Three Simple Models of Social Capital and Economic Growth

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Abstract

This paper proposes three theoretical growth models that incorporate social capital, based on varied expositions on the concept of social capital and the empirical evidence gathered to date. In these models, social capital impacts growth by assisting in the accumulation of human capital, by affecting financial development through its effects on collective trust and social norms, and by facilitating networking between firms that result in the creation and diffusion of business and technological innovations. We solve for the optimal allocation of resources towards the building of social capital, examine the models' comparative statics and transitional dynamics, and demonstrate how a tax and subsidy scheme may correct the resource under-allocation that results from the public good aspect of social capital creation.

1   Introduction

The concept of social capital, which refers to features of social organizations, such as networks, norms and trust, that facilitate coordination and cooperation for mutual benefit, has found increasing acceptance among economists in the last five years. Like other sociological concepts, its amorphous nature elicited initial skepticism among mainstream economists, who questioned the validity of classifying social interactions as a form of capital.[1] Many economists now

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[1]See, for example, Arrow (2000) and Solow (2000).

acknowledge that social capital shares similarities with physical and human capital in its intertemporal dimension and its ability to generate a stream of future benefits.

More importantly, different facets of social capital have been demonstrated to have a profound impact on economic development and growth. Indicators of social capital has been shown to affect local financial development as well as general economic growth in Italy [Guiso, Sapienza and Zingales (2000), Helliwell and Putnam (1995)]. Many cross-country studies have shown the importance of trust in determining an economy's growth prospects. For example, Knack and Keefer (1997) find that a one-standard deviation increase in a survey-based measure of country-level trust increases economic growth by more than half a standard deviation. Easterly and Levine (1997) and others have highlighted ethnic divisions and inequality as sources of slower growth through their effects on trust, social cohesion, economic policymaking, and violent conflict. In addition, social capital has been shown to be correlated with superior outcomes in watershed conservation in Rajasthan, India [Krishna and Uphoff (2002)], in agricultural trading in Madagascar [Fafchamps and Minten (2002)], in community-based water projects in Central Java, Indonesia [Isham and Kahkonen (2002)], and in voluntary solid waste management in Dhaka, Bangladesh [Pargal, Gilligan, and Huq (2002)]. Further evidence of the impact of social capital on development emerge from studies in Burkina Faso, Paraguay, Thailand, Bolivia, and Mexico that are compiled in Isham, Kelly and Ramaswamy (2002).

Despite the burgeoning number of empirical studies on the economic impact of social capital, there have been relatively few attempts at building theoretical models of social capital and growth. Zak and Knack (2001) construct a largely microeconomic model where social capital ameliorates the principal-agent problem between investors and investment brokers.[2] Glaeser, Laibson, and Sacerdote (2002) model an individual's decision on the optimal amount of social capital to invest in, where the opportunity cost of time and occupational returns to social skills are exogenously given. Routledge and von Amsberg (2003) propose a model where individuals in a community maximize lifetime gains to trade, with friendly trade being Pareto optimal but unfriendly trade the dominant strategy in one-shot game. Social capital, the social structure that supports cooperation, depends on the probability two individuals meet

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[2]In Zak and Knack (2001), there is a continuum of consumers who require investment brokers to access credit markets. Only brokers know actual investment returns, creating a moral hazard problem. Before investments are closed out in the second period, brokers' types are revealed and consumers decide on how much time to spend investigating the broker. The model predicts that low trust environments reduce investment and growth rates, and very low trust societies may be caught in a poverty trap.

in a period, which in turn depends on community size.[3] Technological innovations require a reallocation of labour - frictionless labour mobility leads to higher productivity but destroys social capital - leading to a trade-off between labor efficiency and social capital.

In this paper, we propose three parsimonious growth models where social capital impacts growth by (i) assisting in the accumulation of human capital, (ii) affecting financial development through its effects on collective trust and social norms, and (iii) facilitating collaboration and networking between firms that result in the creation and diffusion of technological and business innovations. Because of the multifaceted nature of social capital, instead of formulating a "grand theory" of social capital and economic growth, each model seeks to build a theoretical basis for the observed empirical relationship between one particular aspect of social capital and growth. Our model differs from Glaeser et al. (2002) and Routledge and von Amsberg (2003) in that the opportunity cost of time spent in creating social capital is endogenous. While Routledge and von Amsberg model the potentially destructive impact of technology-induced economic growth on social capital, we explore multiple channels through which social capital impacts growth. The approach we adopt is a logical development of the representative agent endogenous growth framework, building on models of learning-by-doing, human capital, and R&D by Romer (1986), Lucas (1988), Romer (1990), and Jones (1995). For example, our first model is an extension of the Lucas (1988) human capital model that captures the interdependence between human capital and social capital accumulation. Our approach allows us to solve for the optimal allocation of human resources (whether human capital or labor time) to each activity, and consequently to determine the extent of under-allocation of resources to social capital-creating activities arising from the public goods aspect of social capital. We also examine the comparative statics and/or transitional dynamics of each model.

The paper is organized as follows: Section 2 examines the concept of social capital - its definition(s), attributes and classifications. Sections 3, 4 and 5 are devoted to expositions of theoretical models in which social capital impacts growth through the channels of human capital accumulation, financial development, and technological innovation. Section 6 discusses the implications for public policy derived from these models, while section 7 concludes.

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[3]In this model, a larger community increases the number of trades but reduces the probability that each trade will be friendly.

2   The Concept of Social Capital

2.1   Defining Social Capital

Like many sociological concepts, social capital encompasses many different meanings. While some researchers define social capital in terms of trust and norms of civic cooperation, others characterize it in terms of cultural values such as compassion, altruism and tolerance, while still others emphasize institutions and the quality and quantity of "associational" life. Some researchers find it practical to separate the *sources* of social capital (primarily, social networks) from their *consequences* (which can be positive or negative, depending on the circumstances), such as trust, tolerance and cooperation. Below we present several definitions that relate to particular aspects of social capital that we wish to capture in our models.

According to Coleman (1990), "What I mean by social capital in the raising of children is the norms, the social networks and the relationships between adults and children that are of value for the child growing up. Social capital exists within the family, but also outside the family, in the community ... in the interest, even the intrusiveness, of one adult in the activities of someone else's child." Education, for Coleman, is the strongest expression of the resources generated by the relationships, values, and trust that constitute social capital. [Field, Schuller and Baron (2000)]. These resources include obligations and expectations, information channels, norms and effective sanctions that constrain or encourage certain types of behavior in children.

Putnam's (1996) concept of social capital focuses on features of social life that enable participants to act together more effectively to pursue shared objectives. While Coleman examines the application of social capital to facilitating the accumulation of human capital by particular individuals, Putnam applies the concept at a broader sociological and geographical scale - at the regional level. Networks of civic engagement (neighborhood associations, choral societies, cooperatives, sports clubs, mass-based parties etc.) are an essential form of social capital that foster robust norms of reciprocity that in turn fuels social trust.

Maskell (2000) argues that social capital refers to the values and beliefs that citizens share in their everyday dealings and which give meaning and provide design for all sorts of rules. However, he believes that the formation of social capital is often not a *deliberate* action: social capital is accumulated within the community through processes of interaction and learning. Social capital is in part accumulated as an unintended and even unanticipated consequence of economic activity as people interact with workplace colleagues rather than with their family and friends. Social capital, then, may arise in the commercial

workplace, indeed even in a multinational corporation, as much as it does in civil society.

2.2   Key Attributes of Social Capital

Social capital has several key attributes that form a common thread running through each of our theoretical models. Firstly, social capital is capital because it is an *accumulated stock* from which a stream of benefits flows. Social capital is therefore more than simply a set of social organizations or social values.[4] Social capital can directly enhance output or lead to higher productivity of other resources, such as human and physical capital.

However, as Grootaert (2002) points out, social capital exhibits several characteristics that distinguish it from other forms of capital. For example, like human capital but unlike physical capital, social capital may accumulate as a result of its use. That is, social capital is both an input and an output of collective action. To the extent that social interactions are drawn upon to produce mutually beneficial output, the quality or quantity of these interactions is likely to rise.

In addition, although every other form of capital has a potential productive impact in a typical Robinson Crusoe economy, social capital does not - creating and activating social capital requires at least *two* people. Social capital therefore has public good characteristics, so it is likely to be underproduced because of incomplete collective internalization of the positive externalities inherent in its production. Coleman (1988) argues that the kinds of social structures that enable social norms and the sanctions that enforce them do not benefit primarily the person or persons whose efforts are necessary to bring them about, but benefit all those who are part of such a structure.[5]

On the other hand, social capital, like other forms of capital, is not costless to produce and requires a significant amount of time and effort, if not always money. It is, according to Bourdieu (1986), 'the product of investment strategies, individual or collective, consciously or unconsciously aimed at establishing or reproducing social relationships that are directly usable in the short or long term.' (p.251) Trusting relationships among members of a sports

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[4]However, like Arrow (2000), Solow (2000) is skeptical about the "capital" aspect of social capital. He argues that "behavior patterns" is a more appropriate term.

[5]Coleman gives the example of a dense set of associations among some parents in certain schools. These are the result of a small number of persons, ordinarily mothers who do not hold full-time jobs outside the home. However, these mothers themselves experience only a subset of the benefits of this social capital surrounding the school. Should one of them choose to abandon these activities to take a full time job, the withdrawal of these activities constitutes a loss to all those other parents whose associations and contacts are dependent on them.

club, professional organization, or civic association often take a very long time to build. Moreover, since trust is more easily destroyed than rebuilt, there is a maintenance expense to social capital.

