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Social Capital, Product Imitation and Growth with Learning Externalities

Pierre-Richard Agénor
Hinh T. Dinh

The World Bank
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Abstract

Links between social capital, human capital, and product imitation are studied in an overlapping generations model of endogenous growth where the key benefit of social capital is to promote imitation. There is also a two-way interaction between imitation and human capital. Building social capital (which brings direct utility) requires time. Because life expectancy is endogenously related to human capital, time allocation between market work and social capital accumulation is also endogenously determined. Social capital accumulation depends also on access to infrastructure. The model is calibrated numerically for a low-income country. A policy that helps to promote social capital accumulation may be very effective to foster economic growth, even if it involves offsetting cuts in other productive components of government spending, such as education outlays or infrastructure investment. Offsetting cuts in infrastructure investment, however, may be less effective.

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SOCIAL CAPITAL, PRODUCT IMITATION AND GROWTH WITH LEARNING EXTERNALITIES

Pierre-Richard Agénor*
Pierre-richard.agenor@manchester.ac.uk

Hinh T. Dinh**
hdinh@worldbank.org

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*Hallsworth Professor of International Macroeconomics and Development Economics, University of Manchester, and co-Director, Centre for Growth and Business Cycle Research; and ** Lead Economist, Office of the Chief Economist, World Bank. We would like to thank Baris Alpaslan for research assistance. Financial support from Japanese PHRD TF096317 and Dutch BNPP TF097170 is gratefully acknowledged. The Appendix is available upon request.

1 Introduction

The role of social capital in economic growth and development has attracted renewed interest among researchers and policymakers. As defined by Putnam (1993), social capital consists of "those features of social organization, such as networks of individuals or households, and the associated norms and values that create externalities for the community as a whole."[1] Although a number of economists initially questioned the validity of classifying social interactions as a form of capital, an increasing number of them now acknowledge that social capital shares at least some similarities with physical and human capital in its intertemporal dimension and its ability to generate external effects and future benefits. These externalities and benefits include information sharing among individuals and firms, and the matching of people to economic opportunities, mutual aid and insurance, which may affect expectations and individual behavior, as well as effective collective action. Social capital also enables agents to cope with market imperfections or imperfect institutions.

Because social capital is a multidimensional concept, examining its effects in theoretical and empirical models has proved difficult. In general, the literature on social capital can be divided into two distinct strands. The first one studies the social factors that influence the creation and development of social capital. In that context, there has been much emphasis on networks or associational activity as major indicators of social capital. The second strand focuses on the association between social capital and a range of economic, financial and institutional variables. From that perspective, some studies have argued for instance that networks may help to reduce the uncertainties faced by entrepreneurs in relation to the variability of their income, implying therefore that social capital helps to smooth economic shocks.[2] In addition, some research has found that trust—measured in some studies by the level of corruption in the country, or by the degree of income inequality—and civic norms are stronger in countries with formal institutions that effectively protect contracts and property rights. This suggests

[1] Another definition is provided by Coleman (1990), who describes social capital as "some aspect of social structure that enables the achievement of certain ends that would not be attainable in its absence." See also Durlauf and Fafchamps (2005).

[2] Others, however, suggest that there is no correlation between membership in formal groups and economic performance.

the presence of complementarities between institutions and social capital. It has also been argued that social capital may affect output directly by reducing costs and increasing efficiency, and indirectly through its effect on human capital, both schooling and health, and access to resources (such as access to credit).

Recent theoretical contributions in the literature include Routledge and von Amsberg (2003), Chou (2006), Bofota et al. (2012), and Growiec and Growiec (2012). Routledge and von Amsberg (2003) studied social capital in a model where individuals in a community maximize their lifetime gains to trade. Each trade between two members of a community has the structure of the prisoners' dilemma. Trades are repeated indefinitely, but not necessarily each period. Social capital is defined as the social structure which facilitates cooperative trade as an equilibrium. The trading model is incorporated into a growth model to explore the connections between growth, labor mobility, and social capital. The key insight of the analysis is that technological innovation, which drives growth, involves a reallocation of labor that affects social capital. Chou (2006) considered three channels through which social capital can affect economic growth: *a*) by assisting in the accumulation of human capital; *b*) by affecting financial development through its effects on collective trust and social norms; and *c*) by facilitating collaboration and networking between firms, which result in the creation and diffusion of technological and business innovations. In Growiec and Growiec (2012), the ease of forming new interpersonal contacts (that is, bridging social capital) is proportional to the pool of contacts one already has and the pool of people with whom one is not yet acquainted but might consider being. The size of this pool is in turn determined by the total number of people in the society and, most importantly, by the level of social trust.

