Social Capital and Economic Growth

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Abstract

This paper presents a new framework to analyze the dynamic relationship between social capital and economic growth. This relationship has been analyzed in a quality-ladder growth model where only a few sectors experience technological shock every period leading to labor reallocation within the economy. Social capital (trust, norms, networks) increases as people socialize and decreases with labor migration as social capital is person and place specific. We characterize the equilibrium in which a higher level of social capital increases growth through higher investment but at the same time higher growth weakens social capital due to an increase in labor reallocation rate and less socialization. We show that in the absence of formal institutions, a higher rate of innovation (or adoption of newer technologies) lowers R&D investment as it weakens existing informal institutions. For a country to experience sustained higher growth rate, alternative formal institutions must be improved. A poor country lacking in resources or will to develop formal institutions will be caught up in poverty trap even if they transplant technologies of rich countries. The model, therefore, provides another explanation of why poor countries do not catch up.

JEL Classification:

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1. Introduction

After the pioneering work by Coleman (1988, 90) and Putnam (1993, 2000), the research on social capital has received an enormous attention from economists. Researchers[1] have shown that social capital is an important determinant of economic performance of a country. On the one hand, a country with high stock of social capital tends to grow faster than a country with low stock of social capital but on the other hand, higher growth rate may itself be detrimental to social capital which may, in turn, hamper the growth performance. Putnam et al (1993) argued that a large part of the differences in per capita income between Northern and Southern Italy can be explained by their differences in the level of social capital, measured by membership in formal and informal groups and clubs. Routledge and Amsberg (2003), and Miguel (2003) argued that a higher growth rate erodes social capital by increasing labor migration rate.

Additionally, Putnam (2000) documents that social capital in the US declined monotonically since 1960s, but there was no apparent adverse impact on the US economy. Particularly, during the 1990s US experienced rapid economic growth, a period when there was a sharp decline in social capital. He identifies some possible determinants of this decline as rising female participation in the labor market, increase in geographical mobility, replacement of small stores by supermarkets, individualization of leisure time etc. He argued that during this period alternative (formal) sectors increased rapidly in response to decline in the strength of the informal sector (social capital). Putnam (2000) writes, ``... during the 1980s both public and private spending on security rose rapidly as a share of GNP ... By 1995 America had 40% more

[1] See Knack and Keefer (1997), Temple and Johnson (1998), Zak and Knack (2001), Beugelsdijk et al (2004),Guiso et al (2004), Akcomak and Well (2009) for details.

police and guards and 150% more lawyers and judges than would have been projected in 1970, even given the growth of population and economy.

So, what is `social capital'? According to Putnam et al (1993), ``social capital... refers to features of social organizations, such as *trust*, *norms*, and [social] *networks* that can improve the efficiency of society ...". Durlauf and Fafchamps (2004) identify three main underlying ideas behind social capital; first, it generates positive externalities in the society, second, these externalities are achieved through shared trust, and norms, and third, these shared trust and norms arise from informal forms of organizations. Loosely speaking, any form of social organization or informal institution that facilitates cooperation and coordination, reduces transaction cost or improves market efficiency can be regarded as social capital. For example, since it is extremely difficult and prohibitively expensive to write complete and enforceable contracts in most cases, contracting parties, therefore, can lower the cost of contract by writing a weaker incentive intensive contract[2]. Social connections or social networks may also reduce the impact of moral hazard problem[3]. Granovetter (1995) argued that social networks play a useful role in channeling information about the job and job applicants in the labor market. In many cases, social capital is necessary in resolving conflicts among competing interests, reducing free riders problem and internalizing the externality in the provision of public good[4]. Guiso et al (2004) have shown that social capital plays an important role in the degree of financial development across different parts in Italy. Recently, Akcomak and Weel (2009) investigated 102 European regions and concluded that social capital increases growth rate by fostering innovation.

[2] Rob and Zemsky (2002) show that weaker incentive intensive contracts are desired when output strongly depends on partially observed cooperative efforts of workers.
[3] Jackson and Schneider (2011) have shown that social connections significantly reduced the effects of moral hazard in New York City taxi industry.
[4] See Coleman (1988).

This paper presents a model of dynamic relationship between social capital and economic growth where not only the positive impact of social capital on economic growth but also the detrimental impact of growth on social capital has been considered. The economy consists of three sectors: households, production (intermediate and final good) and R&D[5]. In this representative agent framework, every period a consumer allocates its time between working and socializing and makes consumption and saving decision. Following Zak and Knack (2001) and Guiso et al (2004), we assume that the consumers can invest their savings only through investment brokers. These brokers are opportunists in the sense that given the opportunity they would cheat and run away with the money. However, their ability to cheat (or the frequency of getting caught and money recovered) depends upon the strength of informal (social capital) and formal institutions. Therefore, a higher level of social capital increases investment and growth by reducing the broker's ability to cheat (and therefore increasing investment).

The stock of social capital increases when people spend more time socializing[6] and decreases when people migrate[7] from one place to another. The evolution of social capital has been endogenized in the model by using optimal socializing time and by generating labor reallocation rate at each time by using a variant of Aghion-Howitt (1992) Schumpeterian growth model. The assumption that social capital is a by-product of individual's rational decision and that it is destroyed when people switch locations is in line with the observations made by Arrow (2000). Arrow (2000) writes, ``*There is considerable consensus ... that much of the reward for social interactions is intrinsic - that is, the interaction is the reward - or at least that the motives for interaction are not economic ... The relations between the market and social interactions*

[5] In the context of developing or poor countries, R&D expenditure can be viewed as the expenditure on buying new technologies from developed countries.
[6] Similar to time investment in Glaeser et al (2002).
[7] Social capital is person and place specific. See Glaeser and Redlick (2009)

appear to be two-sided. On the one hand ... the market needs supplementation (for efficiency) by nonmarket relations [social capital]. *On the other hand, labor or supplier turnover in response to price* [changes] *may destroy the willingness to offer trust or, more generally, to invest in the future of the relation*".

While we characterize the steady state equilibria analytically, because of the complexity of the model we calibrate the model for further insight. Using plausible parameter values, we show that in order to have sustained economic growth, it is optimal to improve the efficiency of the formal institutions (police, law, judiciary etc) in response to decline in social capital when a country experiences higher innovation rate. However, increase in spending on formal institutions on the one hand, increases growth through increase in investment but on the other hand reduces it due to its negative impact on social capital.[8] Therefore, improvement in formal institutions should not only take into account the decline in social capital because of higher economic growth but also consider its own negative impact on social capital.

It has been argued that the reason for the failure of poor countries catching up with the rich countries is the lack of institutions.[9] That is, in the absence of functional institutions, economic performance of poor countries may not improve significantly even if the technologies of the developed countries, which have been proven useful, are used.[10] We show that in response to technological improvement, growth performance does not improve as expected because of the corresponding decline in social capital. Therefore, to have sustained economic growth, alternative (formal) institutions must be developed continuously in response to a positive technological shock to the economy. A poor country, therefore, lacking in either resources or

[8] A higher expenditure on formal institution increases investment income and growth by reducing cheating, however, because of crowding out and the resulting decline of socialization time together with an increase in labor migration rate reduces social capital which , turn, hampers growth.
[9] See Keefer and Knack (1997) and Acemoglu et al (2005).
[10] Also see Francois and Zabojnik (2005)

will to improve its institutions will be caught up in poverty trap. In this paper, we derive the optimal expenditure on formal institutions which increases when the innovation rate is expected to increase (or if a poor country decides to buy more new technologies).

Although there have been quite a significant number of empirical research on this topic, our theoretical understanding on this issue is still preliminary. Among the significant theoretical contributions on social capital and economic growth are by Zak and Knack (2001) and Routledge and Amsberg (2003). Zak and Knack (2001) look at the relationship between trust and growth in a heterogeneous agent growth model where consumers are randomly matched with investment brokers every period. In this random matching model, trust is formed and destroyed completely every period. Routledge and Amsberg (2003) look at the impact of growth on social capital. In a prisoner's dilemma framework, they define social capital as the social structure that facilitates cooperation. They argue that technological innovation results in reallocation of labor which reduces the feasibility of cooperative trade by reducing the probability of repeated interaction. This paper contributes to the literature by considering, first, the social capital as a sluggish[11] variable which can be accumulated over time by socialization and is weakened by labor migration rate and, second, by incorporating both sides of the relationship into the model. This paper, therefore, provides a richer framework for our understanding of the dynamic relationship between social capital and economic growth.

The rest of the paper is organized as follows. Section 2 presents the model, Section 3 characterizes the equilibrium in a decentralized economy, Section 4 solves for social planner's problem, Section 5 calibrates the model and discusses short- and long-run effects on the economy when a country tries to achieve higher growth through technological improvement, and Section 6 discusses the results and presents some possible extensions of the model.

[11] Both Zak and Knack (2001) and Routledge and Amsberg (2003) treat social capital/trust as flow variable.

