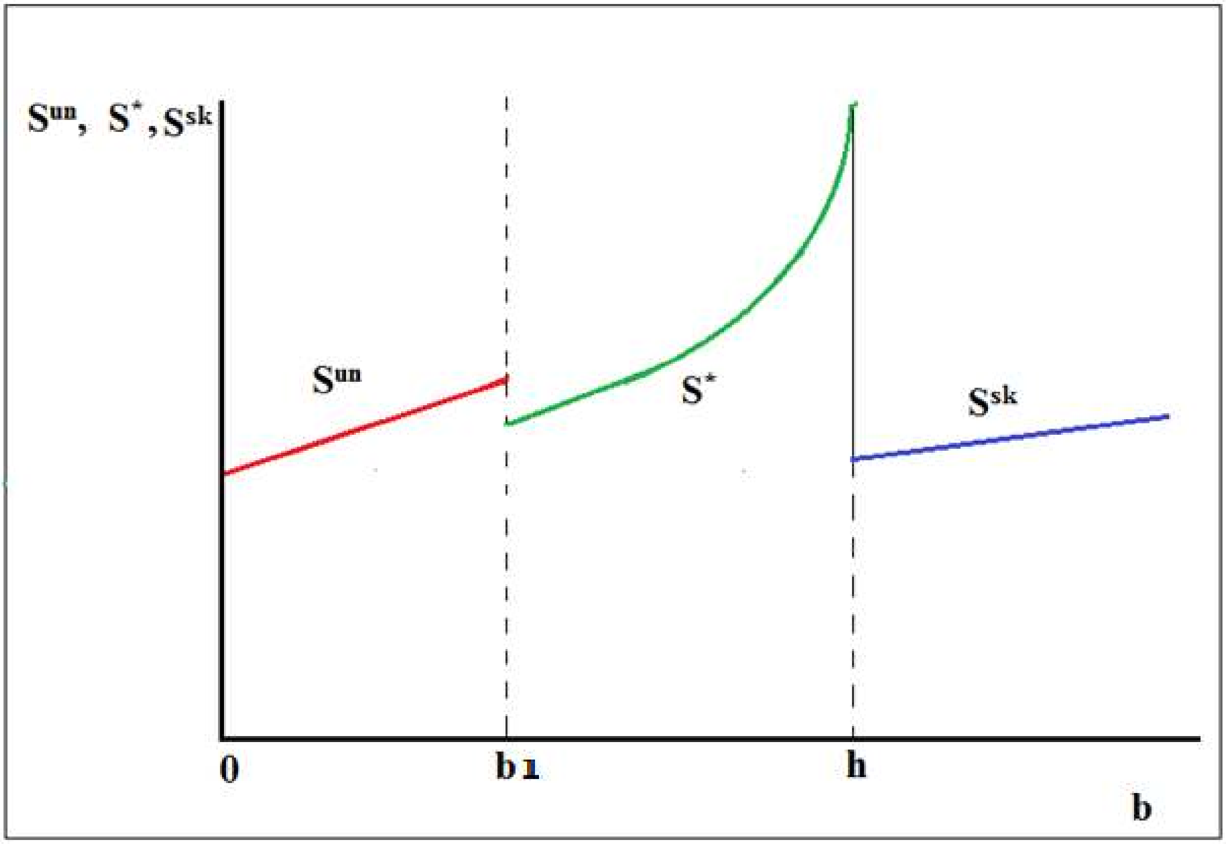


Figure 1

Figure 1[7] shows the social capital of three individuals in the society. The red portion is the social capital of an unskilled individual. The middle range in green portion shows an increasing or convex upwards social capital of those who borrow money to become skilled. The last range in blue portion shows the social capital of skilled individuals.

Since this expression was used to find the threshold b_1, $S^* \geq S^{un}(\frac{w_u}{w_s})^{\alpha+\beta}$, the social capital for unskilled individuals will scale down in Figure 1.

[7]For detailed working of graph, see Appendix F
It scales down because of the condition:

$w_s > w_u$ Therefore: $(\frac{w_u}{w_s})^{\alpha+\beta} < 1$

0.7 Zero bequest level

When an individual has to finance the entire cost of education, in that case we see whose social capital will be higher. Those who borrow money to become skilled compared to those who prefer to remain unskilled. To make this comparison simpler, we find a threshold level of non-monetary cost of social exclusion. An individual who has a non-monetary cost below this threshold will have a higher social capital by remaining unskilled versus that individual who borrows money to become skilled. If the non-monetary cost crosses this threshold level, all individuals who borrow money to become skilled will have a higher social capital versus those who prefer to remain unskilled. Thus, this condition is found by comparing:

$$S^{*}\,(b{=}0) \leq S^{un}\,(b{=}0)\,\left(\frac{w_u}{w_s}\right)^{\alpha+\beta} \tag{24}$$

$$\frac{(1-\alpha-\beta)[(-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m} \leq \frac{(1-\alpha-\beta)[b(1+r)+w_u(2+r)]}{\gamma w_u}\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}$$

$$\beta_{nm} \leq \frac{2+r[\gamma ws(h+\beta_m]-\left(\frac{w_s}{w_u}\right)^{\alpha+\beta}\gamma[-h\{\{\beta_m(1+r)-ws\}+ws\beta_m]}{(h)(2+r)(1-\alpha-\beta)} \tag{25}$$

Therefore, as long as $\beta_{nm} \leq \overline{\beta_{nm}} = S^{*}\,(b{=}0) < S^{un}\,(b{=}0)\,\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}$

0.8 Bequest Dynamics

The evolution of bequest[8] is determined by the sequence:

For an unskilled:

$$b_{t+1} = \beta\log[b(1+r) + w_u(2+r)] \quad \text{if } 0 \leq b_t \leq b_1$$

For skilled borrowers:

$$\beta\log[(b-h)(1+i) + w_s] \qquad \text{if } b_1 \leq b_t \leq h$$

For skilled:

$$\beta\log[b(1+r) + w_s] \qquad \text{if } h \leq b_t$$

Such that the long-run equilibrium for all three classes are as follows:

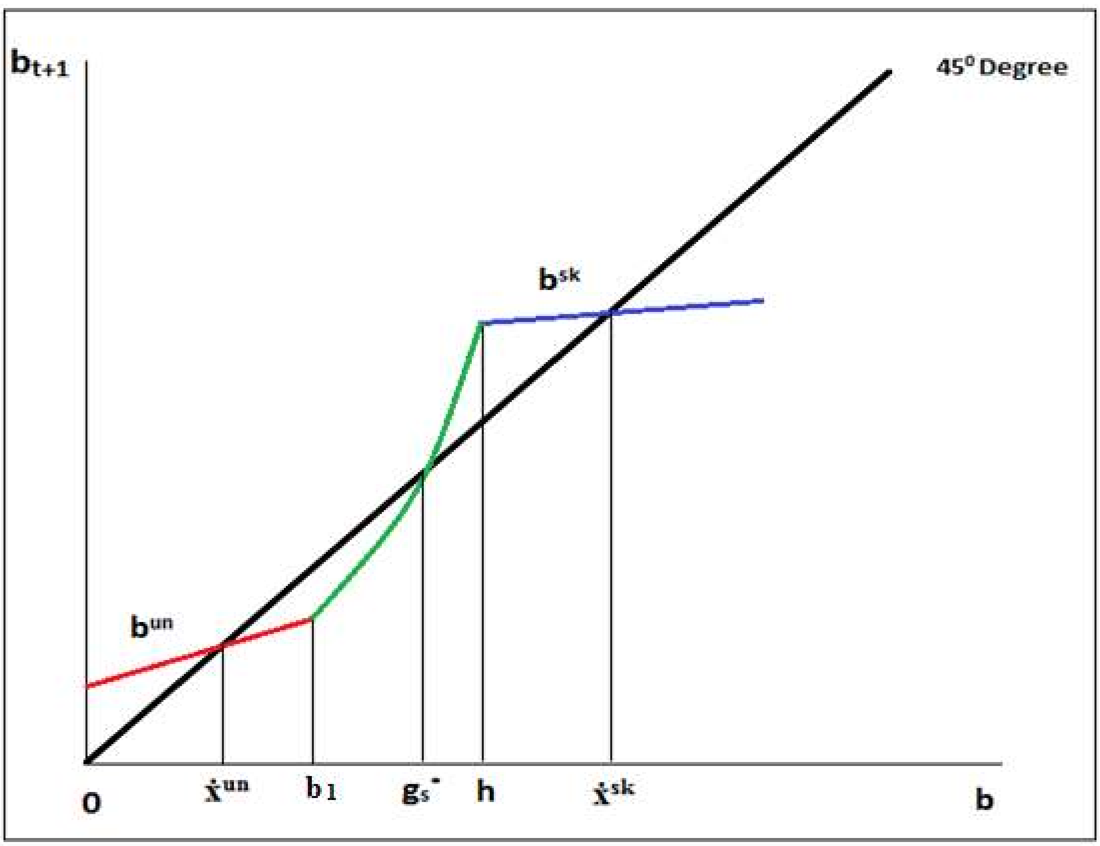


Figure 2

[8]For detailed working, see Appendix G

From Figure 2, we can see that those individuals who inherit a bequest level that is less *f* remain unskilled throughout their lives and so will their children. In the long-run, their bequest converges to the level, $\dot{x}^{un}$:

$$b = \frac{\beta[wu(2+r)]}{1-\beta b(1+r)} = b^{un} \text{ or } \dot{x}^{un} \qquad (26)$$

Those who inherit a bequest level more than *f* invest in social capital and get a reduced interest rate on borrowed money in order to accumulate costly education. Their descendants may or may not become skilled as it depends on the critical point, g_s^*.

$$b = \beta(S^*)$$

$$b = \beta\frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m}$$

$$\frac{[h(\gamma w_s-(1-\alpha-\beta)\beta_{nm}-\beta(1-\alpha-\beta)\{\beta_m(1+r)-w_s\}]}{2[\gamma w_s-(1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{+\sqrt{h^2\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+\beta^2(1-\alpha-\beta)^2\{\beta_m(1+r)-w_s\}^2 \ldots}}{2[\gamma w_s-(1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{-2h(\gamma w_s-(1-\alpha-\beta)\beta_{nm}.\beta(1-\alpha-\beta)\{\beta_m(1+r)-w_s\}+4\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}\ldots}}{2[\gamma w_s-(1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{.\beta(1-\alpha-\beta)\{h\beta_m(1+r)-w_s\beta_m\}}}{2[\gamma w_s-(1-\alpha-\beta)\beta_{nm}]} \qquad (27)$$

Individuals who inherit less than this critical point initially invest in human capital but their future generations may be unable to become skilled and so they converge to an unskilled long-run equilibrium, $\dot{x}^{un}$. Those who inherit more than this critical point, their descendants are able to become skilled and converge to the skilled long-run equilibrium level, $\dot{x}^{sk}$:

$$b = \frac{\beta[ws-h(1+r)]}{1-\beta b(1+r)} = b^s \text{ or } \dot{x}^{sk} \tag{28}$$

Proposition 1: If an economy fulfills the condition where $0< g_s^* < \dot{x}^{sk}$ then its composition of skilled and unskilled labour depends on the number of individuals who inherit less than g_s^* in time period, *t*.

(A) A poor economy which inherits less than g_s^*, converges to the long-run equilibrium of unskilled future individuals, $\dot{x}^{un}$

(B) A developed economy which inherits greater than g_s^*, converges to the long-run equilibrium of skilled future individuals, $\dot{x}^{sk}$

However, an important analysis can suggest as to which component can reduce the threshold, g_s^*, so that more skilled individuals are able to join the labour force in future.

From Figure 2, we can see that the threshold *f* and g_s^* are critical thresholds for short-run and long-run respectively. Thus, we perform a comparative static analysis to see if these thresholds can be reduced to zero.

$\frac{\partial b_1}{\partial \beta_{nm}}$ is positive $\frac{\partial gs*}{\partial \beta_{nm}}$ is negative[9]

This comparative static shows that in the short-run, a higher non-monetary cost is going to increase the threshold, b_1. This means that less people are initially aware of the benefit of social

[9]For detailed working, see Appendix H

capital. On the contrary, in the long-run, a higher non-monetary cost decreases the threshold, g_s^*. This implies that due to the benefit of better flow of information, more people are going to become skilled by borrowing at a lower interest rates well as their future descendants. However, as we said earlier that those who inherit more than g_s^*, converge to a higher long-run equilibrium, $\dot{x}^{sk}$.

The economic intuition could be that in the short-run, those who possess a bequest level, b_1, find higher utility from investing in social capital and borrowing rather than being unskilled throughout their lives. This bequest level is less than the critical point, gs^*, therefore all who inherit at least b_1 converge to the lower equilibrium where everyone is unskilled in future. On the other hand, those who possess a higher bequest level, gs^*, they converge to the equilibrium point where everyone is skilled in future. b_1 is a temporary point so it's called the short-run and gs^* is the turning point so it's the long-run.