The present paper contributes to the literature in several ways. First, as in some recent studies, we focus on the macroeconomic effects of social capital. We study the links between social capital, human capital, and product imitation (or *implementation* innovation), in an overlapping generations (OLG) model of growth à la Romer (1990). In the model, the key benefit of social capital is that it helps to promote imitation. This is consistent with the survey evidence on the importance of social networks for economic activity provided by Fafchamps and Quinn (2012) for a group of low-income countries.

At the same time, the model accounts for a two-way interaction between imitation and human capital. This interaction has important implications. A common argument is that by specializing in imitation (or low-skill intensive activities), incentives to invest in (advanced) education in low-income countries are diminished, thereby constraining their long-term growth prospects. However, the two-way causality considered here implies that such specialization is not necessarily detrimental to sustained growth in these countries—at least in a first stage—because the technical knowledge that comes with it helps to promote human capital accumulation indirectly.

Second, we account for the fact that, social capital, just like human capital, is constructed by individuals; that is, at the individual level, building social capital (which brings direct utility in the model) requires time. This is consistent with Bourdieu's (1986, p. 256) view, according to which social capital, viewed as a network of relationships, is "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." Indeed, trusting relationships among members of a professional organization, or civic association often take time to build. Being involved in parent-teacher associations, for instance, which may help to promote human capital of one's offspring, requires time. The implication is that, in the presence of a time constraint, trade-offs emerge when market wages and other incentives to work (such as changes in life expectancy) are altered by public policies. Specifically, in the model each agent faces an endogenous trade-off between allocating time to building social capital, which promotes imitation, as noted earlier, and market work. This is akin to the analysis in Smulders and Beugelsdijk (2004), where agents have a preference for socializing, which they trade off against material well-being. Participation in social networks for instance requires time and this may come at the expense of participation in market activities. Hence, because labor supply is endogenous, policies aimed at promoting the accumulation of social capital may be offset by changes in individual time allocation, and actually decrease the rate of economic growth.

Third, we assume that social capital built at the individual level depends not only on the already existing networks and the average stock of social capital available in the economy, but also on access to infrastructure. Improved access to roads, electric-

ity, and telecommunications facilitates social networking; in that sense, social capital and infrastructure are (gross) complements. At the same time, however, this does not prevent some types of infrastructure and social capital to be (net) substitutes. As argued by Annen (2013) for instance, firms lacking access to street lights for instance may partly compensate for that and reduce security threats if they operate in neighborhoods with strong connections among individuals. From that perspective, social connections may at least in part compensate for the lack of paved roads or access to telecommunications. Finally, we examine the role of public policy (changes in the allocation of government spending) in fostering social capital accumulation, with a focus on the dynamic trade-offs that may be associated with offsetting changes in productive components of public expenditure.

The key results of our analysis can be summarized as follows. In a low-income country engaged in imitation activities, a policy that helps to promote social capital accumulation (including through industrial clusters, as discussed by Dinh et al. (2013, pp. 122-45) in a review of East Asia's experience) may be very effective to foster economic growth—even if it involves offsetting cuts in other productive components of government spending, such as education outlays or infrastructure investment. The mechanism is the following. An increase in access to social capital promotes activity in the imitation sector; in turn, the accumulation of technical knowledge generates a learning externality which helps to promote human capital accumulation in the longer term—even though the relative stock of human capital may fall in the short run if higher spending on social capital is financed by lower spending on education. In the long run, the human capital stock may itself be higher. All of these effects would therefore tend to promote growth. However, in the model a higher human capital stock also raises life expectancy, the savings rate, and time allocated to market work, which in equilibrium depends only on preference parameters. Given an overall time constraint, all else equal time allocated to social capital accumulation by individuals will need to fall. This could reduce effective labor supply and offset the initial expansion in social capital—which in turn would tend to hamper growth. Thus, the net effect on long-run growth is in general ambiguous. Nevertheless, numerical simulations using a calibrated version of the model suggest that for a range of plausible parameter values, the net effect of an

increase in government spending on social capital, even when it is offset by a reduction in spending on education, may be to promote growth. However, if the increase in spending on social capital is financed by a cut in spending on infrastructure, this result is more difficult to achieve, because of the other benefits associated with public capital in terms of imitation activity and the production of final goods.

The remainder of the paper is organized as follows. Section 2 presents the model. As in several other contributions, social capital is defined as an accumulated stock, from which individuals derive a stream of benefits. Social capital is therefore more than simply a set of social organizations or social values, as argued in some of the literature; it enhances output by raising the productivity of other resources, especially labor in the imitation sector. At the same time, it also depends on the supply of these other resources, especially government spending. Thus, social capital is both a determinant and an outcome of growth. Section 3 defines the equilibrium, whereas Section 4 characterizes the balanced growth path. Section 5 presents the benchmark calibration and Section 6 discusses various experiments involving changes in government spending on social capital and spending targeted at promoting imitation activities. The final section draws together the policy implications of the analysis and offers some concluding remarks.