2.3 Classifying Social Capital

2.3.1 The Scope and Sources of Social Capital

Social capital may exist at three levels. *Micro*-level social capital exists within networks of individuals or households. It has come to be accepted that the externalities from these interpersonal interactions may either be positive or negative. For example, interactions between individuals in a network which create social capital may benefit these individuals at the expense of those excluded from the network. Micro-level social capital consists of 'bonding' and 'bridging' social capital. The former refers to relations between family members, close friends and neighbors, the latter to more distant associates and colleagues who have somewhat different demographic characteristics. In our first model, we will argue that micro-level bonding social capital plays a key role in human capital accumulation. In our second model, bridging social capital builds collective trust which aids financial development.

The analysis of social capital at the *meso* level expands the concept of social capital to include vertical as well as horizontal associations and behavior within and among other entities, such as firms. While bonding or integrating relationships take place within a group and facilitate interaction and collective action within it, linking relationships strengthen linkages between the group and other organizations. The capacity to leverage resources, ideas and information from formal institutions beyond the community, most notably the state, is a key function of linking or meso-level social capital [Woolcock (2002)]. It is meso-level social capital that facilitates R&D networks in our third model.

The last and most encompassing view of social capital includes the social and political environment that shapes social structure and enable norms to develop. This *macro* view includes the most formalized institutional relationships and structures, such as the political regime, the rule of law, the court system, and civil and political liberties. However, in this paper, we will not attempt to model the relationship between macro-level social capital (also known as 'government social capital' or 'social infrastructure') and growth, as this has been done elsewhere, such as Chin (2002) and Gradstein (2003).

2.3.2 The Forms of Social Capital

At each of the three levels explained above, social capital affects economic growth as a result of interactions between two distinct types of social capital

- *structural* and *cognitive*. As noted in Grootaert and van Bastelaer (2002), structural social capital facilitates information sharing and collective action and decision-making through established roles and social networks supplemented by rules, procedures and precedents. Cognitive social capital, on the other hand, refers to shared norms, values, trust, attitudes and beliefs, and is a more subjective and intangible concept. Krishna (2000) terms the first type of social capital as 'institutional capital' and the second as 'relational capital'. The two forms of social capital are often complementary. For example, cooperation between parents who are neighbors are based on a cognitive bond, and may also be reflected in a formal structural arrangement if they are both deeply involved in the parents-teachers association of the local school.

3   Social Capital and Human Capital

The impact of civil society, the way individuals in a society work together for common purposes, on the education and raising of children has long been recognized. This is perhaps best encapsulated in the old African proverb, "It takes a village to raise a child". Among social scientists, James S. Coleman was one of the first to make explicit reference to the concept of social capital in evaluating society's impact on human capital accumulation. Coleman (1994) argues that "social capital is the set of resources that inhere in family relations and in community social organization and that are useful for the cognitive or social development of a child or young person." (p.300) It is interesting to note that the great pioneer in the study of the economics of human capital, Gary Becker, recognized the importance of family relations on human capital accumulation. Becker (1993) acknowledges that "(n)o discussion of human capital can omit the influence of families on the knowledge, skills, values, and habits of children ... Therefore, even small differences among children in the preparation provided by their families are frequently multiplied over time into large differences" (p.21).

In Coleman's view, the family background of a student affects his accumulation of skills and knowledge in three ways. Financial capital, approximated by the family's wealth or income, provides physical resources that can aid achievement: a fixed place in the home for studying, materials to aid learning, and financial resources that smooth family problems. Human capital, approximately measured by parents' education, provides the potential for a cognitive environment for the child that aids learning.[6] Coleman then argues that this human capital possessed by parents, if not complemented by social capital

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[6]This argument supports the inclusion of positive spillover effects from the existing stock of human capital on new human capital creation in the Lucas (1988) model.

embodied in family relations, is irrelevant to their child's educational growth. Similarly, Woolcock (2002) argues that the most innovative ideas in the mind of the brightest person will amount to little unless that person also has access to others to inform, correct, assist with and disseminate their work. These observations form the basis of our first theoretical model of social capital and growth.

3.1 Empirical Evidence

Coleman (1988) provides empirical evidence that the presence of social capital within the family is important in determining whether a child drops out of school. He uses the number of siblings, which measures the dilution of adult attention to a child, as a proxy for social capital. In addition, Coleman also finds that social capital outside the family has a significant impact on the dropping out decision. Students who have changed schools because their parents moved are more likely to drop out than their peers. For families that have moved often, the social relations that constitute social capital are broken at each move. Moreover, Coleman finds that dropout rates are lower in religiously based private schools than in public or secular private schools. Whether parents devote time to religious activities, it appears, affects human capital accumulation in their offspring.

Grootaert, Oh and Swamy (2002) present evidence that community participation in parent-teacher associations in Burkina Faso is associated with substantially higher rates of school attendance. Other important empirical findings pertaining to our first model may be found in Costa and Kahn (2001), where the rise in women's labor force participation rates explains the observed decline in social capital produced within the home, and in Gleaser, Laibson and Sacerdote (2000), who find that people who invest in human capital also invest in social capital. Moreover, social capital appears to have interpersonal complementaries: people who belong to groups with more social capital tend to invest more in social capital themselves.

3.2 The Formal Model

In each of our three models, there are many identical infinitely-lived agents. Here, each agent faces a trade-off between devoting resources (human capital, specifically) to final goods production (which enables current consumption), to human capital accumulation, and to the building of bonding social capital. The last activity produces no income by itself but increases the effectiveness of human capital accumulation. In an overlapping generations framework, this activity would include involvement in parent-teacher associations and "quality

time" spent with one's offspring.

The formal model we propose incorporates the following elements: (1) the building or accumulation of social capital requires resources to be diverted from other productive uses; (2) social capital decays over time without new "investment" in social capital; (3) the existing stock of social capital has spillover effects on the building of new social capital; (4) social capital has a positive impact of human capital accumulation but no direct effect on final goods production; (5) human capital has positive intertemporal spillovers in its accumulation; and (6) human capital is an important input in final goods production.[7]

Mathematically, the model may be summarized as follows:

$$\dot{K} = Y - C - \delta_K K, \tag{1}$$

$$\dot{H} = E\left(u_H H\right)^{1-\psi} S^{\psi} - \delta_H H, \tag{2}$$

$$\dot{S} = P\left(u_S H\right)^{1-\sigma} S^{\sigma} - \delta_S S, \tag{3}$$

$$Y = A K^{\alpha}\left(u_Y H\right)^{1-\alpha}, \tag{4}$$

where K is the aggregate physical capital stock, Y is aggregate output, C is aggregate consumption, H is the stock of human capital, S is the stock of social capital, δ_K is the physical capital depreciation rate, δ_H is the human capital depreciation rate, δ_S is the social capital depreciation rate, A, E and P are productivity parameters, and α, σ and ψ are elasticity parameters constrained to lie on the (0,1) interval. The above equations describe the evolution of the physical, human, and social capital stocks respectively. The model collapses to the Lucas (1988) model of human capital and growth if $\psi = 0$ since S and the $\dot{S}$ equation then become irrelevant.

3.2.1 The Decentralized, Competitive Model

We now flesh out the microeconomic foundations of our model of human and social capital. In the final goods sector, firms seek to maximize profits, π_Y, by choosing the optimal allocation of labor, u_Y, and the optimal amount of physical capital, K :

$$\max \ A K^{\alpha}\left(u_Y H\right)^{1-\alpha} - w_Y u_Y H - r_K K,$$

where w_Y is the wage rate in the final goods sector and r_K is the rental price of capital.

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[7]That the stock of social capital does not directly impact final good production is a necessary abstraction in order for social capital and human capital to be separately identified.

Optimizing firms equate the marginal products of labor and capital to the wage rate and the rental price of capital respectively:

$$
\begin{aligned}
w_Y &= (1 - \alpha) A k^\alpha u_Y^{-\alpha}, \\
r_K &= \alpha A k^{\alpha-1} u_Y^{1-\alpha},
\end{aligned}
$$

where $k \equiv K/H$ denotes the physical-human capital ratio.

Individuals seek to maximize lifetime utility subject to constraints, that is:

$$
\max \int_0^\infty e^{-\rho t} \frac{C^{1-\theta} - 1}{1 - \theta} dt
$$

subject to

$$
\begin{aligned}
\dot{K} &= r_K K + w_Y u_Y H + w_H u_H H - P_H \dot{H} - C, \\
\dot{H} &= E (u_H H)^{1-\psi} S^\psi - \delta_H H, \\
\dot{S} &= \widetilde{P} (u_S H)^{1-\sigma} - \delta_S S, \\
1 &= u_Y + u_H + u_S,
\end{aligned}
$$

where w_H is the prevailing wage in the human capital sector, P_H is the price of each unit of new human capital, and $\widetilde{P} \equiv P S^s$. That is, individuals do not internalize the externalities that their formation of social capital confer on the accumulation of social capital by others. This is the public good aspect of social capital that we discussed earlier. Note, however, that individuals fully recognize the impact of social capital accumulation on human capital accumulation. (Indeed, this may be their sole motive for building social capital!) In addition, we assume that educational services are priced so that they exactly cover the costs of providing such services, that is $P_H \dot{H} = w_H u_H H$.