Economic implication is that if greater number of people are able to gain education and become a part of skilled labour force, that improves the dynamics of the society such that there will be less income inequality. Also, we can incorporate another element in the utility function which could be of technological absorption and how workers can become skilled and increase their incomes without borrowing.

0.9 Conclusion

This paper is different from the conclusion which Galor and Zeira (1993) find. They conclude that the distribution of skilled and unskilled labour is solely dependent upon the initial inheritance level which also determines the aggregate output and macroeconomic equilibrium in the long-run. Those who inherit more than the critical threshold will converge to a higher long-run equilibrium. Thus, if all individuals converge to the same long-run equilibrium then the future descendants know of their bequest level. Nevertheless, our paper's focus is more on the psychological cost of social exclusion from mobility and the skilled wages which can create a difference in the long-run equilibriums. Also, for those who require additional funds to finance their education can do so by investing in social capital and getting a reduced interest rate on it.

On the whole, we can say that people accumulate social capital through repeated interaction between members of the society and the benefits are realized once cheap credit is accessed by the borrowers to invest in human capital. Effective policy by the government can be to reduce the cost of building social capital as it has multiple benefits in terms of acquiring cheap credit. Government can initiate a programme to keep a record of all the individuals which can further reduce monitoring cost of the lenders. In this way, they can verify the borrowers conveniently. Another policy design could be by the government to promote joint-financing which consider social capital as a collateral.

0.10 Appendix A

In this appendix, we give a detailed exposition of the lagrangian's calculations and the optimal values of different components.

$$\max_{c,\, b,\, S_i} \quad U_{i,t+1} = \alpha \log(c_{t+1}) + \beta \log(b_{t+1}) + (1-\alpha-\beta) \log R(\hat{S}).\ S_{i,t+1} \qquad (3)$$

subject to:

$y_{t+1} = c_{t+1} + b_{t+1} + \gamma_i S_{t+1}$

By setting up the lagrange, we find the following expression:

$L = \alpha \log(c_{t+1}) + \beta \log(b_{t+1}) + (1-\alpha-\beta) \log R(\hat{S}).\ S_{i,t+1} + \lambda\ [y_{t+1} - c_{t+1} + b_{t+1} + \gamma_i S_{t+1}\ ]$

$$\frac{\partial L}{\partial c} = \frac{\alpha}{c_{t+1}} = \lambda \qquad (i)$$

$$\frac{\partial L}{\partial b} = \frac{\beta}{b_{t+1}} = \lambda \qquad (ii)$$

$$\frac{\partial L}{\partial S} = \frac{1-\alpha-\beta}{S_{t+1}} = \lambda \qquad (iii)$$

$$\frac{\partial L}{\partial \lambda} = y_{t+1} = c_{t+1} + b_{t+1} + \gamma_i\, S_{t+1} \qquad (iv)$$

By using *equation (i) & (iii),* we find*:*

$$c_{t+1} = \frac{\alpha \gamma_i\, St+1}{1-\alpha-\beta} \qquad (A)$$

By using equation *(ii) & (iv),* we find*:*

$$b_{t+1} = \frac{\beta \gamma_i St+1}{1-\alpha-\beta} \qquad (B)$$

Plugging *(A) & (B)* in *equation (iv),* we get*:*

$$y = \frac{\alpha \gamma_i St+1}{1-\alpha-\beta} + \frac{\beta \gamma_i St+1}{1-\alpha-\beta} + \gamma_i S_{t+1}$$

$$S_{t+1}{}^{*} = \frac{(1-\alpha-\beta)y_{t+1}}{\gamma_i}$$

Plug it in *(A)* and *(B)* to find c^* and b^*

$$c_{t+1}{}^{*} = \alpha y_{t+1}$$

$$b_{t+1}{}^{*} = \beta y_{t+1}$$

The indirect utility function is calculated as:

$$V = \alpha\log(c_{t+1}) + \beta\log(b_{t+1}) + (1-\alpha-\beta)\log R(\hat{S}).\ S_{i,t+1}$$

Plug in the optimal values for consumption, bequest and social capital in the function above to find the indirect utility function.

$$V = \alpha\log(\alpha y_{t+1}) + \beta\log(\beta y_{t+1}) + (1-\alpha-\beta)\log R(\hat{S}).\ \frac{(1-\alpha-\beta)y_{t+1}}{\gamma}$$

$$V = \alpha\log(\alpha) + \alpha\log(y_{t+1}) + \beta\log(\beta) + \beta\log(y_{t+1}) + (1-\alpha-\beta)\log R(\hat{S}) + (1-\alpha-\beta)\log(1-\alpha-\beta) + (1-\alpha-\beta)\log y_{t+1} - (1-\alpha-\beta)\log\gamma$$

Simplifying the expression, we get:

$$V_t = \log y_{t+1} - (1-\alpha-\beta)\log\gamma_i + \varepsilon$$

$$\varepsilon = \alpha\log\alpha + \beta\log\beta + (1-\alpha-\beta)\log(1-\alpha-\beta) + (1-\alpha-\beta)\log R(\hat{S})$$

0.11 Appendix B

In this appendix, we will solve for the incentive compatibility constraint where an individual is indifferent between the default amount or incurring monitoring as well as non-monitoring cost.

$$d(1+i)=\beta_{m}.zf(S_i) + \beta_{nm} f(S_i)$$

Making 'z' the subject of the equation , we get:

$$zf(S_i) = \frac{d(1+i)-\beta_{nm}f(Si)}{\beta_m} \quad \textit{(z and } \beta_{nm} \textit{ are linear functions of social capital)}$$

Plugging it in equation below which shows per unit cost of interest rate which the lender charges:

$$i = r + zf(S_i)$$

$$i = r + \frac{d(1+i)-\beta_{nm}f(Si)}{\beta_m}$$

$$i\,\beta_m = r\,\beta_m - \beta_{nm}(Si) + d(1+i)$$

$$i\,\beta_m - di = r\,\beta_m - \beta_{nm}(Si) + d$$

$$i = \frac{r\beta_m + d - \beta_{nm}(Si)}{(\beta_m - d)}$$

$$1+i = \frac{\beta_m[1+r] - \beta_{nm}f(Si)}{(\beta_m - d)}$$

Note:

d=(b-h) is negative since this is the amount borrowed.