2 The Model

Consider an OLG economy where nonaltruistic individuals live for two periods, adulthood and old age. Each individual is endowed with one unit of time in adulthood and zero unit in old age. Total population is thus constant and the size of each cohort is set to $\bar{N}$. Wages in adulthood are the only source of income, and savings can be held only in the form of physical capital. Agents have no other endowments, except for an initial stock of physical capital at $t = 0$, which is the endowment of an initial old generation. Adults decide on the allocation of their time between work, education, and social capital accumulation. At the end of adulthood there is a non-zero probability of dying.

In addition to individuals, the economy is populated by firms and a government.

There are four sectors in the economy: the first produces a final good (manufacturing, for short), the second intermediate inputs (which depreciate fully after use), the third human capital (which is nonrival), and the fourth is engaged in imitation. Each new imitation involves the production of a new intermediate good. Labor is used in the production of the manufacturing good and imitation activities. In addition to labor, firms producing the manufacturing good use also human and private physical capital, public infrastructure, and intermediate goods. The good can be either consumed in the period it is produced, or stored to yield physical capital at the beginning of the following period. Labor moves freely across all sectors.

As noted earlier, social capital is usually defined as consisting of the informal forms of institutions and organizations that are based on the social relationships, networks, and associations that create shared knowledge, mutual trust, social norms, and unwritten rules. It is thus a combination of intangible objects. One of the most important common components of the different definitions of social capital, as discussed by Durlauf and Fafchamps (2005) and Sabatini (2005), is that it improves social connectivity through information sharing and mutual communication. In the context of the model, this concept is operationalized by making its stock a function of several variables: social norms and values, human capital, and government spending on activities that promote the creation of social capital. In addition, we also assume that access to infrastructure (namely, roads and telecommunications) is a necessary input in the accumulation of social capital.[3]

The government invests in infrastructure and spends on education, imitation, social capital, and some other (not directly productive) items. It finances its expenditure by taxing wages. It cannot borrow and therefore must run a balanced budget in each period. Finally, all markets clear and there are no debts or bequests between generations.

2.1 Individuals

At the beginning of adulthood, each individual allocates a fixed fraction of time $\varepsilon^H \in (0,1)$ to schooling. Schooling is publicly-provided and free of charge. Each individual

[3] In a quantative sense, as discussed later, this assumption is not critical for the results.

j must decide how much time they should allocate to social capital accumulation, ε^S. The time constraint therefore takes the form

$$\varepsilon_t^{W,j} + \varepsilon_t^{S,j} + \varepsilon^H = 1, \tag{1}$$

where $\varepsilon_t^{W,j}$ denotes time allocated to market work.[4]

Let $c_{t+n}^{t,j}$ denote consumption of individual j at period $t+n$, with $n = 0, 1$, and $q_t \in (0,1)$ the probability of survival from adulthood to old age. Discounted utility takes the form

$$U_t^j = \eta_C \ln c_t^{t,j} + \eta_S \ln K_t^{S,j} + \frac{q_t}{1+\rho} \ln c_{t+1}^{t,j}, \tag{2}$$

where $\rho > 0$ is the subjective discount rate, $K_t^{S,j}$ the individual's stock of social capital, and $\eta_C, \eta_S > 0$ parameters which measure the individual's relative preference for current consumption and social capital, respectively. Thus, social capital brings direct utility.[5]

Because taxes are levied only on middle-aged workers, and the price of the manufacturing good is normalized to unity, the period-specific budget constraints are given by[6]

$$c_t^{t,j} + s_t^j = (1-\tau) H_t^j \varepsilon_t^{W,j} w_t, \tag{3}$$

$$c_{t+1}^{t,j} = (1 + r_{t+1}) s_t^j / q_t, \tag{4}$$

where w_t is the economy-wide wage rate in efficiency units of labor, H_t^j individual human capital, $\tau \in (0,1)$ a constant tax rate, s_t^j savings, and r_{t+1} the rate of return on holding (physical) assets between periods t and $t+1$.

2.2 Manufacturing Production

The manufacturing good is produced by identical competitive firms of mass 1, indexed by i. Production requires the use of effective labor, given by the product of average

[4] Note that ε_t^W does not depend on the sector of occupation (manufacturing or imitation); because of the assumption of labor mobility, the wage is the same in both sectors.

[5] Alternatively, it could be assumed that the time spent accumulating social capital brings positive utility. This would not alter qualitatively our results.

[6] To abstract from unintended bequests, the saving left by agents who do not survive to old age is assumed to be confiscated by the government, which transfers them in lump-sum fashion to surviving members of the same cohort. The effective rate of return to saving is thus $(1 + r_{t+1})/q_t$, as shown in (4). See Agénor (2012, Chapter 1) for a more detailed discussion.

human capital of individuals born in $t-1$, H_t, and effective labor hours (the product of employment, $N_{i,t}^Y$, by average time spent in market work, ε_t^W) private capital, $K_t^{P,i}$, public infrastructure, K_t^I, and a combination of intermediate inputs, $x_{j,t}^i$, $j = 1, ...M_t$, where M_t denotes the existing number of intermediate goods. Thus, social capital has only an indirect effect on manufacturing production, through its impact on imitation activity. Although public capital is nonexcludable, it is partially rival because of congestion effects; for simplicity, congestion is taken to be proportional to the aggregate private capital stock, $K_t^P = \int_0^1 K_t^{P,i} di$.