Note that the production functions for new human capital and social capital both exhibit constant returns to scale. This restriction is required in order for all forms of capital to grow at the same rate on the balanced growth path. Lastly, for tractability's sake, we assume that social capital by itself does not give pleasure to the individual and is thus excluded from the utility function.

3.2.2 Solving the Model

We define the following variables that are constant in the steady state: $k \equiv K/H$ (the physical capital-human capital ratio), $s \equiv S/H$ (the social capital-human capital ratio), $c \equiv C/H$ (the consumption-human capital ratio), and $y \equiv Y/H$ (the output-human capital ratio).

In the steady state,

$$u_H^* = \frac{(1-\psi)(\gamma_H^* + \delta_H)}{\rho + \theta\gamma_H^* + \delta_H},$$

$$u_S^* = \frac{\psi(1-\sigma)(\gamma_H^* + \delta_S)}{(1-\psi)(\rho + \theta\gamma_H^* + \delta_S)}u_H^*,$$

$$s^* = \left(\frac{\rho}{\gamma_H^* + \delta_S}\right)^{\frac{1}{1-\sigma}}u_S^*,$$

where γ_H^* is the steady state growth rate of the economy. (See the Appendix for details.)

Defining the implicit function $f(\gamma_H^*) = 0$, where $f(\gamma_H^*) \equiv \gamma_H^* + \delta_H - Eu_H^{*1-\psi}s^{*\psi}$, we solve numerically for γ_H^* after substituting the above expressions for u_H^*, u_S^*, and s^*.[8] Once γ_H^* is found, it can be substituted back into these same expressions to obtain u_H^*, u_S^*, and s^*. Furthermore,

$$k^* = \left(\frac{A\alpha}{\rho + \theta\gamma_H^*}\right)^{\frac{1}{1-\alpha}}(1 - u_H^* - u_S^*),$$

$$c^* = \frac{\rho + \theta\gamma_H^* - \alpha\gamma_H^*}{\alpha} \cdot k^*,$$

$$y^* = Ak^{*\alpha}(1 - u_H^* - u_S^*)^{1-\alpha}.$$

3.2.3 Divergence Between the Competitive and Planner Solutions

It can be shown via simulations that the competitive solution results in an under-allocation of human capital to the accumulation of social capital. That is, u_S^* is smaller in the competitive solution than in the hypothetical social planner's solution. Simulations also show that the economy's growth rate and output-capital ratio are higher in the social planner's solution. Figures 1, 2, and 3 show that the divergence between the planner and competitive solutions for the steady state growth rate (γ_H^*), allocation of human capital to social capital creation (u_S^*), and output-physical capital ratio (y^*/k^*) are decreasing in the productivity parameters E and P. (The vertical axis in each of the figures shows the ratio of the competitive solution to the planner's solution. Larger values on the vertical axis therefore indicate a smaller degree of divergence between the two solutions.) In other words, the poorer an economy is at creating human and social capital, the more harmful the inability of individuals to internalize the externalities associated with social capital accumulation.

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[8]Closed-form solutions cannot be obtained in this three-sector growth model.
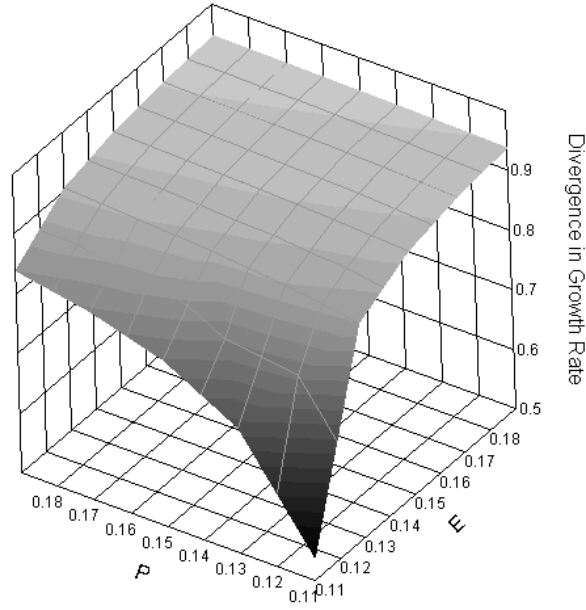
Figure 1: The Impact of Productivity Parameters on the Divergence of the Planner and Competitive Solutions for the Economy's Growth Rate
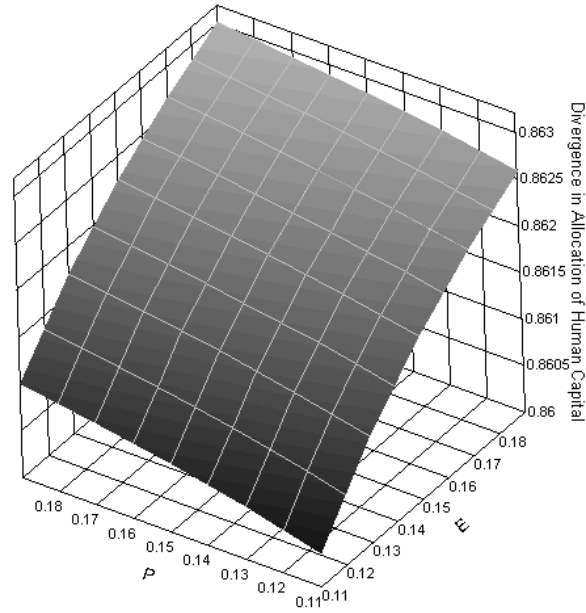

Figure 2: The Impact of Productivity Parameters on the Divergence of the Planner and Competitive Solutions for the Optimal Allocation of Human Capital
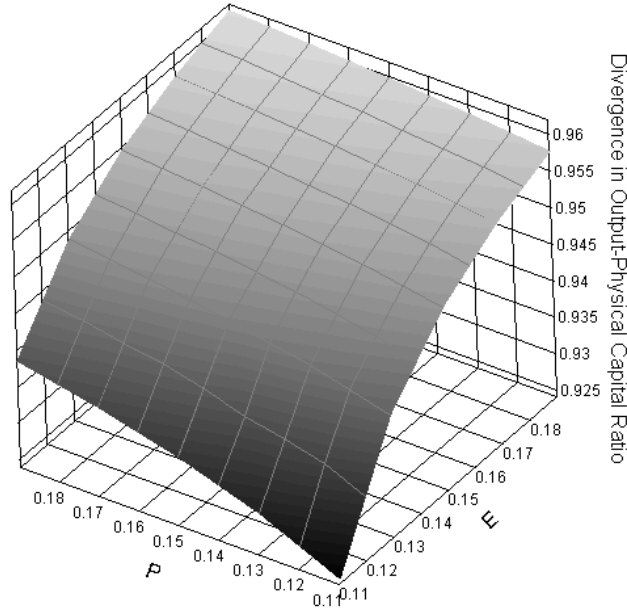
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Figure 3: The Impact of Productivity Parameters on the Divergence of the Planner and Competitive Solutions for the Steady State Output-Capital Ratio

3.3 Comparative Statics

In this section, we examine the impact of changes in the various parameters of the model on the steady state growth rate. Figure 4 shows that the steady state growth rate is increasing in θ, the risk aversion parameter, and ρ, the rate of time preference. Since social capital and human capital accumulation create long run growth but requires a short run sacrifice of consumption, a higher discount rate results in lower investment in social and human capital, and therefore lower long run growth. The steady state growth rate is increasing in the productivity parameters of the human capital and social capital accumulation equations, E and P, as well as the social capital spillover parameter in the social capital accumulation equation, σ. The stronger the public good aspect of social capital, the larger its impact on economic growth. Interestingly, there is a U-shaped relationship between the steady state growth rate and the social capital elasticity parameter in the human capital accumulation equation, ψ. Because of the constant returns to scale production functions for $\dot{H}$ and $\dot{S}$, the steady-state growth rate of the economy is higher at very low and very high values of ψ than at intermediate values.
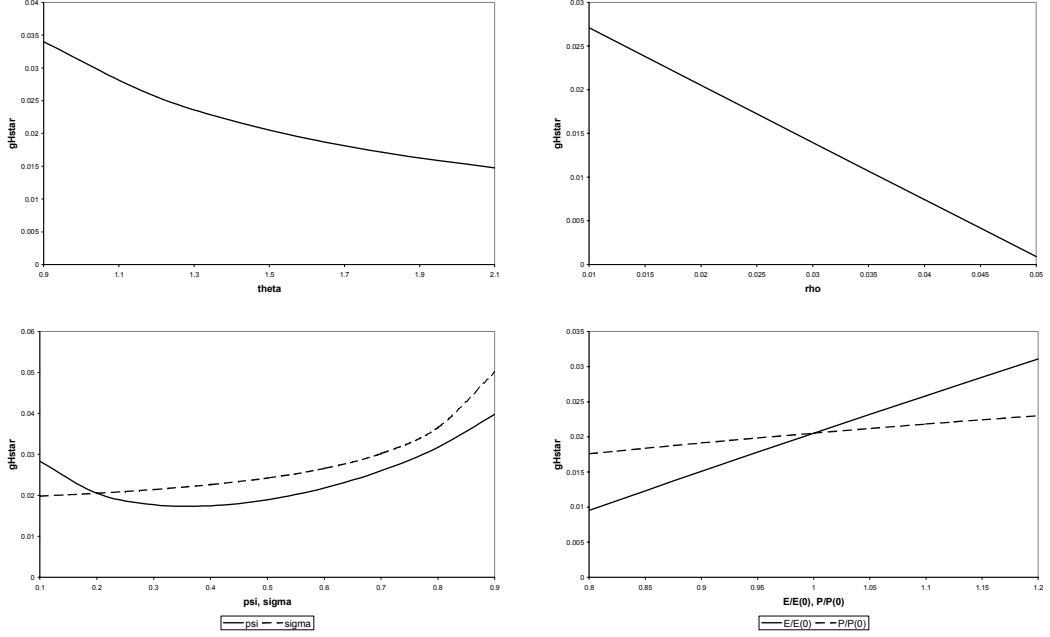
Figure 4: Effect of Various Parameters on the Steady-State Growth Rate