$\beta_{nm} = f(S_i)$ (linear function)

Now, we will perform the comparative static analysis on *(1+i)* with respect to non-monetary cost of social capital

$$\frac{\partial(1+i)}{\partial S_i} = \frac{-(\beta_{nm})}{(\beta_m - d)} < 0$$

Since, (b-h) is negative, the derivative becomes negative. This relationship implies that as the social capital accumulation of an individual increases, the interest charged on the amount borrowed decreases.

0.12 Appendix C

In this appendix, we find the solution to the assumption that was used in the write up.

Assumption 1 proves whether an individual invests in human capital or not. For this we compare the indirect utility of being skilled (b>h) with that of being unskilled (b<h).

$$V_s \geq V_u$$

$$log[(b_t - h)(1+r) + w_s\,] + log(1-\alpha-\beta)\log R(\hat{S}) - (1-\alpha-\beta)log\gamma\, w_s \quad \geq$$

$$log[b_t(1+r) + w_u(2+r)\,] + (1-\alpha-\beta)\log R(\hat{S}) - (1-\alpha-\beta)log\gamma\, w_u$$

By taking-anti-log, we find:

$$[(b_t - h)(1+r) + w_s\,] \geq \left(\frac{w_s}{w_u}\right)^{1-\alpha-\beta} [\,b(1+r) + w_u(2+r)\,]$$

$$\frac{(b-h)(1+r)+w_s}{b(1+r)+w_u(2+r)} \geq \left(\frac{w_s}{w_u}\right)^{1-\alpha-\beta}$$

The ratio of skilled individual's income to an unskilled individual's income is greater than the ratio of their wage rates. If this binding condition is satisfied, an individual invests in human capital.

0.13 Appendix D

The second condition shows if an individual invests in social capital or not. For this we compare the indirect utility of being skilled by borrowing (b<h) *(1+i)* with that of an unskilled individual (b<h).

Finding threshold *f* from the condition:

$$V_s^* \geq V_u$$

$$\log[(b_t - h)(1+i) + w_s] - (1\text{-}\alpha\text{-}\beta)\log\gamma\, w_s \quad \geq \log[b_t(1+r) + w_u(2+r)] - (1\text{-}\alpha\text{-}\beta)\log\gamma\, w_u$$

By taking anti-log, we find:

$$[(b_t - h)(1+i) + w_s] \geq \left(\frac{w_s}{w_u}\right)^{1-\alpha-\beta} [b(1+r) + w_u(2+r)]$$

Simplifying the expression, we get:

$$S^* \frac{\gamma w_s}{(1-\alpha-\beta)} \gtreqless S^{un}. \frac{\gamma w_u}{(1-\alpha-\beta)}. \left(\frac{w_u}{w_s}\right)^{\alpha+\beta}$$

Factoring out $\frac{\gamma}{(1-\alpha-\beta)}$

Now plug in the values for S^* and S^{un} in the expressions above:

$$(1\text{-}\alpha\text{-}\beta)\left[\frac{(b-h)\{\beta_m[1+r]-w_s\}+w_s\beta_m}{[(b-h)\{(1-\alpha-\beta)\beta_{nm}-\gamma w_s\}+\gamma w_s\beta_m]}\right] \geq \frac{(1-\alpha-\beta)}{\gamma w_u}\left(\frac{w_u}{w_s}\right)^{\alpha+\beta} [b(1+r) + w_u(2+r)]$$

$$\gamma w_u. [(b-h)\{\beta_m[1+r] - w_s\} + w_s\beta_m] \geq [(b-h)\{(1-\alpha-\beta)\beta_{nm} - \gamma w_s\} + \gamma w_s\beta_m]. \left(\frac{w_u}{w_s}\right)^{\alpha+\beta} [b(1+r) + w_u(2+r)]$$

$$\gamma w_u. [(b-h)\{\beta_m(1+r) - w_s\}] + \gamma w_u w_s\beta_m] \geq$$

$$(\frac{w_u}{w_s})^{\alpha+\beta}\ [b(1+r)].\ [(b-h)\{(1-\alpha-\beta)\beta_{nm}-\ \gamma w_s\}+\gamma w_s\beta_m].\ +$$

$$(\frac{w_u}{w_s})^{\alpha+\beta}.\ w_u(2+r)\ [(b-h)\{(1-\alpha-\beta)\beta_{nm}-\ \gamma w_s\}+\gamma w_s\beta_m]$$

Note:

We assume: $\gamma w_s > (1-\alpha-\beta)\beta_{nm}$ throughout our analysis:

$$b^2\ (1+r)\ (\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}$$

$$+b[\gamma w_u\{\beta_m(1+r)-w_s\}-h(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s\beta_m+wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}]$$

$$+[-\gamma w_u.h\{\beta_m(1+r)-w_s\}+\gamma w_u w_s\beta_m-wu(2+r)h(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s\beta_m]$$

Checking if the positive/negative root is $\gtreqless h$

$$f_{positive} \gtreqless h$$

$$\frac{-b+\sqrt{b^2-4ac}}{2a} \gtreqless h$$

$$f_{positive} \gtreqless h$$

$$\frac{-b+\sqrt{b^2-4ac}}{2a} \gtreqless h$$

$$b^2-4ac \gtreqless (2ah+b)^2$$

$$b^2 - 4ac \gtreqless (4a^2h^2 + b^2 + 4ahb)$$

$$-c \gtreqless ah^2 + bh$$

$$-[-\gamma w_u.h\{\beta_m(1+r) - w_s\} + \gamma w_u w_s \beta_m - wu(2+r)h(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} -$$

$$wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s \beta_m] \quad \gtreqless$$

$$h^2 (1+r) (\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} + h\,\gamma w_u\{\beta_m(1+r) - w_s\} - h^2(1+$$

$$r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} - h(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s\beta_m + hwu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s -$$

$$(1-\alpha-\beta)\beta_{nm}\}]$$

$$-\gamma w_u w_s \beta_m + wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s \beta_m \gtreqless -h(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s \beta_m$$

Factoring out $\gamma w_s \beta_m$:

$$w_u\ [(2+r)(\frac{w_u}{w_s})^{\alpha+\beta} - 1] \gtreqless -h(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}$$