The production function of firm i takes therefore the form

$$Y_t^i = (\frac{K_t^I}{K_t^P})^\epsilon (K_t^{P,i})^\alpha (H_t \varepsilon_t^W N_{i,t}^Y)^\beta [\int_0^{M_t} (x_{j,t}^i)^\eta dj]^\gamma, \tag{5}$$

where $\alpha, \beta, \gamma \in (0,1)$, $\eta \in (0,1)$, $\epsilon > 0$, and $1/(1-\eta) > 1$ is the elasticity of demand between pairs of intermediate goods. In addition, the production function distinguishes between the returns to specialization, as measured by γ, and the parameter that determines the demand elasticity, η, as shown later. There are constant returns in private inputs, so that $\alpha + \beta + \gamma = 1$.

With the price of the manufacturing good normalized to unity, profits of firm i in the manufacturing sector, $\Pi_{i,t}^Y$, are given by

$$\Pi_{i,t}^Y = Y_t^i - \int_0^{M_t} p_t^j x_{j,t}^i dj - w_t H_t \varepsilon_t^W N_{i,t}^Y - r_t K_t^P,$$

where p_t^j is the price of intermediate good j and r_t the rental rate of private capital.

Each producer maximizes profits subject to (5) with respect to private inputs, labor and capital, and demand for all intermediate goods $x_{j,t}^i$, $\forall j$, taking factor prices and M_t as given. This yields

$$r_t = \alpha \frac{Y_t^i}{K_t^{P,i}}, \quad w_t = \beta \frac{Y_t^i}{H_t \varepsilon_t^W N_{i,t}^Y}, \tag{6}$$

$$x_{j,t}^i = (\frac{\gamma \eta Z_t^i}{p_t^j})^{1/(1-\eta)}, \quad j = 1, ...M_t, \tag{7}$$

where

$$Z_t^i = Y_t^i / \int_0^{M_t} (x_{j,t}^i)^\eta dj. \tag{8}$$

Because each firm demands the same amount of each intermediate good, equation (7) implies that the aggregate demand for intermediate good s is

$$x_{j,t} = \int_0^1 x_{j,t}^i di = \int_0^1 (\frac{\gamma\eta Z_t^i}{p_t^j})^{1/(1-\eta)} di. \tag{9}$$

Because all firms producing the manufacturing good are identical and their number is normalized to unity, $K_t^P = K_t^{P,i}$, and $Z_t = Z_t^i$, $\forall i$, and the total demand for intermediate goods is the same across firms, $x_t^i = x_t$, $\forall i$. Moreover, in a symmetric equilibrium, $x_{j,t}^i = x_t^i$, $\forall j$. Thus, $\int_0^1 [\int_0^{M_t} (x_{j,t}^i)^\eta dj]^\gamma di = M_t^\gamma x_t^{\eta\gamma}$. Let also $N_t^Y = \int_0^1 N_{i,t}^Y di$ denote total labor employed in the production of the manufacturing good. Using these results together with equation (5) and the constant returns to scale assumption, aggregate output of the manufacturing good can be written as

$$Y_t = \int_0^1 Y_t^i di = \left\{ (k_t^I)^\epsilon (\frac{K_t^P}{M_t})^\alpha (\frac{H_t \varepsilon_t^W N_t^Y}{M_t})^\beta x_t^{\eta\gamma} \right\} M_t, \tag{10}$$

where $k_t^I = K_t^I / K_t^P$ is the public-private capital ratio. In what follows M_t will also be referred to as the stock of technical knowledge.

2.3 Intermediate Goods

Firms in the intermediate sector are monopolistically competitive. There is only one producer of each input s, and each of them must pay a fee to the imitation firm in order to use the design of that input. The number of firms in the intermediate-good sector is thus also M_t. Production of each unit of an intermediate good s requires θ units of the manufacturing good.[7]

Once the fee involved in purchasing the blueprint has been paid, each intermediate-good producer sets its price to maximize profits, $\Pi_{j,t}^I$, given the perceived total demand function for its good (which determines marginal revenue), $x_{j,t}$:[8]

$$\Pi_{j,t}^I = p_t^j x_{j,t} - \theta x_{j,t}. \tag{11}$$

Substituting (9) in this expression and imposing $Z_t^i = Z_t$, $\forall i$, yields

$$\Pi_{j,t}^I = (p_t^j - \theta)(\frac{\gamma\eta Z_t}{p_t^j})^{1/(1-\eta)}.$$

[7] The production technology in the intermediate good sector is thus proportional to the production technology in the final good sector.