2. The Model

In order to analyze the dynamic relationship between social capital and growth, we use a variant of the quality-ladder growth model of Aghion and Howitt (1992). We extend the model by incorporating the labor-socialization trade off and by incorporating institutional factors that can affect the return from investment.

2.1 Production

In this economy, there is only one final consumption good produced by competitive firms. This final good can be produced using an intermediate good and the best available technology in that intermediate good sector. There is a continuous mass one of intermediate good sectors[12]. Intermediate goods are produced using only labor[13]. Each unit of labor hour produces exactly one unit of intermediate good irrespective of the sector in which a worker works in. Therefore, we denote l_{it} as the output of intermediate good sector i at time *t*, which employs l_{it} units of labor hour. Each sector produces only one type of intermediate good in which they have complete monopoly power.

The contribution of intermediate good sector, i, towards the final good, Y_{it}, at time t is given by

$$Y_{it} = A_{it}\, l_{it}^{\alpha} \tag{1}$$

where A_{it} is the state of the art technology in intermediate good sector i. Aggregate final good is the sum of the contributions of all intermediate good sectors towards the final good.

$$Y_t = \int_0^1 Y_{it}\ di \quad = \quad \int_0^1 A_{it}\, l_{it}^{\alpha}\ di \tag{2}$$

[12] We assume that each intermediate good sector is located at different locations. This is to ensure that once a worker switches job he moves to a different location.
[13] We abstract away from physical capital for simplicity.

2.2 Technology (R&D)

We assume that there is a different R&D sector[14] for each intermediate good. The Poisson arrival rate of innovation in each sector is given by $\lambda\, n_{it}$, where λ is an innovation parameter, n_{it} $\left(=\frac{N_{it}}{A_t}\right)$ is the productivity adjusted investment in the R&D sector i, N_{it} is the investment into R&D and A_t is the state of the art technology in the economy at time *t*. We assume that innovation is increasingly difficult, that is, the probability of innovation decreases when we go up in the ladder in the technological innovation for the same level of investment, N_{it}. Each innovation at time t in any sector *i* permits the innovator to start producing in sector i using the leading edge technology, A_t. Each innovation raises the technology parameter, A, by a constant factor, γ. Once an innovation occurs in sector i, either the existing firm purchases the patent from the innovator or only the ownership of the firm changes.[15] After the innovation, the technology in that sector jumps discontinuously from A_{it} to the state of the art technology, A_t.

Although, technology grows discontinuously at the individual sector level, economy wide technology, A_t, evolves gradually. We assume that this leading technology grows at a rate proportional to the aggregate flow of innovation, n_t , per unit of time. The economy-wide growth rate of technology is given by

$$\frac{\dot{A}_t}{A_t} = \lambda\, n_t \ln\gamma \quad , \qquad \gamma > 1 \tag{3}$$

where $n_t = \int_0^1 n_{it}\, di$ is the aggregate productivity adjusted investment into R&D sector. We define $a_{it}(= A_{it}/A_t)$ as the relative productivity of intermediate good sector i with respect to the

[14] Having R&D sector is more relevant for the developed countries. For other economies (emerging or poor countries) we can interpret R&D expenditure as the expenditure on buying technologies from the developed world.
[15] This is to ensure that after the innovation the same (previously employed) workers along with some new workers are working in that firm and there is not a complete restructuring inside that firm.

state of the art technology in the economy. We assume that the relative productivities are distributed across different intermediate good sector according to:

$$F(a) = a^{\frac{1}{\ln \gamma}} \quad , \quad 0 \leq a \leq 1 \tag{4}$$

where $F(a)$ is the cumulative distribution function of the relative productivities, a. The probability distribution function of the relative productivity, a, therefore, is $f(a) = \frac{1}{\ln \gamma}\ a^{\frac{1}{\ln \gamma}-1}$. At any time, the distribution of relative productivities stays the same but the relative position of firms change.

2.3 Consumers

We consider an economy populated with a continuous mass one of representative consumers. Each consumer is endowed with one unit flow of time which is allocated between working l and socializing $(1 - l)$. At each time *t*, a consumer makes two decision, first, how much to consume and how much to save and, second, how to allocate its time between working, l, and socializing, $(1 - l)$. We assume that people socialize because they get some sort of satisfaction out of it[16]. A representative consumer's preference is given by the following intertemporal isoelastic utility function:

$$U = \int_0^\infty u(C_t, 1 - l_t)\, e^{-\beta t}\, dt = \int_0^\infty \frac{1}{\rho}\, [C_t(1 - l_t)^\eta]^\rho\, e^{-\beta t}\, dt \tag{5}$$

$$-\infty < \rho \leq 1; \quad \eta > 0$$

where C_t is the consumption in period *t*, β is the discount factor, and η captures the impact of socialization on the welfare of consumers.

As in Zak and Knack (2001) and Guiso et al (2004), we assume that consumers can invest their savings only through investment brokers. There is a continuum of risk-neutral

[16] This is a standard labor-leisure tradeoff utility function where we redefine leisure time as socialization time.

investment brokers. These brokers invest consumer's savings into R&D firms and receive the return after the realization period. However, they are opportunists and can abscond with the money with probability, $(1-\phi)$, where ϕ captures the strength of the existing institutions in the economy which protects the consumers from the fraudulent behavior of these brokers. The strength of institutions, ϕ, in turn, depends on the strength of *informal institutions*, which we call *social capital,* and the *formal institutions*[17]. A higher stock of social capital and a better formal institutional environment, by reducing the probability of cheating, increases the expected return from R&D investment. The representative consumer's budget constraint, therefore, is given by:

$$\dot{V}_t = W_t\, l_t + \phi_t\, r_t\, V_t - C_t - T_t \quad ; \quad 0 \le \phi_t \le 1, \tag{6}$$

where V_t is the value of the all assets held by consumers, W_t is the current wage rate, and r_t is the market interest rate. The strength of institutions, ϕ_t, depends on the services provided by the stock of social capital, s_t, and productivity-adjusted expenditure, $g_t\ (= G_t/A_t)$, on formal institutions finance by lump-sum tax (or contributions) T_t, where G_t is the current expenditure on formal institutions at time *t*.

$$\phi_t = 1 - e^{-a\, s_t - b\, g_t} \quad ; \quad a, b > 0 \tag{7}$$

where, a and b capture the impact of social capital and formal institutions on the effectiveness of the institutions and therefore on the return from investment. Alternatively, s_t and g_t can also be interpreted as a measure of personalized and generalized trust, respectively, in the economy.

Assuming that the brokers do not save, their per period consumption is given by $C_t^b = (1-\phi_t) r_t V_t$, where $(1-\phi_t)$[18] is the probability with which the brokers can cheat. Assuming

[17] The strength of formal institution is captured by the productivity-adjusted expenditure. These expenditure may either be done by the government (on law and order, for example) or by private organizations (neighborhood watch, for example).

[18] Alternatively, $(1-\phi_t)$ can also be interpreted as the transaction cost of searching an honest broker or the cost of writing a complete and enforceable contract with the new broker.

that, the expenditure (G_t) on formal institutions matches the total contributions (T_t) every period, the economy-wide budget constraint can be given by:

$$\dot{V}_t = W_t\, l_t\ + \phi\left(s_t, g_t\right) r_t\, V_t - C_t - G_t \tag{8}$$

2.2 Social Capital

As argued earlier, since social capital increases with socialization and decreases with labor migration, we consider the following equation for the evolution of the stock of social capital:

$$\dot{s_t} = (1 - l_t) - m_t\, s_t\ , \qquad 0 \le m_t \le 1\ ;\ \ 0 \le s_t < \infty \tag{9}$$

where, $(1 - l_t)$ is the time people spend socializing and m_t is the rate of labor migration across different sectors in the economy. If a proportion m_t of workers switch jobs then the social capital is destroyed by a measure of $m_t s_t$.

Since the motive of socialization is not economic, the consumers do not consider the impact of their socializing decision on the social capital. This creates an additional source of externality into the model (*social capital externality*) where the formation of social capital is the side product of the individual rational decision of socialization.

We consider three different institutional environments in our paper. The first institutional environment (Benchmark: Case I) corresponds to the standard Schumpeterian growth model with labor- socialization tradeoff where it is assumed that institutions are perfect ($\phi = 1$) and there is no cost to maintain it. In the other two frameworks, we consider that institutions are no longer perfect and it is costly to improve their strength. In case II, only informal institutions act as checks and balances in the economy. The strength of these institutions is endogenously determined in the model. Finally, we consider both social capital and formal institutions as

determinants of institutions in the economy where social capital is endogenously determined as in case II and expenditure, G, on formal institutions is optimally chosen.

3. Decentralized Economy

We start our analysis with the last case where both social capital, s, and formal institutions, g, determine the strength of institutions, ϕ, in the economy where social capital is determined endogenously within the model while the expenditure on formal institutions, G, is optimally chosen.