Since, L.H.S > R.H.S , the positive root > h

$$f_{negative} \gtreqless h$$

$$\frac{-b - \sqrt{b^2 - 4ac}}{2a} \gtreqless h$$

$$-b^2 + 4ac \gtreqless (2ah + b)^2$$

$$-b^2 + 4ac \gtreqless (4a^2h^2 + b^2 + 4ahb)$$

$$2ac \gtreqless 2a^2h^2 + b^2 + 2ahb$$

Plugging in the values:

$$2(1+r)\,(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}[-\gamma w_u.h\{\beta_m(1+r)-w_s\}+\gamma w_u w_s\beta_m-wu(2+r)h(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s\beta_m]\gtreqless$$

$$h^2(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+\gamma^2{w_u}^2\{\beta_m(1+r)-w_s\}^2$$

$$+\ h^2(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\gamma^2{w_s}^2{\beta_m}^2$$

$$+{w_u}^2(2+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}-2\gamma w_u\{\beta_m(1+r)-w_s\}.h(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-2\gamma^2 w_u\{\beta_m(1+r)-w_s\}.\{(1+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta^2}w_s\beta_m\}+\ 2\gamma{w_u}^2(2+r)\{\beta_m(1+r)-w_s\}.(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}\ +2h(1+r)^2\left(\frac{w_u}{w_s}\right)^{\alpha+\beta^2}\gamma w_s\beta_m.\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-2h(1+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta^2}.wu(2+r).\ \{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2-2\left(\frac{w_u}{w_s}\right)^{\alpha+\beta^2}(1+r).wu(2+r).\gamma w_s\beta_m.\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2$$

$$+2(1+r)\,(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}h\,\gamma w_u\{\beta_m(1+r)-w_s\}-2h^2(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2-2(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}.\gamma w_s\beta_m.\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}+2(1+r)\ h(\frac{w_u}{w_s})^{\alpha+\beta^2}wu(2+r)\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2$$

Solving the expression, we get:

Therefore,

$$2(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}\gamma w_u w_s\beta_m[\,1-2(\frac{w_u}{w_s})^{\alpha+\beta}]$$

$$\gtreqless$$

$$2\ h^2(1+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+\gamma^2 w_u{}^2\{\beta_m(1+r)-w_s\}^2\ (1+$$

$$r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\gamma^2 w_s{}^2\beta_m{}^2\ +w_u{}^2(2+r)^2(\frac{w_u}{w_s})^{\alpha+\beta^2}\ +2\gamma w_u{}^2(2+r)\{\beta_m(1+r)-w_s\}\,.\,(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-$$

$$(1-\alpha-\beta)\beta_{nm}\}-2\gamma^2 w_u\{\beta_m(1+r)-w_s\}.\{(1+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta^2}w_s\beta_m\}+2(1+r)\ (\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s-$$

$$(1-\alpha-\beta)\beta_{nm}\}h\,\gamma w_u\{\beta_m(1+r)-w_s\}$$

$$-2\left(\frac{w_u}{w_s}\right)^{\alpha+\beta^2}(1+r).\,wu(2+r).\,\gamma w_s\beta_m.\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2+2(1+r)\ h(\frac{w_u}{w_s})^{\alpha+\beta^2}wu(2+$$

$$r)\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}^2$$

L.H.S is negative due to the term $1<2(\frac{w_u}{w_s})^{\alpha+\beta}$ and R.H.S is positive.

$$\text{Therefore,}\ f_{negative}<h$$

This threshold depicts that whoever inherits a bequest level beyond f finds it optimal to invest in social capital irrespective of their occupation.

0.14 Appendix E

In this appendix, we find the optimal investment in social capital given the individuals borrow money. Since interest rate is a function of social capital and general form of social capital is a function of interest rate, we will solve them simultaneously.

$$1+i=\frac{\beta_m[1+r]-\beta_{nm}.Si}{d(\beta_m-1)}$$

$$S=\frac{(1-\alpha-\beta)[(b-h)(1+i)+ws]}{\gamma w_s}$$

By plugging in the value for *(1+i)* in the equation for optimal investment in social capital, we find S^*:

$$S=\frac{(1-\alpha-\beta)[(b-h)(\frac{\beta_m[1+r]-\beta_{nm}.Si}{(b-h)(\beta_m-1)})+ws]}{\gamma w_s}$$

$$S^*=\frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{-(b-h)[\gamma w_s-(1-\alpha-\beta)]+\gamma w_s\beta_m}$$

$\beta_{nm}=Si$ (linear function)

Note:

We assume $\gamma w_s>(1-\alpha-\beta)$ and b<h in this case

To check the functional form of S^*, we find the first and second derivative.

$$\frac{\partial S^*}{\partial b}=$$

$$\frac{[-(b-h)\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}+\gamma w_s\beta_m].\{\beta_m(1+r)-ws\}.(1-\alpha-\beta)-[(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]...}{[-(b-h)\{\gamma w_s-(1-\alpha-\beta)\}+\gamma w_s\beta_{nm}]^2}$$

$$\frac{[.-(b-h)\{\gamma w_s-(1-\alpha-\beta)\}}{[-(b-h)\{\gamma w_s-(1-\alpha-\beta)\}+\gamma w_s\beta_{nm}]^2}$$

Checking numerator for the sign:

$$[-(b-h)\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} + \gamma w_s\beta_m].\{\beta_m(1+r) - ws\}.(1-\alpha-\beta)$$

$$\gtreqless -[(1-\alpha-\beta)[(b-h)\{\beta_m(1+r) - ws\} + ws\beta_m](b-h)\{\gamma w_s$$

$$-(1-\alpha-\beta)$$

Factoring out: $(1-\alpha-\beta)$, we get:

$$\gamma w_s\beta_m{}^2(1+r) - \gamma w_s{}^2\beta_m \gtreqless w_s\beta_m(1-\alpha-\beta)\beta_{nm} - \gamma w_s{}^2\beta_m$$

$$\gamma\beta_m(1+r) > (1-\alpha-\beta)\beta_{nm}$$ is positive

$\frac{\partial S^*}{\partial b}$ = +ve

Keeping $\frac{\partial S^*}{\partial b}$ = 0, we get 0. Thus, function is minimum at value of

$$S^* = \frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s+]+\gamma ws\beta_m}$$ when b=0

$\frac{\partial^2 S^*}{\partial b^2}$ =

Taking $\gamma\beta_m(1+r) > (1-\alpha-\beta)\beta_{nm}$ from the first derivative as A (+ve value)

$$\frac{A}{[-(b-h)\{\gamma w_s - (1-\alpha-\beta)\} + \gamma w_s\beta_{nm}]^2}$$

$$A.[-(b-h)\{\gamma w_s - (1-\alpha-\beta)\} + \gamma w_s\beta_{nm}]^{-2}$$

$$\frac{-2A(-1)\{\gamma w_s - (1-\alpha-\beta)[-(b-h)\{\gamma w_s - (1-\alpha-\beta)\} + \gamma w_s\beta_{nm}]}{[-(b-h)\{\gamma w_s - (1-\alpha-\beta)\} + \gamma w_s\beta_{nm}]^3}$$

Since, $\gamma w_s > (1-\alpha-\beta)$ *and* $b < h$ so the derivative is positive

$\frac{\partial S^*}{\partial b}$, $\frac{\partial^2 S^*}{\partial b^2}$ both are positive which implies S^* is convex upwards. Also, there are two roots of threshold *f*. Therefore, we proved in Appendix D that the positive root comes after h whereas the negative root is less than h.