3.4 Transitional Dynamics

We next examine the effect of raising the productivity parameters governing the production of human and social capital. In order to present the transitional dynamics of the model graphically, it is necessary to reduce the complexity and dimensionality of the model by assuming a constant saving rate and an exogenous allocation of human capital across the three sectors. That is, we assume u_S and u_H are exogenously given. The dynamics of the model then reduce to equations characterizing the $\dot{s} = 0$ and $\dot{k} = 0$ conditions respectively:

$$s = \left(\frac{P}{E} \cdot \frac{u_S^{1-\sigma}}{u_H^{1-\psi}} \right)^{\frac{1}{1+\psi-\sigma}}, \tag{5}$$

$$k = \left[\frac{A}{E} \left(\frac{s}{u_H} \right)^{1-\psi} \phi \right]^{\frac{1}{1-\alpha}} u_Y. \tag{6}$$

The phase diagram of the simplified model in k, s space is depicted in the upper panels of Figure 5. The shape of the $\dot{k} = 0$ schedule depends on the relative magnitudes of the parameters α and ψ. The lower left panel in Figure 5 shows the impact of an increase in the productivity parameter of the human capital accumulation equation, E, while the lower right panel shows the impact
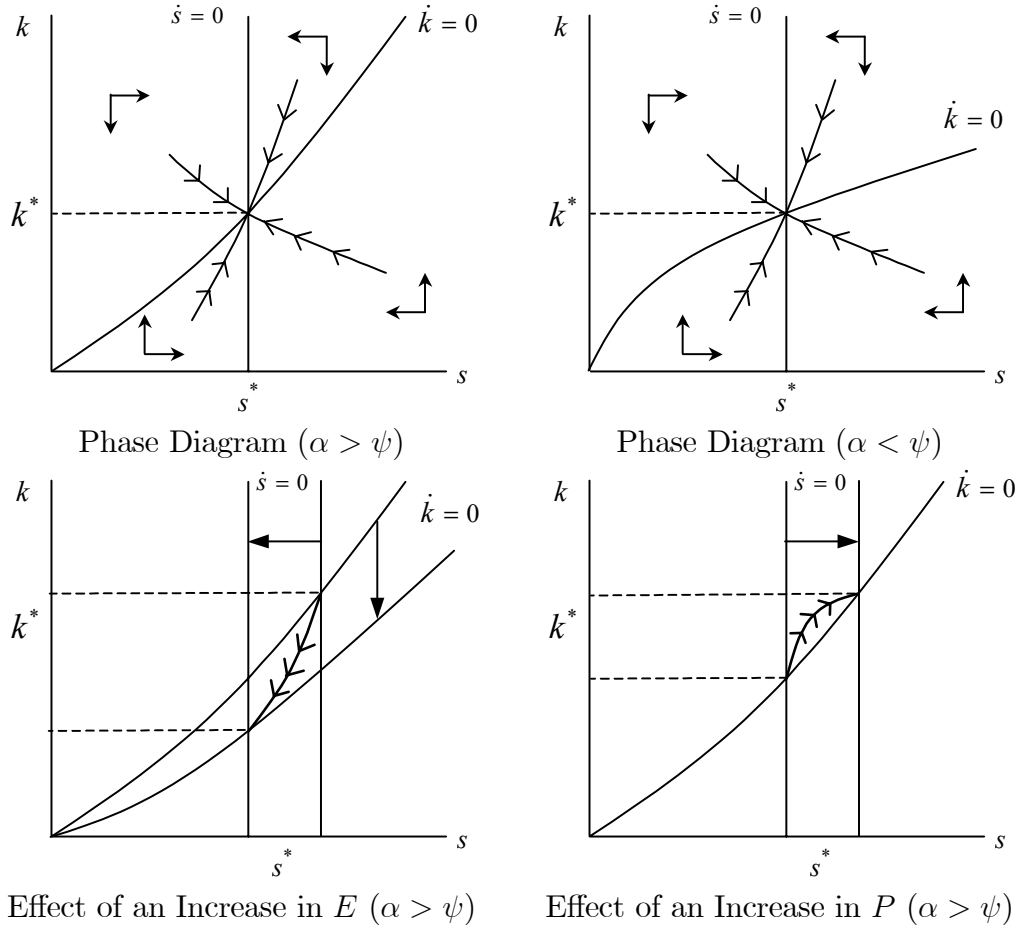
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Figure 5: Transitional Dynamics of the Model

of an increase in the productivity parameter of the social capital accumulation equation, P.

An increase in E causes both the physical capital-human capital ratio, k, and the social capital-human capital ratio, s, to decrease. This is caused by human capital increasing proportionately more than the other two forms of capital. On the other hand, an increase in P causes both k and s to increase. That is, physical capital and social capital increase by proportionately more than human capital. Therefore, government policies that increase the efficiency of human capital accumulation have quite different effects from policies that increase the efficiency of social capital accumulation.

4 Social Capital and Financial Development

A second channel through which social capital may impact economic growth is financial development. Guiso, Sapienza and Zingales (2000) produce evidence of this channel by using microeconomic data on households and firms and exploiting well known differences in social capital and trust across different parts of Italy. Controlling for a large set of household characteristics and other environmental variables such as the quality of legal enforcement and GDP per capita, they find that in areas of country with high social trust, people invest less in cash and more in stock, use more checks, have greater access to institutional credit, and make less use of informal credit. In these areas, firms also have more access to credit and are more likely to have multiple shareholders. In addition, the effect of trust is stronger among less-educated people and where legal enforcement is weaker.

4.1 A Model of Bridging Social Capital

In our proposed model of social capital and financial development, social capital affects growth by increasing the efficiency of the financial sector in transforming individual or household savings into productive investments by firms in the final goods sector. The accumulation process for social capital is similar to that in our first model except that raw labor replaces human capital as an input in production. Individuals may devote time to non-market activities such as participating in community clubs, associations and other networks of civic engagement. These interactions between individuals create bridging social capital of the Putnam variety that raise the level of generalized trust in the community. This in turn spurs the development of financial institutions, resulting in financial intermediation that better reconciles the needs of savers with those of borrowers.

Specifically, the quantity of social capital per worker, S/L, determines the fraction of savings that is transformed into productive new capital. The relationship is allowed to be a non-linear one through the inclusion of the parameter $\iota > 0$:

$$\dot{K} = \left(\frac{S}{L}\right)^{\iota} (Y - C) - \delta_K K, \tag{7}$$

$$\dot{S} = P\left(u_S L\right)^{1-\sigma} S^{\sigma} - \delta_S S, \tag{8}$$

$$Y = AK^{\alpha} \left(u_Y L\right)^{1-\alpha}, \tag{9}$$

$$1 = u_Y + u_S \tag{10}$$

where L denotes the stock of labor (or number of workers), u_Y and u_S denote

the allocation of labor time to final goods production and social capital accumulation respectively, A and P are productivity parameters, and (α, σ) are parameters constrained to lie on the (0,1) interval. Our physical capital accumulation equation builds on Pagano (1993). In Pagano (1993), $I = \phi S$, where ϕ is an exogenous parameter and a proxy for the level of financial development, and S and I refer to saving and investment respectively. The production function for $\dot{S}$ must exhibit constant returns to scale since S and L both grow at rate n in the steady state.[9]

4.1.1 Solutions

Analogous to the first model, we define the following variables which are constant in the steady state: $k \equiv K/L$ (physical capital per worker), $s \equiv S/L$ (social capital per worker), $c \equiv C/L$ (consumption per worker), and $y \equiv Y/L$ (output per worker). The efficiency of financial intermediation is therefore given by s^ι.

The steady-state solutions are shown in the Appendix to be:

$$
\begin{aligned}
u_S^* &= \frac{\Gamma}{\Gamma + \Phi}, \\
\Gamma &= \alpha \iota \left(1 - \sigma\right) \left(n + \delta_S\right) \left(n + \delta_K\right), \\
\Phi &= \left(1 - \alpha\right) \left(\rho + \delta_K\right) \left[\rho + \delta_S - \sigma \left(n + \delta_S\right)\right],
\end{aligned}
\tag{11}
$$

$$
u_Y^* = 1 - u_S^*, \tag{12}
$$

$$
s^* = \left(\frac{P}{n + \delta_S}\right)^{\frac{1}{1-\sigma}} u_S^*, \tag{13}
$$

$$
k^* = \left(\frac{s^{*\iota} A \alpha}{\rho + \delta_K}\right)^{\frac{1}{1-\alpha}} u_Y^*, \tag{14}
$$

$$
c^* = \frac{\rho + \delta_K - \alpha \left(n + \delta_K\right)}{\alpha} \cdot \frac{k^*}{s^{*\iota}}. \tag{15}
$$

4.1.2 Implications

Proposition 1 *We can show that the steady state allocation of labor to social capital accumulation is decreasing in the discount rate but increasing in the elasticity parameter in the transformation of savings into investment, and is independent of the productivity parameter in the social capital accumulation equation. That is, $\partial u_S^*/\partial \rho < 0$, $\partial u_S^*/\partial \iota > 0$, and $\partial u_S^*/\partial P = 0$.*

---

[9]S/L is constant in the steady state and cannot exceed 1 in a closed economy.