3.1 Equilibrium

An allocation in this economy consists of the time paths of consumption, and aggregate output, $[C_t, Y_t]_{t=0}^{\infty}$, time paths of R&D expenditure, state of the art technology, and net present value of the assets, $[N_t, A_t, V_t]_{t=0}^{\infty}$, time paths of interest rate, and wage rate, $[r_t, W_t]_{t=0}^{\infty}$ and time paths of labor supply, migration rate, social capital, government expenditure, and the strength of institutions $[l_t, m_t, s_t, G_t, \phi_t]_{t=0}^{\infty}$. An equilibrium is an allocation where the representative consumers maximize utility, intermediate good producers maximize profit, innovators maximize their net present discounted value and the labor market clears.

We start with the production sector. We assume that the final good sector is competitive while each of the intermediate good sectors is monopolized.[19,20] For simplicity, we also assume that the monopolists use first-degree price discrimination to extract all surplus from the final good sector. It implies that the monopolist can charge $A_{it} l_{it}^{\alpha}$ from the firms in the final good sector. The objective of a monopolist intermediate good firm is choose the optimal level of l_{it} to

[19] Price of the final good is normalized to one.
[20] Quality gap is assumed to be sufficiently large between any two consecutive innovations in order to rule out limit pricing.

maximize its profit, $\Pi_{it} = A_{it}\, l_{it}^{\alpha} - W_t l_{it}$. The demand for labor of an intermediate good firm *i* are given by,

$$l_{it} = \alpha^{\frac{1}{1-\alpha}} \left(\frac{1}{\frac{W_t}{A_{it}}} \right)^{\frac{1}{1-\alpha}} = \alpha^{\frac{1}{1-\alpha}} \left(\frac{1}{w_t} \right)^{\frac{1}{1-\alpha}} a_{it}^{\frac{1}{1-\alpha}} \qquad or \qquad \alpha\, Y_{it} = W_t\, l_{it} \tag{10a}$$

where $w_t \left(= \frac{W_t}{A_t}\right)$ is the productivity adjusted wage rate. The demand for labor increases when the technology in a sector improves and decreases if they do not innovate because of the rise in wage in response to innovation in other sectors. The output and the profit, therefore would also increase with innovation and decrease in its absence. Output and profit of a monopolist intermediate good firm is given by

$$Y_{it} = \alpha^{\frac{\alpha}{1-\alpha}}\, A_{it} \left(\frac{1}{\frac{W_t}{A_{it}}} \right)^{\frac{\alpha}{1-\alpha}} = \alpha^{\frac{\alpha}{1-\alpha}}\, \frac{A_t}{w_t^{\frac{1}{1-\alpha}}}\, a_{it}^{\frac{1}{1-\alpha}} \tag{10b}$$

$$\Pi_{it} = (1-\alpha) Y_{it} = (1-\alpha)\alpha^{\frac{\alpha}{1-\alpha}}\, \frac{A_t}{w_t^{\frac{1}{1-\alpha}}}\, a_{it}^{\frac{1}{1-\alpha}} \tag{10c}$$

The aggregate flow of demand for labor, l_t, can be found by summing equation (10a) over *i*.

$$l_t = \frac{\alpha^{\frac{1}{1-\alpha}}}{1 + \frac{1}{1-\alpha}\ln\gamma} \quad \frac{1}{w_t^{\frac{1}{1-\alpha}}} \tag{11a}$$

We, then, get the following expressions for the productivity-adjusted aggregate output, $y_t (= Y_t/A_t)$, and profit, π_t $(= \Pi_t/A_t)$, in the economy by summing equation (10b) and (10c) respectively over *i*, by using (11a), and diving through by A_t as

$$y_t = \frac{\alpha^{\frac{\alpha}{1-\alpha}}}{1 + \frac{1}{1-\alpha}\ln\gamma} \quad \frac{1}{w_t^{\frac{\alpha}{1-\alpha}}} = \frac{1}{\left(1 + \frac{1}{1-\alpha}\ln\gamma\right)^{1-\alpha}}\; l_t^{\alpha} \tag{11b}$$

$$\pi_t = (1-\alpha)y_t = \frac{1-\alpha}{1+\frac{1}{1-\alpha}\ln\gamma}\ l_t^{\alpha} \tag{11c}$$

In order to find the labor reallocation (migration) rate, we, first, use the expression of w_t from (11a) into (10a) and then differentiate it with respect to time to get:

$$\frac{\dot{l}_{it}}{l_{it}} = \frac{1}{1-\alpha}\left(\frac{\dot{A}_{it}}{A_{it}} - \frac{\dot{A}_t}{A_t}\right) + \frac{\dot{l}_t}{l_t} \tag{12a}$$

The change in the demand for labor has two components. The first is the change in demand for labor across firms and the second is the change in labor hour each worker puts in. Since we are interested in the change in demand for workers only, we will consider only the first term. Noting that $\dot{A}_{it} = 0$ for a non-innovating firm, the number of non-innovating firms being $(1-\lambda n_t)$ at any time *t*, and by using equation (3), we get the following expression for the labor migration rate:

$$m_t = \frac{1}{1-\alpha}\ \lambda\, n_t \ln\gamma\ (1-\lambda\, n_t) \tag{12b}$$

We next turn to the equilibrium in R&D sector. Because the expected payoff to an innovation is the same in every sector, the same equilibrium flow of investment, N_t , will be used in each R&D sector. The value of an innovation[21], V_{it}, (or the value of a firm that innovates at time *t*) in sector *i* at time *t* is given by the net present value of all future profits.

$$V_{it}(A_t) = \int_{\tau=t}^{\infty} e^{-\int_t^{\tau} r_u\, du}\ e^{-\int_t^{\tau} \lambda\, n_u\, du}\ \Pi_{it}(A_t)\, d\tau \tag{13a}$$

where $e^{-\int_t^{\tau} \lambda\, n_u\, du}$ is the probability that this firm is still producing and is not yet replaced at time τ and $\Pi_{it}(A_t)$ is the profit[22] of a firm having technology A_t at time $\tau \geq t$. By using (3) and after

[21] Recall that once the innovation occurs in sector *i* at time *t*, the technology in that sector jumps from $A_{it}$to the state of the art technology, A_t.

[22] $\Pi_{i\tau}(A_t) = (1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha} A_t\ l_{\tau}^{\alpha}\ e^{-\frac{\alpha}{1-\alpha}\int_t^{\tau}\lambda\, n_u \ln\gamma\, du}$

some algebraic manipulations, we get the productivity-adjusted value of an innovation, v_{it} ($= V_{it}/A_t$), as:

$$v_{it}(A_t) = (1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha} \int_{\tau=t}^{\infty} l_\tau^{\alpha}\, e^{-\int_t^{\tau}\left(r_u+\lambda n_u+\frac{\alpha}{1-\alpha}\,\lambda\, n_u \ln\gamma\right)du}\, d\tau \tag{13b}$$

Assuming that R&D sector is competitive, research arbitrage condition determines research intensity in each sector by equating its expected marginal benefit from research to its marginal cost.

$$\lambda\, n_t\, V_{it}(A_t) = N_t \qquad or \qquad v_{it}(A_t) = \frac{1}{\lambda} \tag{14a}$$

Differentiating (13b) and (14a) with respect to time and by equating them to each other, we get v_{it} as:

$$v_{it}(A_t) = (1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha} \frac{l_t^{\alpha}}{r_t+\lambda\, n_t+\frac{\alpha}{1-\alpha}\,\lambda\, n_t \ln\gamma} \tag{14b}$$

Using (14a) and (14b), we get the familiar research-arbitrage condition:

$$\frac{\lambda\,(1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha} l_t^{\alpha}}{r_t+\lambda\, n_t+\frac{\alpha}{1-\alpha}\,\lambda\, n_t \ln\gamma} = 1 \tag{15}$$

Finally, the productivity adjusted value of all the firms (or the value of all the assets held by consumers) is given by:

$$v_t = \frac{1}{\lambda}\,\frac{1}{1+\frac{1}{1-\alpha}\ln\gamma} \tag{16}$$

A representative consumer chooses consumption and labor to maximize utility (Eq. (5)) subject to the budget constraint (Eq. (7)). The first order conditions at the optimum are

$$u_C = C^{\rho-1}(1-l)^{\eta\rho} = \mu \tag{17a}$$

$$-u_l = \eta C^{\rho}(1-l)^{\eta\rho-1} = \mu\, W \tag{17b}$$

$$\phi\, r = \beta - \frac{\dot{\mu}}{\mu} \tag{17c}$$

where μ is the private shadow value of wealth, together with the transversality condition $\lim_{t\to\infty} \mu V e^{-\beta t} = 0$. The interpretation of these equations are standard; (17a) equates the *private* marginal utility of consumption to the shadow value of wealth; (17b) equates the *private* marginal utility of socialization to the opportunity cost, the real wage valued at the shadow value of wealth, while (17c) equates the return of assets to the rate of return of consumption.