0.15 Appendix F

In this section, we try to find the intersection points of S^{un}, S^{sk}, S^{*} . Also, their slopes and intercepts in order to perform a graphical analysis.

$$S^{un} = \frac{(1-\alpha-\beta)[b(1+r)+w_u(2+r)]}{\gamma w_u}$$

$$S^{sk} = \frac{(1-\alpha-\beta)[(b-h)(1+r)+w_s]}{\gamma w_s}$$

$$S^{*} = \frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s+]+\gamma ws\beta_m}$$

Slopes:

$$\frac{\partial\, S^{un}}{\partial b} = \frac{(1-\alpha-\beta)}{\gamma w_u} > 0$$

$$\frac{\partial\, S^{sk}}{\partial b} = \frac{(1-\alpha-\beta)}{\gamma w_s} > 0$$

$$\frac{\partial\, S^{un}}{\partial b} = \frac{\gamma w_s {\beta_m}^2(1+r)-w_s\beta_m(1-\alpha-\beta)\beta_{nm}}{[-(b-h)\{\gamma w_s-(1-\alpha-\beta)\}+\gamma w_s\beta_{nm}]^2} > 0$$

$$\text{Slope } S^{un} \gtreqless S^{sk}$$

$$\frac{(1-\alpha-\beta)}{\gamma w_u} \gtreqless \frac{(1-\alpha-\beta)}{\gamma w_s}$$

$$w_s \gtreqless w_u$$

$$\text{Therefore, Slope } S^{un} > S^{sk}$$

Since skilled wages are greater than the unskilled wages. Slope of S^{un} *is* > S^{sk}

Intercepts:

$$S^{un}(0) = \frac{(1-\alpha-\beta)[(2+r)]}{\gamma}$$

$$S^{sk}(0) = \frac{(1-\alpha-\beta)[(-h)(1+r)+w_s]}{\gamma w_s}$$

$$\text{Intercept } S^{un} \gtreqless S^{sk}$$

$$\frac{(1-\alpha-\beta)[(2+r)]}{\gamma} \gtreqless \frac{(1-\alpha-\beta)[(-h)(1+r)+w_s]}{\gamma w_s}$$

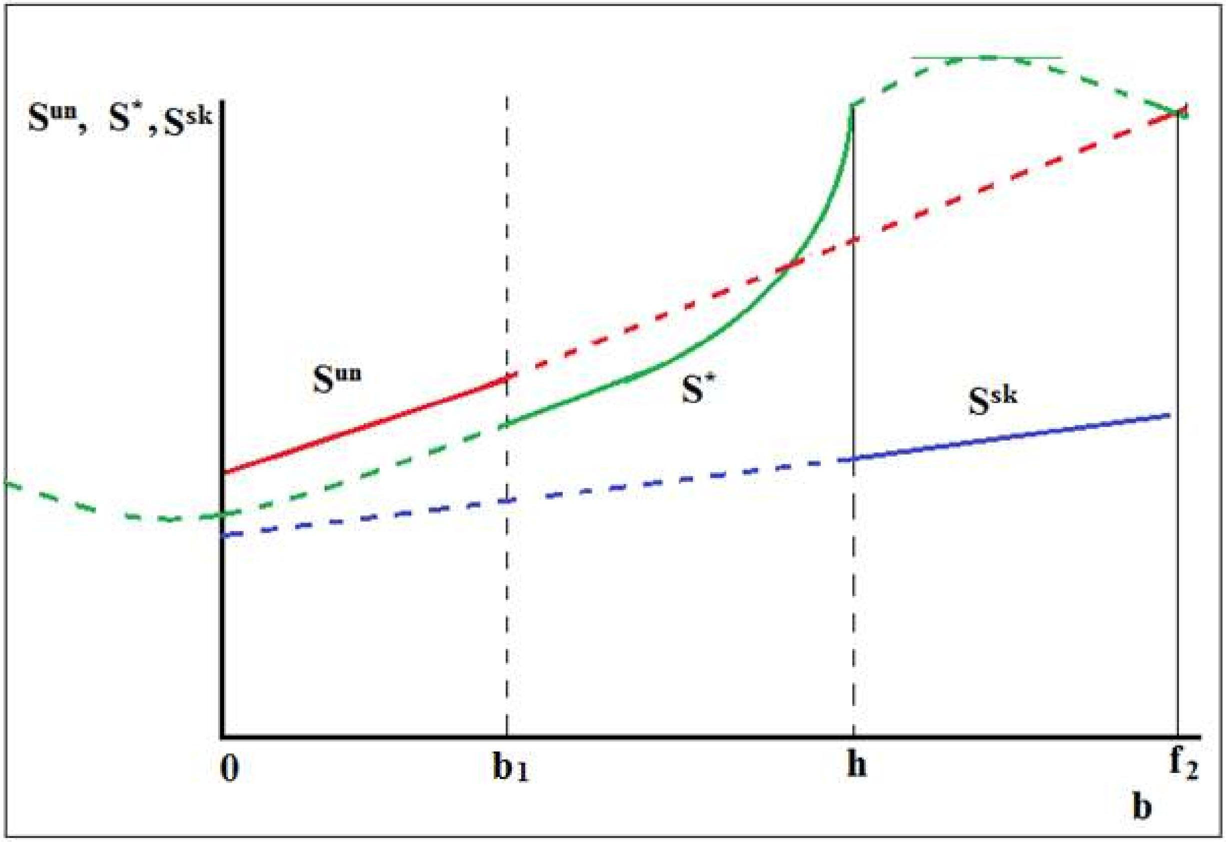
$$w_s(2+r) \gtreqless (-h)(1+r) + w_s$$

$$w_s \gtreqless (-h)$$

$$\text{Therefore, Intercept } S^{un} > S^{sk}$$

$$S^{*}(0) = \frac{(1-\alpha-\beta)[(-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m}$$

This provides a graphical representation of three kinds of social capital of individuals.