[8] Recall that the price of the the manufacturing good is normalized to unity, as noted earlier.

Maximizing this expression with respect to p_t^j, taking Z_t as given, yields the first-order condition

$$\frac{d\Pi_{j,t}^I}{dp_t^j} = (\frac{\gamma\eta Z_t}{p_t^j})^{1/(1-\eta)} - (p_t^j - \theta)(\gamma\eta Z_t)^{1/(1-\eta)}\frac{(p_t^j)^{-1/(1-\eta)-1}}{(1-\eta)} = 0,$$

that is, $1 - (p_t^j - \theta)/[p_t^j(1-\eta)] = 0$. This condition gives the optimal price as[9]

$$p_t^s = p_t = \frac{\theta}{\eta}, \quad \forall j \tag{12}$$

which implies, using (9), that the optimal quantity of each intermediate good demanded by producers of the manufacturing good is

$$x_{j,t} = x_t = (\frac{\gamma\eta^2 Z_t}{\theta})^{1/(1-\eta)}. \quad \forall j \tag{13}$$

From the definition of Z_t^i in (8), in equilibrium $Z_t = Y_t/M_t x_t^\eta$. Substituting this expression in (13) yields

$$x_t = \frac{\gamma\eta^2}{\theta}(\frac{Y_t}{M_t}). \tag{14}$$

As shown in the Appendix, the ratio Y_t/M_t is also constant in the steady state; thus, the equilibrium quantity of each intermediate good is constant along the balanced growth path.

Substituting (12) in (11) yields the maximum profit for an intermediate-good producer:

$$\Pi_t^I = (\frac{1}{\eta} - 1)\theta x_t. \tag{15}$$

A potential producer of an intermediate input decides to enter the market by comparing the profits generated by producing that input, and the price that must be paid for the new design, p_t^M. For simplicity, we assume that intermediate-input producing firms last only one period, and that patents are auctioned off randomly to a new group of firms in each period. Thus, each producer of a new intermediate good holds a patent only for the period during which it is bought, implying monopoly profits during that

[9] It could be assumed that, by promoting the enforcement of informal norms, social capital also lowers information asymmetries that may hinder the production of intermediate goods. Alternatively, social capital could be viewed as promoting the better organization of markets, the efficiency of transactions, thereby reducing the cost of producing intermediate goods. This would imply that high levels of social capital tend to reduce η, thereby from (18) reducing monopoly power. However, there is no clear empirical evidence in favor of these effects.

period only; yet patents last forever (see Agénor and Canuto (2012)). By arbitrage, therefore,

$$p_t^M = \Pi_t^I. \tag{16}$$

2.4 Human Capital

The human capital that each individual j holds at the beginning of period $t+1$ is produced using a combination of individual time allocated to education (which is fixed, as noted earlier), government spending on education per capita, the parent's human capital (through an intergenerational externality), social capital, and the stock of imitated goods:[10]

$$H_{t+1}^j = (\varepsilon^H)^{\nu_H} (\frac{G_t^H}{\bar{N}})^{\nu_1} M_t^{\nu_2} H_t^{1-\nu_1-\nu_2}, \tag{17}$$

where G_t^H is government spending per capita, $\nu_H > 0$ and $\nu_i \in (0,1)$, $i = 1, 2$. Because individuals are identical within a generation, a parent's human capital at t is equal to the average human capital of the previous generation, H_t, which has been viewed in the literature on social capital as measuring the extent to which parents provide a cognitive environment for the child that promotes learning (see for instance Chou (2006)).

Equation (17) also accounts for a spillover effect of the stock of imitated goods on learning; *knowledge grows in part because of imitation of foreign products*, even though this occurs with decreasing returns.[11] As shown later, the accumulation of human capital is also important in promoting the capacity to imitate. Thus, there is also a two-way interaction between imitation and human capital.

[10] For tractability, the learning technology is assumed to exhibit constant returns in all non-time inputs. Note also that we abstract from a possible externality of infrastructure for human capital; see Agénor (2011).

[11] To our knowledge, McDermott (2002) was the first in the literature on endogenous growth to emphasize the benefit of industrial diversification, or a greater variety of intermediate production inputs, for human capital accumulation. See Agénor and Dinh (2013) for a more detailed discussion focusing on imitation and dwelling on studies such as Mathews (2006), Dinh et al. (2012*a*, 2012*b*), and others.