By solving (17a) and (17b), we get the familiar relationship between labor and consumption,

$$1 - l_t = \frac{\eta C_t}{W_t} = \frac{\eta c_t}{w_t} \tag{18a}$$

where $c_t (= C_t/A_t)$ is the productivity adjusted consumption. The Euler equation is given by using (3) and time derivatives of (17a) and (18a) into (17c),

$$\frac{\dot{C}_t}{C_t} = \Omega(l_t)\,[\phi_t r_t - \beta + \Psi(l_t)\lambda\, n_t \ln\gamma] \tag{18b}$$

where, $\Omega(l_t) = -\frac{1-\alpha(1-l_t)}{\eta\rho l_t + (\rho-1)(1-\alpha(1-l_t))} > 0$ and $\Psi(l_t) = -\frac{\eta\rho l_t}{1-\alpha(1-l_t)} > 0$.

Finally, the optimal expenditure, *G*, on formal institution equates the additional return from investment due to strengthening of institutions to its cost.

$$1 = \phi_g(s, g)\, r_t\, v_t \tag{19}$$

We summarize the equilibrium conditions as follows:

Definition 1 *An equilibrium in this economy is given by the time paths of consumption, and aggregate output,* $[C_t, Y_t]_{t=0}^{\infty}$ *that satisfies (8), and (111b), time paths of R&D expenditure, state of the art technology, and net present value of the assets,* $[N_t, A_t, V_t]_{t=0}^{\infty}$ *given by (15), (3) and (16), time paths of interest rate, and wage rate,* $[r_t, w_t]_{t=0}^{\infty}$ *consistent with (18b) and (11a) and time paths of labor supply, migration rate, social capital, and formal institutions* $[l_t, m_t, s_t, G_t, \phi_t]_{t=0}^{\infty}$ *given by (18a), (12b), (9), (19) and (7).*

Case I (Benchmark): Perfect Institution ($\phi = 1$)

In this case, the evolution of social capital is no longer relevant. The production and R&D sectors will have the same optimality conditions. Since the institutions are perfect and it is costless to maintain, consumer's budget constraint can now be written as:

$$\dot{V} = Wl + rV - C \tag{20a}$$

Consumer's optimization gives us the same labor supply function as earlier (18a). However, the Euler condition is now:

$$\frac{\dot{C}_t}{C_t} = \Omega(l_t)\,[r_t - \beta + \Psi(l_t)\lambda\, n_t \ln\gamma] \tag{20b}$$

Additionally, optimality conditions with respect to government expenditure on formal institutions, G, is now no longer relevant because of the costless nature of institutions.

Case II: No Formal Institution ($G = 0$) and Endogenous Social Capital

The optimality conditions in production and R&D sectors are again the same as earlier. The agent's optimality condition and the Euler equation are again given by (18a) and (18b). Again, as in case I, there is no optimality condition for G.

Proposition 1 *Growth rate is highest when the institutions are perfect and costless to maintain and is lowest when only social capital is the only source of checks and balances in the economy. Whether the growth rate in the third case is close to the first or the second case would depend on the effectiveness of formal institutions.*

Proof: See Appendix A ❑

The strength of institution, ϕ, is lower in case II as institutions are no longer perfect. Although, lower ϕ increases results in higher interest rate, *r*, return from investment, ϕr, declines. A lower return from investment not only reduces the supply of funds for R&D investment but also lowers consumption due to fall in investment income, ϕrv. This fall in consumption induces

people to work more and thereby, increases consumption and demand for R&D investment by increasing wage income and profit respectively. Since the prior effect dominates, both consumption and R&D investment and consequently the growth rate are lower in case II unless social capital itself is large enough to facilitate the role of perfect institution.

A positive expenditure, *G*, immediately crowds out current consumption. As argued above, this fall in consumption increases *l* and consequently increases both consumption and demand for R&D investment. Also, increase in G, raises the strength of institutions which induces people to supply more funds at the expense of consumption. Overall, consumption falls and investment rises which ultimately raises the growth rate of the economy. If formal institutions are more effective, the increase in ϕ is larger and therefore more R&D fund will be supplied at the expense of consumption resulting in even higher growth. Because maintaining institutions, ϕ, are no longer costless will always be less than perfect and therefore R&D investment and consequently growth rate in case II will always be between case I and case II.

Comparing the first two cases highlights the importance of incorporating the social capital into the growth models. We observe that when institutions are not perfect and are determined only by the strength of social capital then the growth rate is lower than what would have been predicted by a standard growth model. When formal institutions are included into the model and are optimally chosen then growth performance improves. Hence, it is important not only to incorporate social capital as a determinant of institutions in the economy but also to maintain an optimal balance between informal and formal institutions.

3.2 Macroeconomic Dynamics

We define a balanced growth path as an equilibrium path in which all variables grow at a constant rate except for labor allocation, interest rate, migration rate, social capital and the

strength of institutions, which are constant. Following our definition of balanced growth path, it is convenient to write the system in terms of stationary productivity adjusted variables. It is straightforward to express the dynamics of the decentralized economy in terms of $c,\ l,\ \phi\ (s,g)$, m and n as

$$\dot{c_t} = c[\Omega(l_t)\ [\phi_t r_t - \beta + \ \Psi(l_t)\lambda\, n_t \ln\gamma] - \lambda\, n_t \ln\gamma] \tag{21a}$$

$$\dot{s_t} = (1 - l_t) - m_t s_t \tag{21b}$$

along with labor market clearing conditions,

$$l_t + \frac{\eta}{\alpha}\left(1 + \frac{1}{1-\alpha}\ln\gamma\right)^{1-\alpha}\ c_t\ l_t^{1-\alpha} = 1 \tag{21c}$$

$$\frac{\alpha^{\frac{1}{1-\alpha}}}{1 + \frac{1}{1-\alpha}\ln\gamma}\ \frac{1}{w_t^{\frac{1}{1-\alpha}}} + \eta\frac{c_t}{w_t} = 1 \tag{21d}$$

research arbitrage condition (15), labor migration rate (12b), optimal expenditure on formal institutions (19), institutions $\phi = \phi(s,g)$, and the economy-wide budget constraint[23]

$$w_t l_t\ + (\phi_t\, r_t - \lambda\, n_t \ln\gamma)\ v_t - c_t - g_t = 0 \tag{20e}$$

Imposing the steady-state conditions $\dot{c} = \dot{s} = 0$, we can solve the system (21) for the steady-state values of productivity-adjusted variables, consumption ($\tilde{c}$), R&D investment ($\tilde{n}$), optimal expenditure on formal institutions ($\tilde{g}$), and wage rate ($\tilde{w}$), and the other variables, interest rate ($\tilde{r}$), labor ($\tilde{l}$), migration rate ($\tilde{m}$), social capital ($\tilde{s}$), and the strength of institutions ($\tilde{\phi}$). Finally, productivity-adjusted output ($\tilde{y}$), profit ($\tilde{\pi}$) and value of assets ($\tilde{v}$) can be found by using (11b), (11c) and (16) respectively.

By linearizing (21a) and (21b) around the steady state, we obtain the following system in the neighborhood of steady state,

[23] We, first, write (7) in terms of $\dot{v}$, and then use $\dot{v} = 0$ from (15).

$$\begin{bmatrix} \dot{s} \\ \dot{c} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} s - \tilde{s} \\ c - \tilde{c} \end{bmatrix} \tag{21}$$

where the determinant of the Jacobian, $\Delta = a_{11}a_{12} - a_{21}\,a_{22} < 0,$ is negative[24]. Therefore, one eigenvalue is negative (stable) and the other is positive (unstable). Since productivity-adjusted consumption can adjust instantaneously, while the stock of social capital is constrained to adjust continuously, the system defines a well-behaved saddle path. Starting from the initial stock of social capital, s_0, the economy follows a unique stable transitional adjustment path and corresponds to the positively sloped dashed locus in Figure 1. The time path of the stock of social capital and productivity-adjusted consumption is, therefore, given by

$$s(t) = \tilde{s} + (s_0 - \tilde{s})\, e^{\theta t} \tag{22a}$$

$$c(t) = \tilde{c} + \left(\frac{a_{21}}{\theta - a_{12}}\right) (s(t) - \tilde{s}) \tag{22b}$$

where θ denotes the stable eigenvalue.

For a better understanding of the dynamic relationship between social capital and economic growth, we consider the effect of an unanticipated permanent increase in the R&D innovation parameter, λ. The following proposition discusses its long-run impact on the economy:

Proposition 2 *Under the assumption that the probability of innovation remains less than half* $\left(\lambda n < \frac{1}{2}\right)$*, an increase in the innovation parameter λ has the following effects:*

(i) *Investment into R&D increases while consumption falls.*

(ii) *Social capital declines because of less socialization and increased labor migration rate.*

(iii) *Expenditure on formal institution rises in order to compensate for the decline in social capital.*

(iv) *Growth rate increases, not only, due to an increase in the innovation parameter, λ, but also, because of the resulting increase in R&D investment, n.*

Proof: ***See Appendix C.*** ❑

[24] See Appendix B.