Proof. Using equation (11),

$$\partial u_S^* / \partial \rho = \frac{(\Gamma + \Phi)\,\partial \Gamma / \partial \rho - \Gamma \partial \Phi / \partial \rho}{(\Gamma + \Phi)^2} < 0,$$

since $\partial \Gamma / \partial \rho = 0$, $\partial \Phi / \partial \rho > 0$ and $\Gamma > 0$. In addition,

$$\partial u_S^* / \partial \rho = \frac{(\Gamma + \Phi)\,\partial \Gamma / \partial \iota - \Gamma \partial \Phi / \partial \iota}{(\Gamma + \Phi)^2} < 0,$$

since $\partial \Gamma / \partial \iota > 0$, $\partial \Phi / \partial \iota = 0$, and $\Phi > 0$. Finally,

$$\partial u_S^* / \partial P = \frac{(\Gamma + \Phi)\,\partial \Gamma / \partial P - \Gamma \partial \Phi / \partial P}{(\Gamma + \Phi)^2} = 0.$$

since $\partial \Gamma / \partial P = 0$ and $\partial \Phi / \partial P = 0$. ∎

Proposition 2 *In the steady state, social capital per worker, s, and the efficiency of financial intermediation, s^ι, are decreasing in the discount rate, ρ, and increasing in the productivity parameter in the social capital accumulation equation, P.*

Proof. From equation (13) and using Proposition 1,

$$\frac{\partial s^*}{\partial \rho} = \left(\frac{P}{n + \delta_S} \right)^{\frac{1}{1-\sigma}} \cdot \frac{\partial u_S^*}{\partial \rho} < 0,$$

Similarly,

$$\frac{\partial s^*}{\partial P} = \frac{1}{1-\sigma} \cdot \left(\frac{P}{n + \delta_S} \right)^{\frac{\sigma}{1-\sigma}} > 0$$

∎

Proposition 3 *Physical capital per worker, k, and output per worker, y, are increasing in the productivity parameter in the social capital accumulation equation, P, in the steady state.*

Proof. From equation (14), k^* is increasing in s^*. Since we showed previously that $\partial s^* / \partial P > 0$, it follows that $\partial k^* / \partial P > 0$. Note that u_Y^* is independent of P since $u_Y^* = 1 - u_S^*$ and $\partial u_S^* / \partial P = 0$. From the production function, $y^* = A k^{*\alpha} u_Y^{1-\alpha}$. Therefore, $\partial y^* / \partial P > 0$. ∎
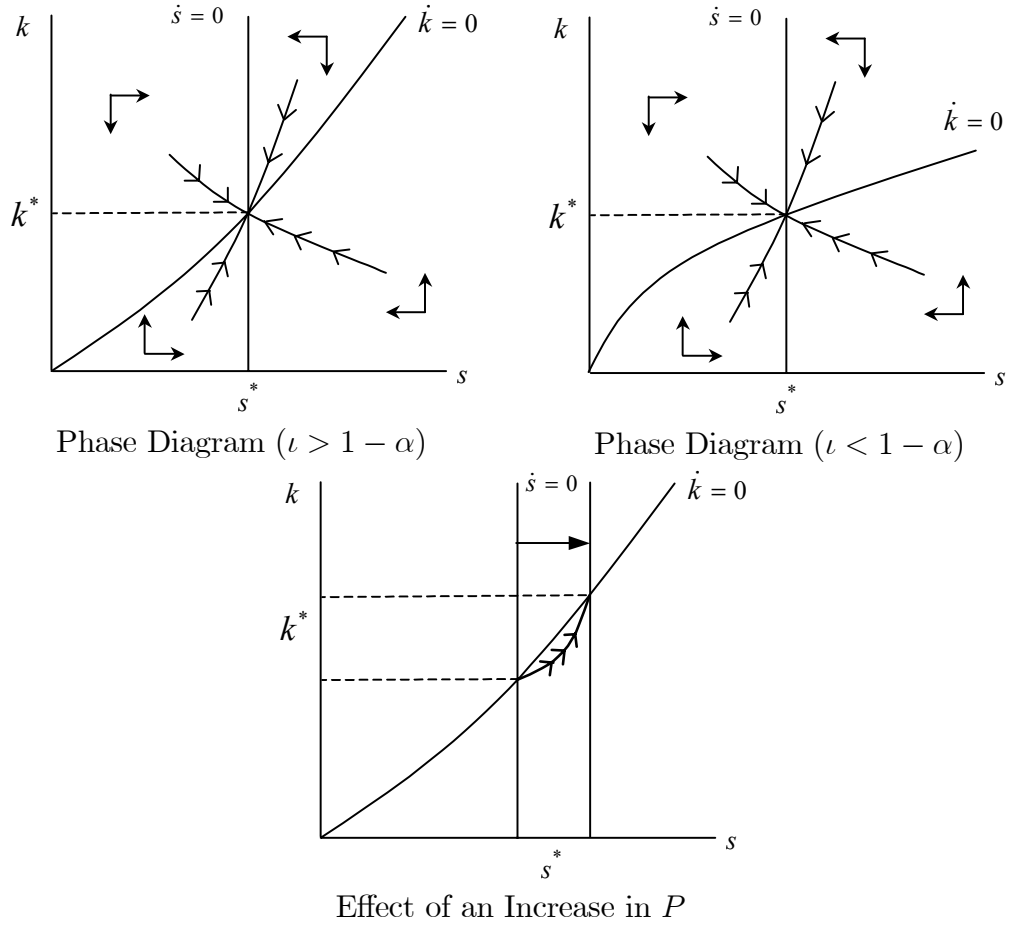
Phase Diagram ($\iota > 1 - \alpha$)

Phase Diagram ($\iota < 1 - \alpha$)

Effect of an Increase in P

Figure 6: Transitional Dynamics of the Model

4.2 Transitional Dynamics

As in our previous model, we assume a fixed saving rate and an exogenous allocation of labor in order to illustrate the dynamics of this model in k, s space. The top left and top right panels in Figure 7 depict the two possible phase diagrams, depending on the relative magnitudes of the parameters ι and α. The lower panel in the same figure show the paths of k and s following a positive shock to the productivity parameter in the social capital accumulation equation, P. (We discuss in a later section how government policies can affect this parameter.) Both k and s rise smoothly to their higher levels in the steady state, confirming Propositions 2-3.

5   Social Capital and Innovation

5.1   Social Capital and High-Technology Firms

In developed countries, the "New Economy" of the 1990s and the new millennia has witnessed a distinct gravitation towards inter-organizational linkages in the form of partnerships and consortia. Many firms and industries have formed productive collaborative relationships with other firms, laboratories and universities, as well as local and national governments to leverage the benefits of cooperation.[10] The reason for this trend is that the investments required to sustain technology development and deployment have increased to such an extent that single firms are often unable to undertake the level of risk necessary for innovation.

Fountain (1998) argues that gains in economic performance and innovative capacity depend on the institutional effectiveness of these relationships as measured by the available stock of linking or meso-level social capital. Social capital is created when a group of organizations develops the ability to work together for mutually productive gain. The relationships between the organizations may be horizontal among similar firms in associations, vertical in supply chains, and multidirectional in their linkages to sources of technical knowledge, human resources, and public agencies. Cooperation paradoxically enhances competitiveness, information sharing leads to joint gains, while the importance of reputation and trust ensure reciprocity and fair play within a given network. Social capital is located both in the sharable resources held by individual institutions in a network as well as in the overall structure of the network. Social capital is preserved by careful selection of network players and strict sanctioning of inappropriate network-destroying behavior.

Fountain gives two examples of high-performance network structures that have developed significant levels of intra-network trust. The first describes the ways in which firms in the biotechnology industry partner to remain at the forefront of research and development. The second examines the dynamics that undergird regional industrial systems, as exemplified by the semiconductor industry in Silicon Valley.