2.5 Social Capital

The individual stock of social capital at the beginning of period $t+1$ is a function of several variables: social norms and values, which are taken as exogenous, and measured by an index Q; the time that individuals allocate to social capital accumulation, ε_{t+1}^{S}; the parent's human and social capital, H_t and K_t^S; and government spending (per capita) on activities that promote the creation of social capital, G_t^S:[12]

$$K_{t+1}^{S,j} = Q(\varepsilon_{t+1}^{S,j})^{\lambda_S}(k_t^I)^{\lambda_I}(\frac{G_t^S}{\bar{N}})^{\lambda_1}(K_t^S)^{1-\lambda_1}, \tag{18}$$

where $\lambda_S, \lambda_I > 0$, and $\lambda_1 \in (0,1)$.

Parental human capital which is nonrival, is taken here as a proxy for the fact that education promotes interactions among individuals (through social networks, newspaper readership, etc.) and thus social exchange, and that more educated parents tend to instill the same values to their children.

Access to infrastructure matters to promote social capital as well. Roads and telecommunications help to develop social interactions and social networks.

Government spending on activities that promote social capital consists of outlays aimed at promoting trade associations (which help to disseminate knowledge) and at improving the functioning of courts, the police, and the judiciary in general (what may be termed *institutional social capital*), which in turn improves confidence in personal safety, confidence in public institutions, commercial contracts, and promotes economic exchange. Thus, this component of government spending is assumed to promote so-called *generalized trust*.[13] This specification is also consistent with the evidence showing that trust and civic norms are stronger in countries with formal institutions that effectively protect contracts and property rights. In particular, a legal system that ensures contract enforcement enables the transition from *personalized exchange* to *anonymous trade*, a process that is often viewed as an essential step in the growth process.[14]

[12] We abstract from other possible determinants suggested by theory and empirical studies, such as political institutions, urbanization, and so on. See Durlauf and Fafchamps (2005).

[13] See Durlauf and Fafchamps (2005)). Baliamoune-Lutz (2005) provides evidence that measures of generalized trust affect economic development in Africa.

[14] At the same time, however, in an environment where laws that protect property rights are strong, trusting others (and thus social capital) may be less relevant. Thus, if the legal structure improves over time, the role of social capital may diminish gradually, as observed in industrial countries.

2.6 Imitation Sector

Firms engaged in imitation (or *implementation innovation*) adapt or copy foreign designs to create new domestic intermediate inputs, using the same technology. Adaptation or copying are not costless; Local firms invest resources in order to absorb and adapt the information needed to replicate new products invented abroad.

Specifically, the flow production of new designs depends on average human capital in the economy, H_t, labor, in quantity N_t^R, access to (congested) public infrastructure, social capital, K_t^S, and the size of the population, $\bar{N}$:[15]

$$M_{t+1} - M_t = \vartheta(\frac{K_t^S}{M_t})^{\phi_1}(k_t^I)^{\phi_2}\frac{H_t N_t^M}{\bar{N}}, \tag{19}$$

where $\vartheta > 0$ is a scale variable measuring the number of "imitable" goods from abroad (that is, the maximum number of foreign goods that can be copied, given the country's resource endowments), $\phi_1 \in (0, 1)$, and $\phi_2 > 0$. The assumption that ϑ is fixed captures the idea that the number of goods that can be copied at any point in time is limited to (a fraction of) the finite number of goods that have been discovered elsewhere; this is a key difference between imitation and innovation. However, the ability to imitate foreign technologies is constrained by domestic factors; in particular, the higher the stock of social capital, the stronger the ability to imitate.

Government spending on imitation (in the form of grants for leasing equipment and structures, for instance) and access to public capital have a direct impact on the ability to imitate. In particular, by fostering imitation today, public infrastructure also has a positive external effect on future imitation activity. However, both inputs are subject to congestion. In the case of government spending, the congestion factor is the stock of human capital, to account for the fact that, as general knowledge increases, government spending becomes less relevant—unless it keeps pace with the economy's available human capital stock—for innovation activities. In the case of infrastructure,

[15] Note that the stock of imitated goods does not create a direct positive externality for future imitation activities—in contrast to the so-called *standing-on-shoulders (SOS) effect*, which characterizes models of horizontal innovation and growth (see Gancia and Zilibotti (2005)). Here, the externality associated with the stock of imitated goods is *indirect*—it occurs through the impact of M_t on human capital accumulation, as implied by (19). The absence of an SOS effect can be viewed as a key difference between imitation and (true) innovation.

the congestion factor is again the private capital stock.[16]

The effect of H_t is consistent with the view (and the evidence) suggesting that human capital is among the domestic factors that dictate how successfully developing countries can absorb foreign technologies.[17] In fact, investing in human capital makes imitation possible both directly (as implied by (19)) and indirectly—by promoting social capital, as discussed earlier.

The term K_t^S/M_t accounts for two conflicting effects on imitation activity. First, it captures the view that social capital is important for imitation, although this occurs with diminishing marginal returns.[18] A possible mechanism through which this may occur is that when producers live in areas (or clusters) with a larger extent of social networks and have high norms, they are more likely to engage in imitation of foreign goods. A key reason may be that social networks also serve to channel information about new, imported technologies. Alternatively, because imitation is a risky activity, it may be easier to engage in it in an environment where trust is widespread; or, in the spirit of Routledge and Amsberg (2003), social capital may improve labor mobility, which in turn may change the feasibility of cooperative trade and promote the ability to imitate.