An increase in the innovation parameter immediately increases the demand for investment into R&D (Eq. 15) leading to an increase in the market interest rate, r, and overshooting R&D investment, n, while crowding out current consumption, c and expenditure on formal institutions, g. This decline in c, in turn, induces people to work more and thereby increasing equilibrium labor hour (21c), l, and reducing the wage rate (20c), w. Also, the strength of institutions, ϕ, deteriorates due to decline in g. Growth rate in the economy rises not only due to the increase in λ but also due to the consequent rise in R&D investment, n. Finally, labor migration rate (12b) increases, both directly due to an increase in λ and indirectly due to rise in n, as long as the probability of innovation, λn, remains below half. On impact decline in consumption implies that $\dot{c} < 0$ and it rises overtime to its steady-state level resulting in decrease in the supply of R&D funds (Eq. 21a) after its initial overshooting. Growth rate and labor migration rate, therefore, also decline during the transitional path. Over time, as g starts rising in response to decline in the strength of institutions (both because of initial decline in g and because of decline of s over time), it crowds out consumption during the transitional phase. Once again, this decline in consumption raises equilibrium labor which along with higher labor migration reduces social capital during the transition period. Increase in labor increases wage income and therefore reducing the impact of crowding out on consumption. Consumption continues to decline, labor continues to rise and consequently social capital continues to fall as long as the benefit of improving formal institutions exceeds the cost. Although optimal expenditure on formal institutions, g, overall increases (19), it is not enough to compensate fully for the decline in the social capital and therefore, overall, the strength of institutions, ϕ, declines.

4 Social Planner

Now we briefly discuss the Pareto optimal allocation. Decentralized equilibrium is Pareto suboptimal because of two sources of externalities. The first is the externality in the R&D sector where the monopolists do not internalize the loss to the earlier monopolist caused by new innovation (*business stealing effect*) resulting in too much innovation and they ignore the impact of their innovation on the next innovation (*intertemporal spillover effect*) leading to too little innovation in the decentralized economy. The second source of externality is the *social capital externality* where consumers do not take into account the impact of socialization on social capital as they take the stock of social capital as given at any point of time. Since the full benefit of socialization is not taken into account, consumers spend less time socializing in decentralized economy.

4.1 Equilibrium

Since there is no inefficiency in the production side, the equilibrium conditions are again given by equations (9), (10) and (11). The resource constraint[25] can now be written as:

$$N_t = \left(\alpha + \phi\left(s_t, \frac{G_t}{A_t}\right)(1-\alpha)\right) Y_t - C_t - G_t \tag{23}$$

The social planner chooses consumption, labor and R&D investment to maximize utility (5) subject to the technology growth (3), evolution of social capital (9), resource constraint (23) and labor migration rate (12b). The optimality conditions are

$$\frac{1}{\lambda \ln \gamma}\left(C^{\rho-1}(1-l)^{\eta\rho} + \mu_2 m_N s\right) = \mu_1 \tag{24a}$$

$$\frac{1}{\lambda \ln \gamma}\left(\eta C^{\rho}(1-l)^{\eta\rho-1} + \mu_2(1+m_N N_l s)\right) = \mu_1 N_l \tag{24b}$$

$$\left(\lambda \ln \gamma - \frac{\mu_2}{\mu_1} m_N s\right) N_A - \frac{\mu_2}{\mu_1} m_A s = \beta - \frac{\dot{\mu_1}}{\mu_1} \tag{24c}$$

[25] See Appendix D for derivation of resource constraint for the Social Planner.

$$\left(\frac{\mu_1}{\mu_2}\lambda \ln\gamma - m_N s\right) N_s - m \quad = \quad \beta - \frac{\dot{\mu_2}}{\mu_2} \tag{24d}$$

where μ_1 and μ_2 denote the shadow value of technology and social capital, respectively, together with the transversality conditions

$$\lim_{t\to\infty} \mu_1 A e^{-\beta t} = \lim_{t\to\infty} \mu_2 s e^{-\beta t} = 0 \tag{24e}$$

There are some key differences from the corresponding conditions for the decentralized economy. First, (24a) equates the utility of an additional unit of consumption, adjusted by its impact on social capital multiplied by the shadow value of social capital, to the shadow value of technology. Since additional consumption reduces the funds available for R&D investment and thereby increases social capital by reducing labor migration rate, (12b), people would consume less compared to decentralized economy. Second, (24b) equates the *social* marginal benefit of socialization (which includes its positive impact on social capital as well) to the real wage valued at the shadow value of technology. Third, (24c) and (24d) are the intertemporal efficiency conditions, where (24c) equates the rate of return of technology to the social return of consumption and (24d) equates the return of social capital to the rate of return of consumption evaluated in terms of the shadow value of social capital.

We can express the macrodynamic equilibrium of the centrally planned economy in terms of productivity adjusted variables as

$$\dot{c_t} = c[\Gamma_1(c, l, n, s, g, m, \phi) - \lambda\, n_t \ln\gamma] \tag{24a}$$

$$\dot{l_t} = \Gamma_2(c, l, n, s, g, m, \phi) \tag{24b}$$

$$\dot{s_t} = (1 - l_t) - m_t s_t \tag{24c}$$

where the expression for Γ_1 and Γ_2 are given in appendix E.

5 Quantitative Results

Due to complexity of the model, we calibrate the model in order to obtain further insight. Although some of the parameters of the current model are difficult to pin down with our current knowledge of the technology of R&D and the absolute and relative effectiveness of social capital and formal institutions, the calibration exercise still provides useful insights on the dynamic relationship between social capital and economic growth. The baseline parameter values are given as follows: $\alpha = 0.7;\ \beta = 0.02;\ \gamma = 2;\ \lambda = 0.3,\ 0.4;\ \eta = 0.1;\ a = 1;\ b = 100.$ Our choice of the preference parameters, α and β are standard. The parameter η describes the degree of substitution between socialization/leisure and consumption. We chose η as 0.1 in order to ensure that people socialize 10-20% of the total available time out of working and socializing. It is in contrast with the previous literature where the estimated work time is approximately 1/3 of the total available time. The reason for this difference is that we are not considering any other leisure activities and therefore our total time is approximately 10 hours a day, not 24 hours. The choice of the innovation size, γ, and innovation probability parameter, λ, are such that the growth rate in the decentralized economy in the most general framework remains between 2 to 5%. However, we can easily change these parameters to reflect varying growth experience of different countries. In this regard, it can be argued that the countries experiencing higher growth are able to either innovate more frequently or getting the necessary resources (for example, foreign investment) in order to sustain higher growth. However, the qualitative results of the model are unchanged for other reasonable parameter values as well. As social capital is accumulated over time whereas expenditure on formal institutions is a flow variable, b, should be sufficiently high for it to have any significant impact on the economy.[26] One may also argue that

[26] In case III of table 1A it can be seen that the magnitude of s is significantly higher than that of g.

formal institutions should have larger impact as it affects the whole economy in general, as compared to social capital which is more local in nature. It is because of these reasons, we have chosen a significantly high value for b.

First, we will compare the steady-state results in the decentralized economy (table 1A) and central planner's (table 1B) case under the, abovementioned, three different institutional environments. Thereafter, we analyze the comparative static results under these institutional frameworks for both, the decentralized and central planner case. Finally, we examine the dynamic effect of increase in innovation parameter, λ, on the economy.

5.1 Steady-State

In the benchmark model (Case I), the steady state growth rate in a decentralized economy (table 1A) is given by 2.75%, when we consider the innovation parameter, λ, to be 0.3. People consume 79.53% of the total output produced, spend 10.21% of the time socializing, and 8.8% of them switch jobs at any time. However, once we allow for endogenous institutions (Case II and Case III), growth performance deteriorates. In case II, in the absence of any formal institution, growth rate falls by 0.43 percent points. In a less than perfect institutional environment, $\phi = 0.74$, reduces the supply of funds for R&D investment, thereby reducing R&D investment and increasing the market interest rate. As investment income falls from 0.09 (rv) to 0.08 (ϕrv), the loss in income reduces consumption. As mentioned earlier, this fall in consumption induces people to work more (from 0.898 to 0.899), thereby increasing wage income (from 0.4433 to 0.4437) which, in turn, increases consumption. Since the first effect dominates the second, overall consumption falls from 0.515 to 0.509. Once we include optimal formal institutions in the model (Case III), growth rate rises by 0.3 percent point (to 2.6%) compared to case II and is

closer to the benchmark case. As argued earlier, overall, consumption falls from 0.509 to 0.503 and R&D investment rises from 0.111 to 0.125 leading to a higher growth (2.6%) in the economy. Finally, market interest rate declines as a result of increase in R&D investment supply and there is a further decline in social capital due to decrease in socialization time from 0.1009 to 0.0997 and due to an increase in labor migration rate (from 7.5% to 8.4%) as the economy grows at a higher rate. The results in the social planner's case (Table 1B) are qualitatively similar except that socialization increases from 9% to 16% when social capital is included in the model. This is because the social planner internalizes social capital externality and therefore considers the additional benefit of socialization on growth through an improvement in social capital.