5.2   Social Capital and Traditional Firms

According to Maskell (2000), social capital also facilitates the 'low-tech' learning and innovation that takes place when firms in traditional industries are innovative in how they handle and develop resource management, logistics,

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[10]These relationships involve shared resources, group problem-solving, multiple sources of learning, collaborative development, and diffusion of innovation.

production, organization, marketing, sales, distribution, industrial relations, and other tasks and activities. He argues that much of this is due to inter-firm learning. Pure market interactions by themselves are often incapable of facilitating this due to the problem of asymmetric information. For example, potential buyers of information want to ascertain the merit of knowledge offered for sale. But when fully informed of the content of the knowledge offered, it has in effect acquired it for free.[11]

Maskell argues that these market failures in the exchange of knowledge between firms can only be overcome when open market relations are superseded by stable and reciprocal exchange arrangements based on trust. Trust will characterize a relation between firms when each is confident that the other's present value of all foreseeable future exchanges exceeds the possible benefits of breaking the relation. The key argument is that the time and resources needed to build a relationship varies with the stock of social capital that the firms in question might attain through membership in a community. However, according to Maskell, "(w)e still know very little about the actual process by which social capital is produced and accumulated, beyond suspecting that it might be a mainly unanticipated consequences of doing something else - just like, for instance, learning by doing." (p.114)

5.3   The Model Incorporating 'Learning-By-Doing'

In this model, innovation or the creation of new technology follows a process similar to Romer (1990) and Jones (1995). The rate of innovation depends on the allocation of labor to the R&D sector as well as the effect of spillovers from past innovation activities. However, here the rate of innovation also depends on the stock of social capital in the economy. In turn, social capital (unlike in our first two models) is created partly through 'learning-by-doing' as an unintended consequence of firms simply engaging in productive activities. But in order to leverage the social capital that is embodied in the types of networks described previously, firms have to invest at least some labor resources towards seeking suitable network partners and identifying productive collaborative activities. The equations of motion describing the evolution of physical capital, technology and social capital are:

$$\dot{K} = Y - C - \delta_K K, \tag{16}$$

$$\dot{A} = B\left(u_A L\right)^\eta S^\beta A^\psi, \tag{17}$$

$$\dot{S} = P\left(u_S L\right)^\sigma S^\phi \widehat{K}^\lambda - \delta_S S, \tag{18}$$

$$Y = K^\alpha \left(u_Y A L\right)^{1-\alpha}. \tag{19}$$

---

[11]This problem was recognized in Arrow (1970).

where A denotes technology, $\widehat{K}$ denotes the aggregate physical capital stock that each firm takes as exogenously given, B and P are productivity constants, and $\alpha, \beta, \eta, \psi, \sigma, \phi$, and λ are elasticity parameters that lie on the (0,1) interval.

5.3.1 The Solution

As derived in the Appendix, the growth rates of technology and social capital on the balanced growth path are:

$$\gamma_A^* = \frac{\eta(1-\phi) + \beta(\sigma + \lambda)}{(1-\psi)(1-\phi) - \beta\lambda} n, \tag{20}$$

$$\gamma_S^* = \frac{(\sigma + \lambda)n + \lambda\gamma_A^*}{1-\phi}. \tag{21}$$

We can show algebraically that both γ_A^* and γ_S^* are increasing in the elasticity parameters of the $\dot{A}$ and $\dot{S}$ equations: $\beta, \lambda, \sigma, \psi$, and ϕ.

Defining the following variables that are constant in the steady state, $\widehat{k} \equiv K/AL$ (physical capital per effective unit of labor), $s \equiv S/L$ (social capital per worker), $\widehat{c} \equiv C/AL$ (consumption per effective unit of labor), and $\widehat{y} \equiv Y/AL$ (output per effective unit of labor), the solution to the model is shown to be:

$$u_S^* = \frac{1}{1 + (1+\Gamma)\Phi}, \tag{22}$$

$$u_A^* = \frac{\Phi}{1 + (1+\Gamma)\Phi}, \tag{23}$$

$$u_Y^* = \frac{\Gamma\Phi}{1 + (1+\Gamma)\Phi}, \tag{24}$$

$$\Gamma \equiv \frac{\rho + (\eta - 1)n + \beta}{\eta\gamma_A^*},$$

$$\Phi \equiv \frac{\eta[\rho + (1-\phi)\delta_S + (\sigma + \lambda - 1)n + (\theta + \lambda - 1)\gamma_A^*]}{\sigma\beta(\gamma_S^* + \delta_S)}.$$

$$\widehat{k}^* = \left(\frac{\alpha}{\rho + \theta\gamma_A^* + \delta_K}\right)^{\frac{1}{1-\alpha}} u_Y^*, \tag{25}$$

$$\widehat{c}^* = \frac{\rho + \theta\gamma_A^* + \delta_K - \alpha(n + \gamma_A^* + \delta_K)}{\alpha}\widehat{k}^*, \tag{26}$$

$$\widehat{y}^* = \widehat{k}^{*\alpha} u_Y^{*1-\alpha}. \tag{27}$$

22

5.3.2 Comparative Statics

We now examine the impact of changes in various parameters of the model on the steady state allocation of labor to the production of final goods, the creation of innovations, and the accumulation of social capital. The top panels in Figure 5 show that a larger risk aversion parameter, θ, and a larger discount rate, ρ, are associated with a greater allocation of labor to the final goods sector, and correspondingly smaller allocations to the other sectors. This is because final goods production brings instant gratification through current consumption, while social capital accumulation and R&D activities only increase future consumption.

The middle left panel in Figure 8 shows that the social capital elasticity parameter in the $\dot{A}$ equation has a negative relationship with the allocation of labor to final goods production, u_Y, a positive relationship with the allocation of labor to social capital accumulation, u_S, and hump-shaped relationship with the fraction of the labor force allocated to innovative activities, u_A. The middle right panel in Figure 5 shows that the intertemporal spillover parameter in the the $\dot{A}$ equation has a negative relationship with u_Y, a hump-shaped relationship with u_S, and a positive relationship with u_A.

The bottom panels in Figure 5 show that a larger social capital spillover parameter (ϕ) or a larger physical capital learning-by-doing effect (λ) in the social capital accumulation equation results in a greater steady state allocation of labor to *both* innovation creation and social capital accumulation, at the expense of labor allocated to final goods production.

6 Implications for Public Policy

In this section, we discuss the policy implications of the results from our three models. We demonstrate that the failure of private economic agents to internalize the positive spillovers in social capital creation may be addressed via a subsidy to individuals engaging in social capital creation that is financed by a wage tax on the final goods sector. We then discuss the practicalities of implementing such a policy.

6.1 Internalizing the Spillovers in Social Capital Creation: A Tax and Subsidy Scheme

We showed previously that, as individuals do not internalize the positive externalities that their accumulation of social capital confers on the accumulation of social capital by other individuals, there is an underallocation of time or human capital towards activities that create social capital. Specifically, in each
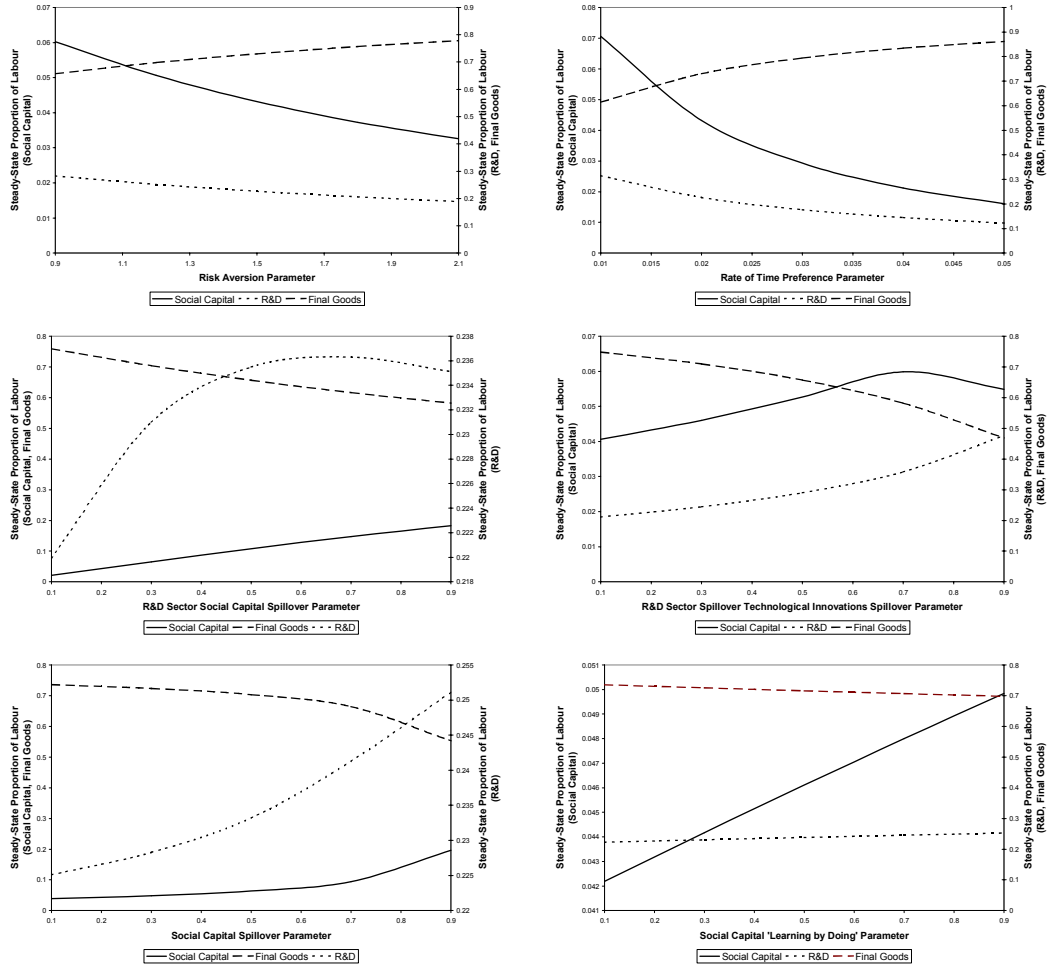
Figure 7: Effect of Parameters on Steady State Labor Allocation

of the three models, u_S^* is larger in the social planner's solution than in the decentralized, competitive solution.