The red solid line shows the steeper social capital of an unskilled individual.

Since, we are using a scaler $(\frac{w_u}{w_s})^{\alpha+\beta} < 1$ to calculate intersection of S^{un} and S^*; therefore, it will scale down proportionately in order to intersect with S^*. The green solid line is of S^* which is convex upwards and it's point of inflection comes after *h.* The positive root, *f,* is greater than *h* too. Hence, we are only considering the portion before threshold *h*. The blue solid line is social capital of a skilled individual. Its slope is flatter than the unskilled individual's social capital. Since these individuals can afford costly education, their intersection comes after *h* cost.

Keeping $\frac{\partial S^*}{\partial b} = 0$, we get 0. Thus, function is minimum at value of

$$S^* = \frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m} \text{ when b=0}$$

We will now prove if $S^*(b=0) \gtreqless S^{un}\ (b=0)\ (\frac{w_u}{w_s})^{\alpha+\beta}$

$$\frac{(1-\alpha-\beta)[(-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m} \gtreqless \frac{(1-\alpha-\beta)[(2+r)]}{\gamma} (\frac{w_u}{w_s})^{\alpha+\beta}$$

$$(\frac{w_u}{w_s})^{\alpha+\beta} < \frac{(2+r)[(-h)\{(1-\alpha-\beta)\beta_{nm}-\gamma w_s\}+\gamma ws\beta_m\ \{\beta_m(1+r)-ws\}+ws\beta_m]}{\gamma[(-h)\{\beta_m(1+r)-ws\}+ws\beta_m}$$

If this condition is satisfied, at bequest level = 0, $S^*(b=0) < S^{un}\ (b=0)\ (\frac{w_u}{w_s})^{\alpha+\beta}$

At the intersection, b=h, we prove if $S^*(b=h) \gtreqless S^{un}\ (b=h)\ (\frac{w_u}{w_s})^{\alpha+\beta}$

$$\frac{(1-\alpha-\beta)ws\beta_m]}{\gamma ws\beta_m} \gtreqless \frac{(1-\alpha-\beta)[h(1+r)+w_u(2+r)]}{\gamma w_u} (\frac{w_u}{w_s})^{\alpha+\beta}$$

$$1 \gtreqless \frac{[h(1+r)+w_u(2+r)]}{w_u} (\frac{w_u}{w_s})^{\alpha+\beta}$$

$$(\frac{w_s}{w_u})^{\alpha+\beta} > \frac{[h(1+r)+w_u(2+r)]}{w_u}$$

Or

$$w_s > [\frac{\{h(1+r)+w_u(2+r)\}}{w_u}]^{\frac{1}{\alpha+\beta}}.\ w_u$$

Thus, at the intersection b=h, $S^* > S^{un}(\frac{w_u}{w_s})^{\alpha+\beta}$. Due to this binding condition, even if the condition, $S^*(b=0) < S^{un}\ (b=0)\ (\frac{w_u}{w_s})^{\alpha+\beta}$ is not satisfied, it will not change our results.

0.16 Appendix G

In this appendix, we will show the calculations for the long-run equilibrium of unskilled as well as the skilled individuals. This will be calculated using optimal value of bequest and the income which corresponds to each category of workers. This is shown below as:

Long-run equilibrium of an unskilled individual is:

$$b=b_{t+1}$$

$$b=\beta\ (y_{t+1})$$

$$b=\beta[b(1+r)+w_u(2+r)]$$

$$b-\beta b(1+r)=\beta w_u(2+r)$$

$$b=\frac{\beta[wu(2+r)]}{1-\beta b(1+r)}=b_u \text{ or } \dot{x}^{un}$$

Long-run equilibrium of skilled individual is:

$$b=b_{t+1}$$

$$b=\beta(y_{t+1})$$

$$b=\beta[(b-h)(1+r)+w_s]$$

$$b-\beta b(1+r)=\beta[w_s-h(1+r)]$$

$$b=\frac{\beta[ws-h(1+r)]}{1-\beta b(1+r)}=b_s \text{ or } \dot{x}^{sk}$$

Finding the critical point, g_s^*

$$b = \beta(S)^*$$

$$b = \beta[\frac{(1-\alpha-\beta)[(b-h)\{\beta_m(1+r)-ws\}+ws\beta_m]}{(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m}]$$

$$b\,[(b-h)[(1-\alpha-\beta)\beta_{nm}-\gamma w_s]+\gamma ws\beta_m]= \beta\,(1-\alpha-\beta)[[(b-h)\{\beta_m(1+r)-ws\}+ws(\beta_m)]$$

$$-b^2\,[\gamma w_s-(1-\alpha-\beta)\beta_{nm}]+b\,[h\{\gamma w_s-(1-\alpha-\beta)\beta_{nm}\}-\beta\,(1-\alpha-\beta)\{\beta_m(1+r)-ws\}+\gamma ws\beta_m\,]+[\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r)-ws\}-\beta\,(1-\alpha-\beta)ws(\beta_m)]$$

Now, we will prove that the positive root will be higher than h so we will consider the lower/negative root only just like for *f* threshold.

$$g_{spositive}^* \gtreqless h$$

$$-c \gtreqless ah^2 + hb$$

$$-\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r)-ws\}+\beta\,(1-\alpha-\beta)ws(\beta_m)] \gtreqless [-h^2[\gamma w_s-(1-\alpha-\beta)\beta_{nm}] + h^2[\gamma w_s-(1-\alpha-\beta)\beta_{nm}] - h\beta\,(1-\alpha-\beta)\{\beta_m(1+r)-ws\} + h\gamma ws\beta_m$$

$$\beta\,(1-\alpha-\beta)ws\beta_m \gtreqless h\gamma ws\beta_m$$

$$\beta\,(1-\alpha-\beta) \gtreqless h\gamma$$

L.H.S > R.H.S thus, we ignore the positive root.