5.2 A Permanent Increase in the Innovation Parameter (λ): Long Run Effects

We now introduce a permanent increase in the innovation parameter, λ, from 0.3 to 0.4. In the benchmark case, we observe that the growth performance improves by 1 percent point. Output, R&D investment and interest rate increases while consumption, socialization and wage rate declines. As the rate of innovation increases, causing the increase in the demand for funds for R&D investment, investment rises while consumption falls instantaneously. This fall in consumption, in turn, increases labor hour, increasing wage income and therefore consumption rises along with a further increase in R&D investment. As the first effect dominates the second, overall, consumption falls from 0.515 to 0.511, and investment rises from 0.132 to 0.136. Growth rate in the economy rises, therefore, not only due to the initial rise in λ, but also due to the resulting increase in R&D investment. If we look at case II, increase in growth rate is only 0.66 percent point. This is because of the detrimental impact of growth on social capital which, in turn, hampers the growth itself. Social capital declines from 1.35 to 1.19 as people now spend

less time socializing (0.997 as opposed to 0.1009) and also because labor migration rate rises (a result of an increase in the rate of innovation) from 7.5% to 9.5%. The resulting decline in the strength of institutions lowers the investment income leading to decline in both R&D investment and consumption. Overall, consumption declines from 0.509 to 0.503 whereas R&D investment declines from 0.112 to 0.107. Therefore, the countries which are trying to grow faster in the absence of relevant formal institutions may not be able to reap the full benefit of using new technologies because of declining social capital. In fact, contrary to the popular belief that new technologies bring more investment, we observe that investment falls in the absence of any formal institution. In contrast, if a country optimally chooses the strength of formal institutions (expenditure on formal institutions increased to 0.0135 from 0.0106) in response to declining social capital, growth performance is far better (increase in growth rate is 0.98 percent point, only marginally lower than the benchmark case). In this case, growth rate (at 3.6%) itself is very close to the benchmark case (3.8%). This is mainly because of the increase in the reward of the investment due to reduced cheating in the economy. Therefore, if a country would like to improve its growth performance, it should change its formal institution in response to declining social capital in order to experience sustained higher economic growth. The last column of the tables report the long run welfare change measured by the optimized utility of the representative agent where C and l are evaluated along the equilibrium path. These welfare changes are measures of equivalent variations, calculated as the percentage change in the initial level of technology necessary to maintain the level of welfare unchanged following the shock. As anticipated, the welfare gain is highest in case I (15.23%) and is lowest in case II (12.31%). Again, we get very similar qualitative results for the social planner's problem. The optimal expenditure on formal institution increases from 0.023 to 0.025, when λ goes up from 0.3 to 0.4.

5.3 Transitional Dynamics

The transitional adjustment paths for case III following an increase in the probability of innovation are illustrated in Fig. 1. The immediate impact of the increase in innovation rate is an increase in demand for R&D investment, overshooting R&D investment immediately from 0.125 to 0.132 and raising market interest rate from 9.5% to 11.97%. This increase in R&D investment crowds out current consumption from 0.503 to 0.497 and expenditure on formal institution from 0.0106 to 0.0101. This downward jump in consumption induces people to work more and socialize less (from 0.0997 to 0.0986) and therefore a decline in wage rate from 0.5044 to 0.5043. With social capital being a sluggish variable, a decrease in expenditure on formal institutions causes the strength of institutions to fall from 0.8955 to 0.8894 leading to increase in cheating in the economy. Overall wage income increases while investment income falls. On balance, the later dominates and total income $(wl + \phi rv)$ falls immediately from 0.54 to 0.535 even though output rises from 0.6487 to 0.6493 (because of the increase in labor hour). Finally, the growth rate in the economy increases on impact not only because of the increase in innovation rate but also due to the corresponding increase in R&D investment.

Over time, social capital starts declining as a result of a reduction in socialization time and an increase in labor migration rate which jumps up from 8.35% to 11.55%. As a response to the reduced strength of institutions, expenditure on formal institutions starts rising. As mentioned earlier, R&D investment declines throughout during the transitional period after the initial jump (overshooting). Growth rate and labor migration rate, therefore, also decline during the transitional path. Over time, as g starts rising in response to decline in the strength of institutions (both because of initial decline in g and because of decline of s over time), it crowds out consumption during the transitional phase. Once again, this decline in consumption raises

equilibrium labor which along with higher labor migration reduces social capital during the transition period. Increase in labor increases wage income, and therefore reducing the impact of crowding out on consumption. Consumption continues to decline, labor continues to rise and consequently social capital continues to fall as long as the benefit of improving formal institutions exceeds the cost. Although the increase in optimal expenditure on formal institutions, g, increases throughout the transition period, it is not enough to fully compensate the decline in the social capital and therefore, the strength of institutions, ϕ, declines in the long run. The reduction in initial consumption and leisure results in short-run welfare loss of 0.86% but as the consumption grows overtime, so does welfare (Fig 2.11) and the overall intertemporal welfare gain is 14.71%.

6 Discussion and Extensions

We have developed a new framework to analyze the endogenous relationship between social capital and economic growth. Our model is based on the argument that a higher social capital is beneficial for economic performance of a country but higher growth reduces social capital. We show that a higher growth prospect reduces social capital by reducing socialization time and by increasing labor reallocation rate. In the absence of any formal institutions, an increase in the rate of innovation reduces the investment into R&D sector, contrary to the standard growth literature. The reason behind this decline is R&D expenditure that is the erosion of the strength of existing informal institutions. It is generally argued that technological advancements require the strengthening of existing formal institutions and in some cases even demand new institutional frameworks. This paper argues that in addition to meeting the above

requirements, formal institutions needs to be improved further to fill the void created by the erosion of existing informal institution, a result of technological advancements.

This model also provides an alternative explanation to the growth convergence conundrum. Even if a poor country may acquire better technologies of rich countries, catch up rate might still be low if the decline in social capital is not compensated by improving formal institutions. Therefore, a poor country lacking in resources or lacking in will to develop formal institutions may, therefore, will remain poor.

Although we have abstained from capital accumulation for simplicity, it is straightforward to include it in the model. Also, a more complete model should incorporate some form of heterogeneity among the economic agents. Improvements in communication technology such as telephone, internet, or online social networks by lowering the cost of maintaining contacts with friends and family increases the size and strength of social networks and therefore the impact of labor reallocation on social capital may not be too strong. Incorporating these features into a model of social capital and economic growth will help in better understanding of this inter-relationship and hence have strong policy implications. In this model, we have assumed that the formal institution is financed by lump-sum payment. It would be interesting to characterize the optimal tax policy for these institutions. As very little is known about the absolute and relative effectiveness of various types of institutions, new research, both at theoretical as well as at empirical level are desired. Lastly, social capital has many dimensions such as trust, norms, social network to name a few. We need to look into the dynamics of each of them separately and their relationship with growth in order to have more precise predictions.

Table 1: Comparative Statics of Steady-State Results

Case I: Benchmark Case (Costless Institutions: $\phi = 1$)

Case II: Social Capital (endogenous) is the only determinant of institutions

Case III: Inclusion of both social capital and formal institution (optimally determined) as determinants of institutions

Baseline Parameters: $\alpha = 0.7,\ \beta = 0.02,\ \gamma = 2,\ \eta = 0.1,\ a = 1,\ b = 100$

Table 1A: Decentralized Economy

$\lambda = 0.3$

	c	l	w	r	n	y	m	s	g	ϕ	*Growth*	*ΔWelfare*
Case I	0.5151	0.8979	0.5048	0.0889	0.1325	0.6476	0.0882	1.1567	-	1.0000	0.0275	-
Case II	0.5089	0.8991	0.5046	0.1054	0.1116	0.6482	0.0748	1.3481	-	0.7403	0.0232	-
Case III	0.5030	0.9003	0.5044	0.0950	0.1252	0.6487	0.0835	1.1939	0.0106	0.8955	0.0260	-

$\lambda = 0.4$

	c	l	w	r	n	y	m	s	g	ϕ	*Growth*	*ΔWelfare*
Case I	0.5115	0.8987	0.5047	0.1146	0.1364	0.6479	0.1192	0.8502	-	1.0000	0.0378	15.23%
Case II	0.5029	0.9003	0.5044	0.1453	0.1074	0.6488	0.0949	1.0497	-	0.6499	0.0298	12.31%
Case III	0.4967	0.9015	0.5042	0.1228	0.1291	0.6494	0.1132	0.8702	0.0135	0.8921	0.0358	14.71%