For example, in the model of social capital and financial development,

$$
\begin{aligned}
u_S^{*DC} &= \frac{\iota \alpha n \left(1 - \sigma\right) \left(n + \delta_S\right)}{\rho \left(1 - \alpha\right) \left(\rho + \delta_S\right) + \iota \alpha n \left(1 - \sigma\right) \left(n + \delta_S\right)}, \\
u_S^{*SP} &= \frac{\iota \alpha n \left(1 - \sigma\right) \left(n + \delta_S\right)}{\rho \left(1 - \alpha\right) \left(\rho + \delta_S - \sigma \left(n + \delta_S\right)\right) + \iota \alpha n \left(1 - \sigma\right) \left(n + \delta_S\right)}.
\end{aligned}
$$

Clearly, $u_S^{*DC} < u_S^{*SP}$ since $\sigma \left(n + \delta_S\right) > 0$ and $\rho > n$. This underallocation may, however, be corrected by an appropriate tax and subsidy scheme.

Suppose the government imposes a proportional tax on the wage bill of the final goods sector to finance a subsidy to social capital creation. The tax rate on the final goods sector is τ_Y while an individual is awarded ξ for every unit of labour time devoted to activities that create social capital. The balanced budget equation for the tax and subsidy scheme is

$$
\xi u_S L = \tau_Y w_Y u_Y L. \tag{28}
$$

Incorporating this scheme in our model of social capital and financial development, we can show that the optimal tax rate that causes the planner's and competitive solutions for u_S^* to coincide is:

$$
\begin{aligned}
\tau_Y^* &= \frac{\Gamma \left(\Psi - \Phi\right)}{\Psi \Phi} > 0, \tag{29} \\
\Gamma &= \iota \alpha n \left(1 - \sigma\right) \left(n + \delta_S\right), \\
\Phi &= \rho \left(1 - \alpha\right) \left(\rho + \delta_S - \sigma \left(n + \delta_S\right)\right), \\
\Psi &= \rho \left(1 - \alpha\right) \left(\rho + \delta_S\right).
\end{aligned}
$$

The optimal tax rate is increasing in the magnitude of the social capital spillover effect as captured by σ. That is, $\partial \tau_Y^* / \partial \sigma > 0$.

6.2   Practical Policy Making

What policies can a government put in place to encourage the creation of more social capital? How do we raise the productivity of social capital creation, that is, produce more social capital given a fixed amount of resources such as the time commitment of individuals?

If social capital is critical to the development of children and the accumulation of human capital, then policies should be targeted at parents to induce them to spend more time with their children and play a more active part in their formal enducation. For example, it may make sense to offer financial rewards and other incentives for parents to join parents-teachers associations. In

some developed countries, experts have advocated the establishment of charter schools, where the government provides school resources but school management is devolved to self-governing groups of parents, teachers and citizens. When parents are empowered with a real voice in the running of their childrens' schools, they are likely to be more enthusiastic about contributing time to parents-teachers activities.

The tax system (such as tax credits and deductions) may also have to be revised to encourage parents to spend time at home with their offspring. Just several decades ago, many mothers would regularly bring their children to their neighbors' and relatives' homes so that they could socialise with other kids or their cousins under adult supervision. Child development experts believe that the lack of such parental oversight today has resulted in a progressive rise in juvenile crime and other social problems in industralized nations. However, such a policy is in conflict with welfare reform undertaken in the US and other countries since the mid-1990s that seek to encourage single mothers to return to the labor force. There is obviously a moral hazard problem in trying to indentify whether an individual's time away from market activities is spent productively in producing social capital or not.

The accumulation of human capital is increasingly an extended and continuous process in today's information age. In recognition of this, governments should promote and fund lifelong learning, so that the education system will emerge as society's most prominent forum for public interaction. Adult education, learning circles, public libraries and universities for mature students are places where people can learn and practise the habits of social trust. They should therefore be positioned at the center of civic life.

We have also shown the social capital affects economic performance through the building of trust when individuals spend time in associational leisure activities. To encourage participation in such activities, there should be adequate government funding (and possibly tax incentives) for sports clubs and other associations. The government must play a leading role in building leisure centers, sports grounds, parks and community centers. In addition to the physical infrastructure, there should be better designed community-based programs and activities to foster stronger ties within local communities.

Communal trust may also be raised when community organizations are allowed to take over the role of providing social services from the government. An example is President Bush's controversial faith-based initiatives to federally fund religious groups to provide such services. In this case, bonding and bridging social capital may increase within the religious community, but the policy may damage the bridging social capital that exists between religious groups and other civic organizations.

In recognition of the importance of social capital within innovation net-

works, government policies should focus on inducing firms to collaborate more intensively with other firms, research labs, universities and government agencies in order to increase the number, size and efficacy of networks. Governments should lay the physical infrastructure that encourage networking such as building research and development hubs, industrial parks and clusters for high technology firms. There could conceivably be tax incentives for private expenditures on network-building activities.

7   Conclusion

This paper represents an addition to the relatively sparse theoretical literature on social capital and economic growth. The approach we adopt is a logical development of the representative agent endogenous growth model, building on models of learning-by-doing, human capital, and R&D by Lucas (1988), Romer (1986), Romer (1990), and Jones (1995).

By way of introduction, we reviewed the multifaceted relationship between social capital and economic growth that has been uncovered in the growing empirical literature. Following a discussion on the concept of social capital, we proposed three theoretical growth models built upon different perspectives on the meaning of social capital that are consistent with the available empirical evidence.

In the first model, bonding micro-level social capital impacts growth by assisting in the accumulation of human capital. Building social capital in this model corresponds in the real world to parents taking time off from work or staying at home with their children, and involving themselves in parent-teachers associations. In the second model, bridging social capital impacts growth by affecting financial development through its effects on collective trust and social norms. Social capital accumulation in this model corresponds to participation in community clubs or engagement in other forms of associational activities. In our last model, meso-level linking social capital arises from the networking and collaborative activities of firms, which then results in the efficient creation and diffusion of business and technological innovations. In each of these models, we solved for the optimum steady-state allocation of human resources to the creation and maintenance of social capital, and examined the models' comparative statics and transitional dynamics.

We demonstrated that the failure of private economic agents to internalize the positive externalities in social capital creation may be addressed by a tax and subsidy scheme. The proposed scheme consists of a wage tax on the final goods sector where the tax receipts are used to reward individuals for time spent engaging in activities that build social capital. We then discussed the

practicalities of implementing such a policy as well as viable ways of raising the productivity of social capital creation. Our future research will focus on the development on an overlapping generations model to study the impact of social capital on fertility choice and human capital accumulation, and the resulting implications for growth and development.

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A   Solving the Models

A.1   Social Capital and Human Capital

The Hamiltonian corresponding to the individual's optimization problem is given by:

$$
\begin{aligned}
\mathbf{H} \;=\; & \frac{C^{1-\theta} - 1}{1 - \theta} e^{-\rho t} + \upsilon \left(r_K K + w_Y u_Y H - C \right) \\
& + \mu \left[E \left(u_H H \right)^{1-\psi} S^{\psi} - \delta_H H \right] + \pi \left[\widetilde{P} \left(u_S H \right)^{1-\sigma} - \delta_S S \right],
\end{aligned}
\tag{30}
$$

where c, u_Y and u_H are control variables; K, H, and S are state variables; and υ, μ, and π are the corresponding co-state variables.

The first order conditions are obtained from $\partial \mathbf{H}/\partial C = 0$, $\partial \mathbf{H}/\partial u_Y = 0$,

$\partial \mathbf{H}/\partial u_H = 0$, $\partial \mathbf{H}/\partial K = -\dot{\upsilon}$, $\partial \mathbf{H}/\partial H = -\dot{\mu}$, and $\partial \mathbf{H}/\partial S = -\dot{\pi}$ respectively:

$$\frac{\dot{C}}{C} = -\frac{1}{\theta}\left(\rho + \frac{\dot{\upsilon}}{\upsilon}\right), \tag{31}$$

$$\frac{\upsilon}{\pi} = \frac{\widetilde{P}\left(u_S H\right)^{1-\sigma}}{w_Y H} \cdot \frac{1-\sigma}{u_S}, \tag{32}$$

$$\frac{\mu}{\pi} = \frac{1-\sigma}{1-\psi} \cdot \frac{\widetilde{P}\left(u_S H\right)^{1-\sigma}}{E\left(u_H H\right)^{1-\psi} S^\psi} \cdot \frac{u_H}{u_S} \tag{33}$$

$$-\frac{\dot{\upsilon}}{\upsilon} = r_K, \tag{34}$$

$$-\frac{\dot{\mu}}{\mu} = (1-\psi)\, E u_H^{-\psi} s^\psi - \delta_H, \tag{35}$$

$$-\frac{\dot{\pi}}{\pi} = \frac{(1-\sigma)\,\psi}{1-\psi} \cdot P u_S^{1-\sigma} s^{\sigma-1} \cdot \frac{u_H}{u_S} - \delta_S. \tag{36}$$

The transversality conditions are:

$$\lim_{t \to \infty} \upsilon(t) K(t) = 0, \tag{37}$$

$$\lim_{t \to \infty} \mu(t) H(t) = 0, \tag{38}$$

$$\lim_{t \to \infty} \pi(t) S(t) = 0. \tag{39}$$

Defining $k \equiv K/H$, $s \equiv S/H$, $c \equiv C/H$, and $y \equiv Y/H$, the steady state conditions $\dot{c}/c = 0$, $\dot{k}/k = 0$, $\dot{s}/s = 0$, $\dot{u}_Y/u_Y = 0$, and $\dot{u}_H/u_H = 0$ may be simplified to the following:

$$A k^{\alpha-1} u_Y^{1-\alpha} = \gamma_H + c/k, \tag{40}$$

$$\alpha A k^{\alpha-1} u_Y^{1-\alpha} = \rho + \theta \gamma_H, \tag{41}$$

$$P u_S^{1-\sigma} s^{\sigma-1} = \gamma_H + \delta_S, \tag{42}$$

$$\frac{\dot{\pi}}{\pi} = \frac{\dot{\upsilon}}{\upsilon}, \tag{43}$$

$$\frac{\dot{\pi}}{\pi} = \frac{\dot{\mu}}{\mu}. \tag{44}$$

where γ_H denotes the growth rate of H. Combining these five equations and simplifying then yields the solutions shown in the main text.