Second, it also captures the view that, as the stock of imitated goods (or, equivalently, the degree of diversification of the production structure) increases, the marginal benefit from social capital falls; there is therefore a negative externality from current imitation activity to future imitation.[19] The idea is that as a country develops, social capital must either grow at the same pace or become less important for production.

[16] Alternatively, it could be assumed that public capital is congested by the stock of designs, or equivalently the (cumulated) size of the imitation sector. This would not affect qualitatively our results.

[17] The level of (advanced) skills in the population is identified by the World Bank (2008) as a key determinant of a country's capacity to undertake the research necessary to understand, implement, and adapt imported technologies. Some studies, such as Falvey et al. (2009) for instance, actually use an indicator of education outcomes (average years of secondary schooling) as a measure of imitative ability. However, as is clear from (20), this is not necessarily a good indicator, as it does not account for other determinants—namely, social capital and infrastructure.

[18] In the same vein, Akcomak and Ter Weel (2009) have argued that social capital helps to promote innovation.

[19] In effect, the stock of technical knowledge acts as a congestion factor, just like private capital acts to mitigate the benefits of public infrastructure.

This is consistent with the evidence for industrial countries showing that some aspects or components of social capital become less relevant as a country becomes richer (see Durlauf and Fafchamps (2005)).

Finally, population $\bar{N}$ captures the "dilution effect" proposed by Dinopoulos and Segerstrom (1999) and Dinopoulos and Thompson (2000), which suggests that the difficulty of imitation grows with the size of the market, as measured by the labor force. The idea is that it is harder to introduce successfully new varieties of goods and replace older ones when markets are very crowded.

Firms choose labor so as to maximize profits, Π_t^M, given the dynamics of imitation captured by (19), $N_t^M > 0$, and taking the economy-wide wage rate (in efficiency units of labor), w_t, the price of designs, p_t^M, and the public-private capital ratio as given:[20]

$$\max_{N_t^M} \Pi_t^M = p_t^M (M_{t+1} - M_t) - w_t H_t N_t^M.$$

The first-order condition is[21]

$$w_t = \left\{ \vartheta (\frac{K_t^S}{M_t})^{\phi_1} (k_t^I)^{\phi_2} \right\} \bar{N}^{-1} p_t^M. \tag{20}$$

2.7 Government

As noted earlier, the government taxes only adult wages. It spends a total of G_t^I on infrastructure investment, G_t^H on education, G_t^S on social capital-related activities, and G_t^O on other items. All its services are provided free of charge. It cannot issue bonds and must therefore run a balanced budget:

$$G_t = \sum G_t^h = \tau H_t \varepsilon_t^W w_t \bar{N}. \quad h = H, I, S, O \tag{21}$$

Shares of public spending are all assumed to be constant fractions of government revenues:

$$G_t^h = \upsilon_h \tau H_t \varepsilon_t^W w_t \bar{N}, \quad h = H, I, S, O \tag{22}$$

[20] It could also be assumed that in order to leverage the social capital embodied in social networks, firms have to invest some labor resources towards seeking suitable network partners and identifying productive collaborative activities. This could be captured by assuming that the wage cost is $(1 + \Lambda_t) w_t$, with $\Lambda_t > 0$ being inversely related to the social capital stock.

[21] Equation (20) is also the zero-profit condition implied by free entry.

Combining (21) and (22) therefore yields

$$\sum_h \upsilon_h = 1. \tag{23}$$

Assuming full depreciation, public capital in infrastructure evolves according to

$$K_{t+1}^I = \varphi G_t^I, \tag{24}$$

where $\varphi \in (0,1)$ is an efficiency parameter that measures the extent to which investment flows translate into actual accumulation of public capital.[22]

2.8 Survival Rate

In line with the evidence suggesting that more educated individuals tend to adopt healthier lifestyles, the survival rate from adulthood to old age is taken to depend on *average* human capital in the economy.[23] Specifically, the relationship takes a concave form:

$$q_t = q_L + \bar{q}(\frac{h_t}{1+h_t})^{\nu_Q}, \tag{25}$$

with $\nu_Q > 0$ and $h_t = H_t/K_t^P$ is the human-private capital ratio. This specification implies therefore that $q_0 = q_L$ and that $\lim_{H_t \to \infty} q_t = q_L + \bar{q} < 1$.[24]

2.9 Market-Clearing Conditions

The asset market clearing condition requires period $t+1$ private capital stock to be equal to savings in period t by individuals born in $t-1$. Given that s_t is savings per individual (which is the same for all, in a symmetric equilibrium), and that the number of adults is $\bar{N}$, we have

$$K_{t+1}^P = \bar{N} s_t, \tag{26}$$

where for simplicity physical capital is assumed to depreciate fully in one period.[25]

[22] See Agénor (2010; 2012, Chapter 1) for a more detailed discussion.