Table 1B: Social Planner

$\lambda = 0.3$

	c	l	w	r	n	y	m	s	g	ϕ	*Growth*	*ΔWelfare*
Case I	0.4319	0.9140	0.5022	0.1363	0.2238	0.6557	0.1447	0.5943	-	1.0000	0.0465	-
Case II	0.4135	0.8372	0.5156	0.1615	0.1625	0.6166	0.1072	1.5190	-	0.7811	0.0338	-
Case III	0.4139	0.9086	0.5030	0.1399	0.2061	0.6529	0.1340	0.6818	0.0229	0.9489	0.0428	-

$\lambda = 0.4$

	c	l	w	r	n	y	m	s	g	ϕ	*Growth*	*ΔWelfare*
Case I	0.4228	0.9157	0.5019	0.1820	0.2338	0.6566	0.1958	0.4301	-	1	0.0648	16.67%
Case II	0.3927	0.8295	0.5170	0.2438	0.1646	0.6126	0.1421	1.2005	-	0.6989	0.0456	12.64%
Case III	0.4033	0.9132	0.5023	0.1868	0.2169	0.6552	0.1831	0.4744	0.0250	0.9491	0.0601	16.14%

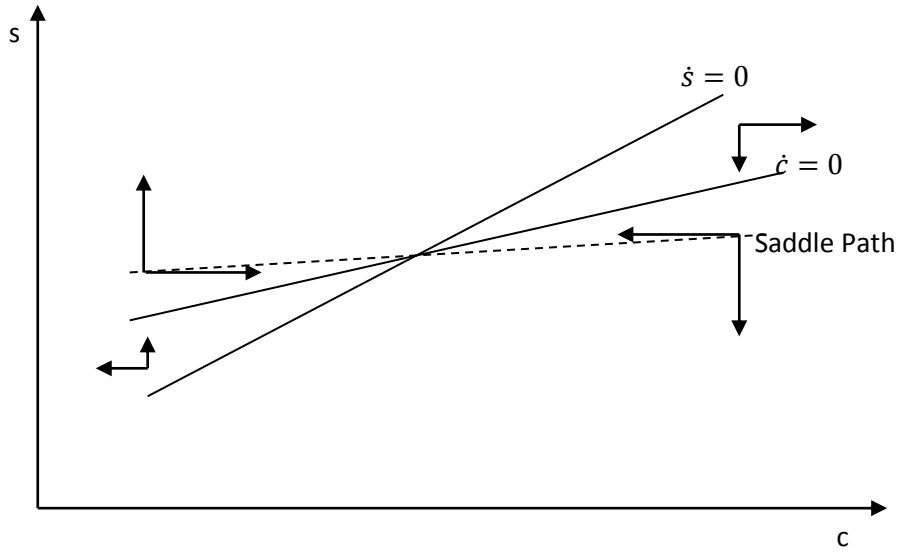
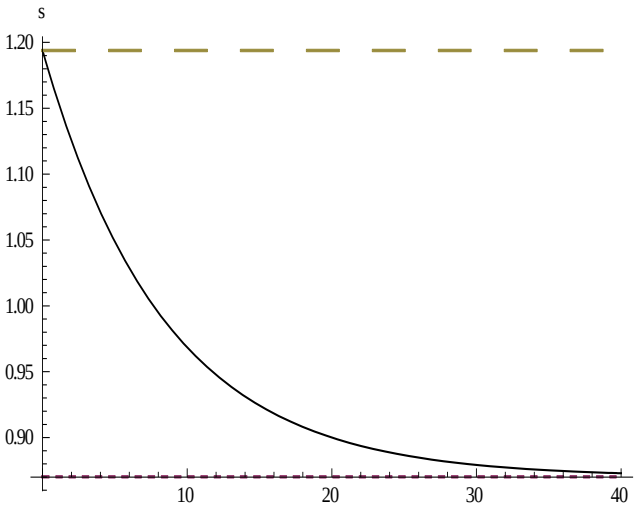


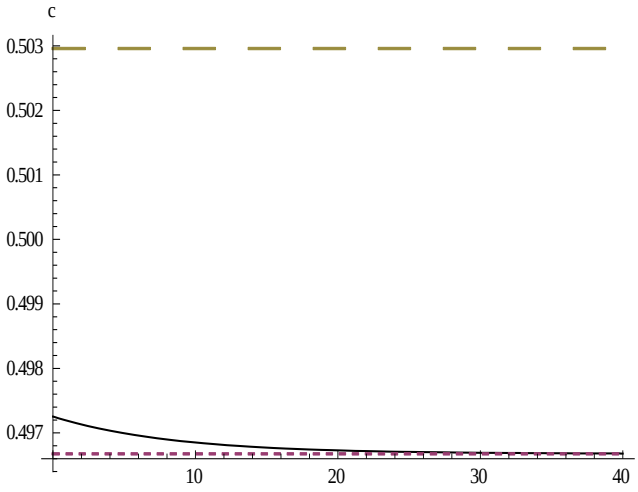
Figure 1: Phase-Diagram

Figure 2: Dynamic Responses to Innovation Shock

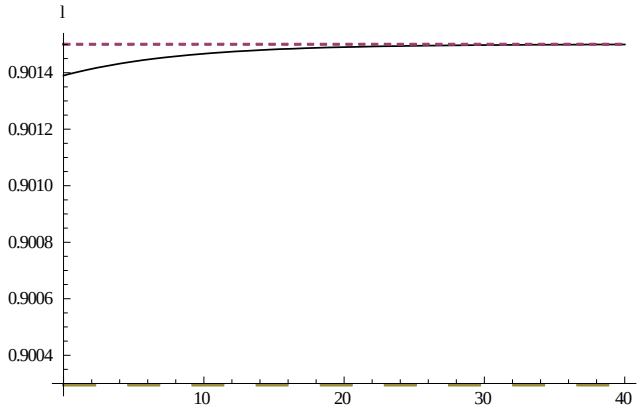
2.1 Social Capital



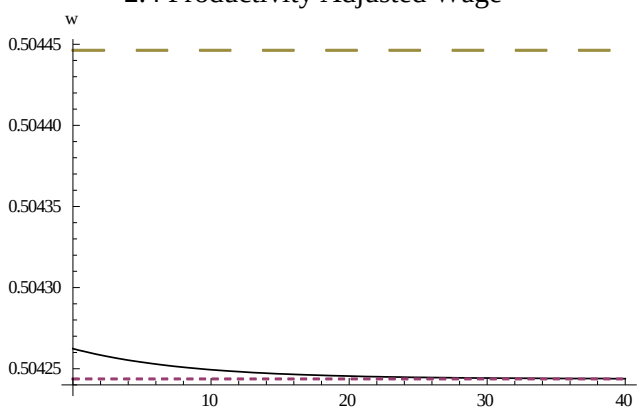
2.2 Productivity Adjusted Consumption



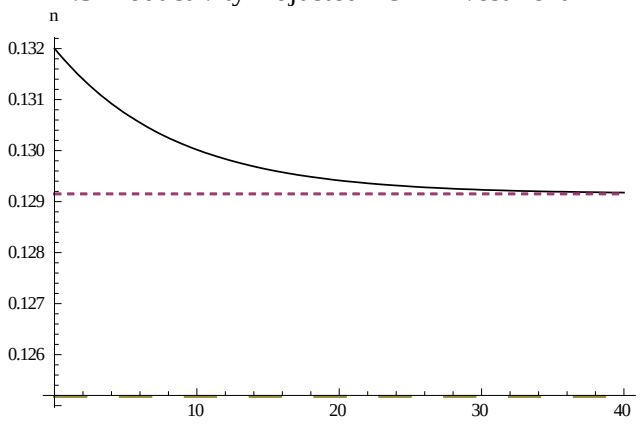
2.3 Labor



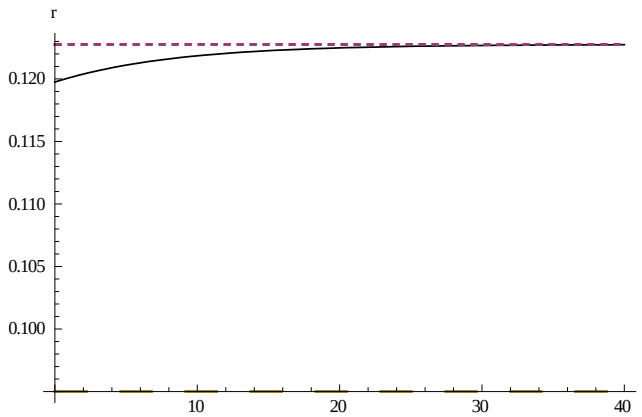
2.4 Productivity Adjusted Wage



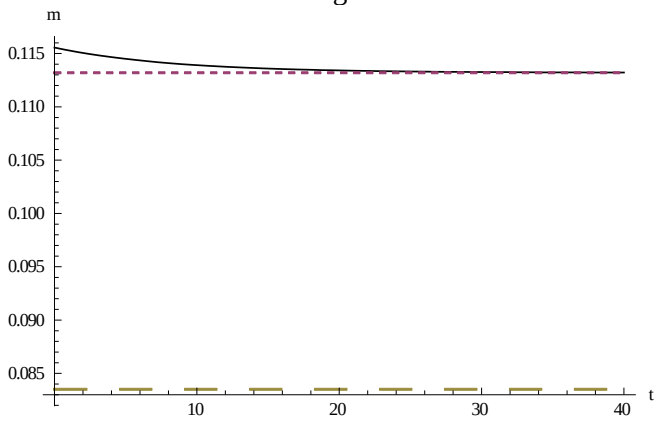
2.5 Productivity Adjusted R&D Investment