A.2 Social Capital and Financial Development

The solution to the social planner's problem is shown below. The Hamiltonian is given by:

$$\mathbf{H} = \frac{C^{1-\theta}-1}{1-\theta}e^{-\rho t} + \upsilon \left\{ s^\iota \left[AK^\alpha \left(u_Y L \right)^{1-\alpha} - C \right] - \delta_K K \right\} \tag{45}$$
$$+ \pi \left[P \left(u_S L \right)^{1-\sigma} S^\sigma - \delta_S S \right],$$

where C and u_Y are control variables, K and S are state variables, and υ and π are the corresponding co-state variables.

The first-order conditions, obtained from $\partial \mathbf{H}/\partial C = 0$, $\partial \mathbf{H}/\partial u_Y = 0$, $\partial \mathbf{H}/\partial K = -\dot{\upsilon}$,:and $\partial \mathbf{H}/\partial S = -\dot{\pi}$, may be expressed as:

$$\frac{\dot{c}}{c} = -\frac{1}{\theta}\left(\rho + \frac{\dot{\upsilon}}{\upsilon} + \iota \frac{\dot{s}}{s} \right), \tag{46}$$

$$\frac{\upsilon}{\pi} = \frac{1-\sigma}{1-\alpha} \cdot \frac{P \left(u_S L \right)^{1-\sigma} S^\sigma}{s^\iota AK^\alpha \left(u_Y L \right)^{1-\alpha}} \cdot \frac{u_Y}{u_S}, \tag{47}$$

$$-\frac{\dot{\upsilon}}{\upsilon} = s^\iota \alpha A k^{\alpha-1} u_Y^{1-\alpha} - \delta_K, \tag{48}$$

$$-\frac{\dot{\pi}}{\pi} = \frac{(1-\sigma)\iota}{1-\alpha} \cdot \frac{P u_S^{1-\sigma} s^{\sigma-1}}{A k^{\alpha-1} u_Y^{1-\alpha}} \cdot \frac{u_Y}{u_S} \left(A k^{\alpha-1} u_Y^{1-\alpha} - \frac{c}{k} \right) \tag{49}$$
$$+ \sigma P u_S^{1-\sigma} s^{\sigma-1} - \delta_S,$$

where $k \equiv K/L$.

Defining $s \equiv S/L$, $c \equiv C/L$, and $y \equiv Y/L$, the steady state conditions $\dot{c}/c$, $\dot{k}/k = 0$, $\dot{s}/s = 0$, and $\dot{u}_Y/u_Y = 0$ may be simplified to the following:

$$s^\iota \left(A k^{\alpha-1} u_Y^{1-\alpha} - \frac{c}{k} \right) = n + \delta_K, \tag{50}$$

$$s^\iota \alpha A k^{\alpha-1} u_Y^{1-\alpha} = \rho + \delta_K, \tag{51}$$

$$P u_S^{1-\sigma} s^{\sigma-1} = n + \delta_S, \tag{52}$$

$$\frac{\dot{\pi}}{\pi} = \frac{\dot{\upsilon}}{\upsilon}. \tag{53}$$

Solving these four equations simultaneously then yields the solutions shown in the main text.

A.3 Social Capital and Innovations

The solution to the social planner's problem is shown below. The Hamiltonian is given by:

$$\mathbf{H} = \frac{C^{1-\theta} - 1}{1 - \theta} e^{-\rho t} + \upsilon \left[K^\alpha \left(u_Y AL \right)^{1-\alpha} - C - \delta_K K \right] \tag{54}$$
$$+ \mu B \left(u_A L \right)^\eta S^\beta A^\psi + \pi \left[P \left(u_S L \right)^\sigma S^\phi \widehat{K}^\lambda - \delta_S S \right],$$

where c, u_Y and u_A are control variables; K, A, and S are state variables; and υ, μ, and π are the corresponding co-state variables.

The first order conditions are obtained from $\partial \mathbf{H}/\partial C = 0$, $\partial \mathbf{H}/\partial u_Y = 0$, $\partial \mathbf{H}/\partial u_A = 0$, $\partial \mathbf{H}/\partial K = -\dot{\upsilon}, \partial \mathbf{H}/\partial A = -\dot{\mu}$, and $\partial \mathbf{H}/\partial S = -\dot{\pi}$ respectively:

$$\frac{\dot{c}}{c} = -\frac{1}{\theta} \left(\rho + \frac{\dot{\upsilon}}{\upsilon} \right), \tag{55}$$

$$\frac{\upsilon}{\pi} = \frac{\sigma}{1 - \alpha} \cdot \frac{P \left(u_S L \right)^\sigma S^\phi \widehat{K}^\lambda}{K^\alpha \left(u_Y AL \right)^{1-\alpha}} \cdot \frac{u_Y}{u_S}, \tag{56}$$

$$\frac{\mu}{\pi} = \frac{\sigma}{\eta} \cdot \frac{P \left(u_S L \right)^{1-\sigma} S^\sigma}{B \left(u_A L \right)^\eta S^\beta A^\psi} \cdot \frac{u_A}{u_S}, \tag{57}$$

$$-\frac{\dot{\upsilon}}{\upsilon} = \alpha \widehat{k}^{\alpha-1} u_Y^{1-\alpha} - \delta_K, \tag{58}$$

$$-\frac{\dot{\mu}}{\mu} = \gamma_A \left(\eta \frac{u_Y}{u_A} + \psi \right), \tag{59}$$

$$-\frac{\dot{\pi}}{\pi} = \left(\frac{\sigma \beta}{\eta} \frac{u_A}{u_S} + \phi \right) \left(\gamma_S + \delta_S \right) - \delta_S, \tag{60}$$

where $\gamma_A \equiv B \left(u_A L \right)^\eta s^\beta A^{\psi-1}$ and $\gamma_S \equiv P \left(u_S L \right)^\sigma S^{\phi-1} \widehat{K}^\lambda - \delta_S$.

From $\gamma_A \equiv B \left(u_A L \right)^\eta s^\beta A^{\psi-1}$, we have

$$\frac{\dot{\gamma}_A}{\gamma_A} = \eta \left(\frac{\dot{u}_A}{u_A} + n \right) + \beta \gamma_S - \left(1 - \psi \right) \gamma_A. \tag{61}$$

In the steady state, $\dot{\gamma}_A = \dot{u}_A = 0$. Hence,

$$\gamma_A = \frac{\eta n + \beta \gamma_S}{1 - \psi}. \tag{62}$$

From $\gamma_S \equiv P \left(u_S L \right)^\sigma S^{\phi-1} \widehat{K}^\lambda - \delta_S$, taking logs and time derivatives yields

$$\sigma \left(\frac{\dot{u}_S}{u_S} + n \right) - \left(1 - \phi \right) \gamma_S + \lambda \left(\gamma_A + n \right) = 0. \tag{63}$$

as $\dot{\gamma}_S = 0$ in the steady state. Moreover, since $\dot{u}_S = 0$ in the steady state,

$$\gamma_S = \frac{(\sigma + \lambda) n + \lambda \gamma_A}{1 - \phi}. \tag{64}$$

Solving for γ_A and γ_S simultaneously yields

$$\gamma_A^* = \frac{\eta (1 - \phi) + \beta (\sigma + \lambda)}{(1 - \psi)(1 - \phi) - \beta \lambda} n, \tag{65}$$

$$\gamma_S^* = \frac{(\sigma + \lambda) n + \lambda \gamma_A^*}{1 - \phi}. \tag{66}$$

Defining $\widehat{k} \equiv K/AL$, $\widehat{c} \equiv C/AL$, and $\widehat{y} \equiv Y/AL$, the steady state conditions $\dot{\widehat{c}}/\widehat{c} = 0$, $\dot{\widehat{k}}/\widehat{k} = 0$, $\dot{u}_Y/u_Y = 0$, and $\dot{u}_A/u_A = 0$ may be simplified to the following:

$$\widehat{k}^{\alpha-1} u_Y^{1-\alpha} - \frac{\widehat{c}}{\widehat{k}} = n + \gamma_A^* + \delta_K, \tag{67}$$

$$\alpha \widehat{k}^{\alpha-1} u_Y^{1-\alpha} = \rho + \theta \gamma_A^* + \delta_K, \tag{68}$$

$$-\frac{\dot{\pi}}{\pi} = -\frac{\dot{v}}{v} + (\sigma + \lambda - 1) n + \phi \gamma_S^* + (\lambda - 1) \gamma_A^*, \tag{69}$$

$$-\frac{\dot{\pi}}{\pi} = -\frac{\dot{\mu}}{\mu} + (\sigma + \lambda - 1) n + (\phi - \beta) \gamma_S^* + (\lambda - \psi) \gamma_A^*. \tag{70}$$

Combining these four equations and simplifying then yields the solutions shown in the main text.