$$g_{snegative}^* \gtreqless h$$

$$2ac \gtreqless 2a^2h^2 + b^2 + 2ahb$$

$$-2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}].\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r) - ws\} + 2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}].[\beta\,(1-\alpha-\beta)ws(\beta_m)]$$

$$\gtreqless$$

$$+2h^2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]^2 + h^2\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}^2 + \beta^2(1-\alpha-\beta)^2\{\beta_m(1+r) - ws\}^2 + \gamma^2 {w_s}^2 {\beta_m}^2 - 2h\beta\,(1-\alpha-\beta)\{\beta_m(1+r) - ws\}.\{(1-\alpha-\beta)\beta_{nm} - \gamma w_s\} + 2h[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]\gamma w_s \beta_m - 2\beta\,(1-\alpha-\beta)\{\beta_m(1+r) - ws\}\gamma w_s \beta_m - 2h^2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]^2 - 2h[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]\gamma w_s \beta_m + 2h[\gamma w_s - (1-\alpha-\beta)\beta_{nm}].\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r) - ws\}$$

Simplifying the expression:

$$-2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}].[\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r) - ws\} - \beta\,(1-\alpha-\beta)ws(\beta_m)]$$

$$\gtreqless$$

$$h^2(1-\alpha-\beta)\beta_{nm} - \gamma w_s\}^2 + \beta^2(1-\alpha-\beta)^2\{\beta_m(1+r) - ws\}^2 + \gamma^2 {w_s}^2 {\beta_m}^2 - 2\beta\,(1-\alpha-\beta)\{\beta_m(1+r) - ws\}\gamma w_s \beta_m$$

Since $\gamma w_s > (1-\alpha-\beta)\beta_{nm}$, we get:

L.H.S < R.H.S

Therefore, we will consider the negative root which is:

$$\frac{[h\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} - \beta(1-\alpha-\beta)\{\beta_m(1+r) - w_s\} + \gamma w_s \beta_m]}{2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{+\sqrt{h^2\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}^2 + \beta^2(1-\alpha-\beta)^2\{\beta_m(1+r) - w_s\}^2 + \gamma^2 {w_s}^2 {\beta_m}^2 \ldots}}{2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{-2h\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}.\beta(1-\alpha-\beta)\{\beta_m(1+r) - w_s\} + h\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}\gamma w_s \beta_m ..}}{2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{-2\gamma w_s \beta_m \beta(1-\alpha-\beta)\{\beta_m(1+r) - w_s\} + 4\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} \ldots}}{2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

$$\frac{\sqrt{.\beta(1-\alpha-\beta)h\{\beta_m(1+r) - w_s\} + 4\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} w_s \beta_m\}}}{2[\gamma w_s - (1-\alpha-\beta)\beta_{nm}]}$$

0.17 Appendix H

In this appendix, we will perform the comparative analysis on g_s^* to see which variable can reduce these short-run and long-run equilibriums.

We will derivate the first part of the fraction:

$$\frac{\partial gs*}{\partial w_s} =$$

Hence, the derivative is negative. Higher skilled wages decrease the long-run threshold.

Shorter proof of the derivation:

Since, this is lower root so we simplify it accordingly to find the relationship:

$$\frac{-b-\sqrt{b^2-4ac}}{2a} \gtreqless 0$$

$$-b \gtreqless \sqrt{b^2-4ac}$$

$$b^2 \gtreqless b^2-4ac$$

$$0 \gtreqless -4ac$$

$$\frac{\partial f}{\partial \beta_{nm}} = 0 \gtreqless -4ac$$

$$b^2 (1+r) \left(\frac{w_u}{w_s}\right)^{\alpha+\beta} \{ \gamma w_s - (1-\alpha-\beta)\beta_{nm} \}$$

$$+b[\gamma w_u\{\beta_m(1+r) - w_s\} - h(1+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} - (1+$$

$$r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}\gamma w_s \beta_m + wu(2+r)\left(\frac{w_u}{w_s}\right)^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}]$$

$+[-\gamma w_u . h\{\beta_m(1+r) - w_s\} + \gamma w_u w_s \beta_m - wu(2+r)h(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} -$

$wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s \beta_m]$

$$0 \gtreqless [-4(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}].[-\gamma w_u . h\{\beta_m(1+r) - w_s\} +$$

$$\gamma w_u w_s \beta_m - wu(2+r)h(\frac{w_u}{w_s})^{\alpha+\beta}\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} - wu(2+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_s \beta_m]$$

Derivate w.r.t β_{nm}

$$0 \gtreqless -4(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}.\gamma w_u . h\{\beta_m(1+r) - w_s\} + 4(1+r)(\frac{w_u}{w_s})^{\alpha+\beta}\gamma w_u w_s \beta_m$$

$$-8wu(2+r)h(\frac{w_u}{w_s})^{\alpha+\beta^2}(1+r)\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\}(1-\alpha-\beta)$$

$$-4(1+r)(\frac{w_u}{w_s})^{\alpha+\beta^2} wu(2+r)\gamma w_s \beta_m (1-\alpha-\beta)$$

Since, L.H.S > R.H.S because R.H.S is negative, therefore, **derivative is positive**

In the short-run, the threshold, *f*, will increase with higher non-monetary cost.

$\frac{\partial g^*}{\partial \beta_{nm}} = 0 \gtreqless -4ac$

$-b^2 [\gamma w_s - (1-\alpha-\beta)\beta_{nm}] + b\,[h\{\gamma w_s - (1-\alpha-\beta)\beta_{nm}\} - \beta\,(1-\alpha-\beta)\{\beta_m(1+r) -$

$ws\} + \gamma ws \beta_m\,] + [\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r) - ws\} - \beta\,(1-\alpha-\beta)ws(\beta_m)]$

$$0 \gtreqless +4[\gamma w_s - (1-\alpha-\beta)\beta_{nm}][\beta\,(1-\alpha-\beta)(h)\{\beta_m(1+r) - ws\}] - 4\beta\,(1-\alpha-$$

$$\beta)ws(\beta_m)][\gamma w_s - (1-\alpha-\beta)\beta_{nm}]$$

Derivate w.r.t β_{nm}

$$0 \gtreqless\ -4[\beta\,(1-\alpha-\beta)^2(h)\{\beta_m(1+r)-ws\}] + 4\beta\,(1-\alpha-\beta)^2 ws(\beta_m)]$$

$$0 \gtreqless\ -(h)\{\beta_m(1+r)-ws\}] + ws(\beta_m)]$$

Simplifying it, we get:

$0 \gtreqless\ hws + (\beta_m)[ws - h(1+r)]$

Since, R.H.S is positive, L.H.S < R.H.S and the **derivative is negative**

In the long-run ,the critical threshold, g_s^* will decrease with a higher non-monetary cost of social exclusion.

0.18 References

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