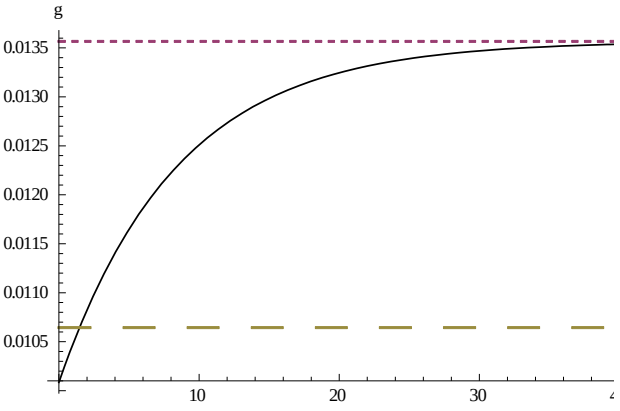
2.6 Interest Rate



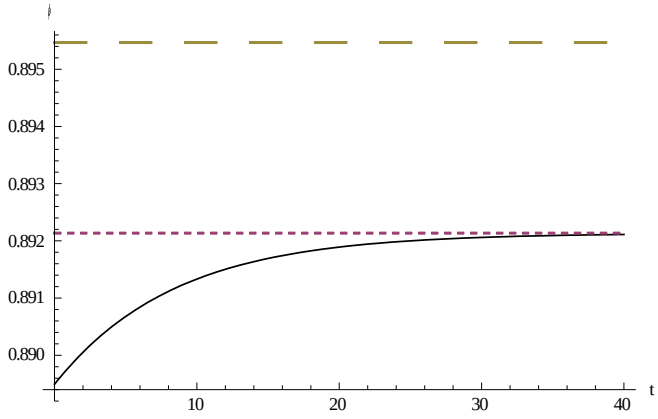
2.7 Labor Migration Rate



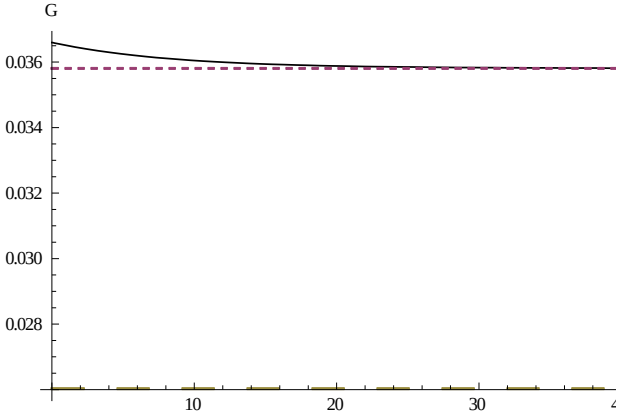
2.8 Formal Institutions



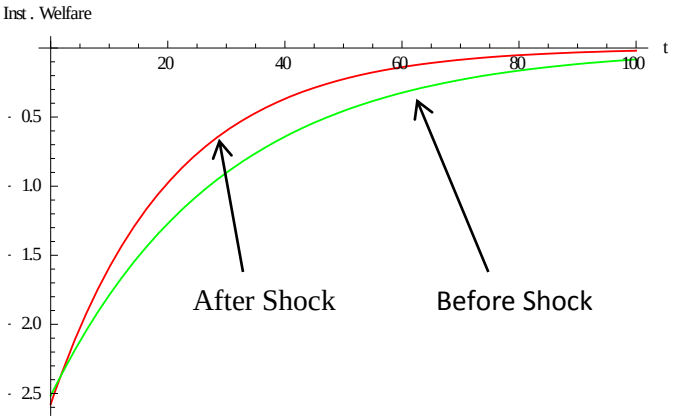
2.9 Institutions



2.10 Growth Rate



2.11 Welfare Path



Appendix

Appendix A: *Proof of Proposition 1*

Part 1

$$\frac{dn}{dg} = \frac{-\lambda\,(1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha}\alpha\, l^{\alpha}\,\phi\, l_c + r\, l\,(-\phi_g(-1+(w\,l)_c) - \phi_s s_l l_c)}{\left[\begin{array}{c}\lambda\,(1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha}\alpha l^{\alpha}\,\phi\,\lambda\ln\gamma v\rho\, l_c \\ +l\left(\left((-1+\rho)\lambda\ln\gamma-\lambda\left(1+\frac{\alpha}{1-\alpha}\ln\gamma\right)\phi\right)(-1+(w\,l)_c)+r\,((-1+(w\,l)_c)s_m m_n+\lambda\ln\gamma v\rho\, s_l l_c)\phi_s\right)\end{array}\right]} > 0 \qquad \text{(A1)}$$

if,

(1) $\quad -(-1+(wl)_c)\phi_g - \phi_s s_l l_c > 0$, and (A2)

(2) $\quad (-1+(wl)_c)s_m m_n + \lambda\, ln\,\gamma\, v\rho\, s_l\, l_c \;> 0$ (A3)

Part 2

$$\frac{dn}{db} = -\frac{(r\, l_c(-1+(w\,l)_c)\,\phi_g)}{\left[\begin{array}{c}\lambda\,(1-\alpha)\left(1+\frac{1}{1-\alpha}\ln\gamma\right)^{\alpha}\alpha l^{\alpha}\,\phi\,\lambda\ln\gamma v\rho\, l_c \\ +l\left(\left(\lambda(-1+\rho)Log[\gamma]-\lambda\left(1+\frac{\alpha}{1-\alpha}\ln\gamma\right)\phi\right)(-1+(w\,l)_c)+r((-1+(w\,l)_c)s_m m_n+\lambda\, ln\,\gamma v\rho\, s_l l_c)\phi_s\right)\end{array}\right]} > 0 \quad \text{(A4)}$$

if (A3) holds.

Appendix B: *Determinant of the Jacobian*

$$\Delta = a11\; a22 - a12\; a21 = \frac{c\Omega(l)}{blrv^2(B\phi+\lambda\ln\gamma)^2}\Big(Br\big(a(lmns(-1+(wl)_c) + Bll_c v\phi + Al^{\alpha}l_c mnsv\alpha\phi) - blv(-1+(wl)_c)(Bm\phi + mnrs\phi_s)\big) + \lambda\ln\gamma\,\Big(ar\,\Big(Al^{\alpha}l_c mnsv\alpha\phi + l\big(mns(-1+(wl)_c) + Blcv(1+\phi)\big)\Big) + Al^{\alpha}l_c v\alpha(Bm\phi(1+brv\rho\phi) + mnrs\phi S) + blrv(Bm(-1+(wl)_c)(-1+(-1+\rho)\phi) - r(mns(-1+(wl)_c) + Bl_c v\rho\phi)\phi_s) + v\lambda\big(Al^{\alpha}l_c m\alpha(1+brv\rho\phi) + lr(al_c + bm(-1+(wl)_c)(-1+\rho) - bl_c rv\rho\phi_s)\big)\ln\gamma\Big)\Big) \;< 0 \qquad \text{(B1)}$$

if $\quad b\; m\; w > a \quad$ (if b is sufficiently high) (B2)

Appendix C: *Proof of Proposition 2*

Appendix D: *Resource constraint of the Social Planner*

Since the social planner takes into account only the incremental profit when considering the value of an innovation, the profit generated by any innovation continues forever. Therefore,

value of all the assets held by consumers is the present discounted value of all future profit at the current level of innovation.

That is, $V = \frac{\Pi}{r} \quad \Rightarrow rV = \Pi$ (D1)

Resource constraint is given by:

$$Y = C + N + G - (1 - \phi)rV \quad \text{(D2)}$$

Using $rV = \Pi = (1 - \alpha)Y$, we get

$$N_t = \left(\alpha + \phi\left(s_t, \frac{G_t}{A_t}\right)(1 - \alpha)\right)Y_t - C_t - G_t \quad \text{(D3)}$$

Appendix E: ***Derivation of Γ_1 and Γ_2***

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