[23] See Agénor (2012, Chapter 3) for a discussion of the evidence on the link between human capital and life expectancy. The assumption that it is *average* human capital that matters explains why q_t is taken as given by individuals when solving their optimization problem.

[24] The human-private capital ratio, a stationary variable as shown later, is used in equation (25) for tractability—even though q_t would still converge to $q_L + \bar{q}$ if the absolute level H_t were used instead.

[25] As in Chou (2006), it could be assumed that the quantity of social capital per person—or rather the ratio of social to human capital stocks here, to ensure stationarity—determines the fraction of savings that is transformed into productive new capital.

Under symmetry, $x_t^j = x_t \ \forall j$, and the market-clearing condition for the goods market is

$$Y_t = C_t + M_t \theta x_t + G_t + K_{t+1}^P, \tag{27}$$

where $C_t = (c_t^t + c_t^{t-1})\bar{N}$ is total consumption at t.

With full employment, labor market equilibrium requires

$$N_t^M + N_t^Y = \bar{N}. \tag{28}$$

Using equation (6) to substitute out for N_t^Y, equation (28) can be used to determine equilibrium employment in the imitation sector:

$$N_t^M = \bar{N} - \beta(\frac{Y_t}{H_t})w_t^{-1}, \tag{29}$$

which is constant if Y_t/H_t and w_t are constant. In that case, the allocation of labor across sectors is also constant.

The main interactions in the production component of the model are displayed in Figure 1.

3 Equilibrium

In a symmetric equilibrium, $H_t^j = H_t$ and $K_t^{S,j} = K_t^S$, $c_{t+n}^{t,j} = c_{t+n}^t$, $\forall j$ and $n = 0, 1$. Extending the definitions used in Agénor and Neanidis (2010), an *equilibrium with imperfect competition* for the model described above is a sequence of allocations $\{c_t^t, c_{t+1}^t, s_t^j\}_{t=0}^{\infty}$, physical capital stocks $\{K_t^P, K_t^I\}_{t=0}^{\infty}$, human capital stock $\{H_t\}_{t=0}^{\infty}$, social capital stock $\{K_t^S\}_{t=0}^{\infty}$, factor prices $\{w_t, r_t\}_{t=0}^{\infty}$, prices and quantities $\{p_t^j, x_{j,t}\}_{t=0}^{\infty}$ of each intermediate input $j \in (0, M_t)$, available varieties, $\{M_t\}_{t=0}^{\infty}$, a constant tax rate, and public spending shares such that, given initial stocks $K_0^P, K_0^I > 0$, $K_0^S > 0$, $H_0 > 0$, and $M_0 > 0$,

a) individuals maximize utility subject to their intertemporal budget constraint and their time constraint, taking the tax rate, the survival rate, the wage rate, the rental rate, and time allocated to human capital accumulation as given;

b) firms in the manufacturing good sector maximize profits, choosing labor, private capital, and intermediate inputs, taking the public capital stock and input prices as given;

c) intermediate goods producers set prices so as to maximize profits, while internalizing the effect of their decisions on the perceived demand curve for their product;

d) producers of new designs in the imitation sector maximize profits by choosing employment, taking wages, prices, the initial stock of designs, as well as human capital, social capital, and public capital, as given;

e) the equilibrium price of each design extracts all profits made by the corresponding intermediate good producer;

f) spending shares and the tax rate are constant, and the government budget is balanced; and

g) all markets clear.

A *balanced growth equilibrium* is a dynamic equilibrium in which

a) c_t^t, c_{t+1}^t, s_t, K_t^P, K_t^I, K_t^S, H_t, Y_t, and M_t, grow at the constant rate $\boldsymbol{\gamma}$, implying that the human capital-private capital ratio, as well as the public-private capital ratio, are also constant;

b) time allocated by individuals to social capital accumulation and market work, ε_t^S and ε_t^W, are constant;

c) the survival rate, q_t, and the savings rate, s_t, are constant;

c) the rate of return on private capital, r_t, and the economy-wide wage rate, w_t, are constant;

d) the price of intermediate goods, p_t, and the price of imitated goods, p_t^M, are constant; and

e) the fractions of the adult labor force engaged in the production of the manufacturing good and imitation, $n_t^h = N_t^h/\bar{N}$, with $h = M, Y$ respectively, are constant and $n_t^M + n_t^Y = 1$.

4 Balanced Growth Path

The balanced growth rate of the economy is derived in the Appendix. Individuals maximize (2) subject to (1), (3), (4), and (18), with respect to $c_t^{t,j}$, $c_{t+1}^{t,j}$, ε_t^S, taking ε^H, τ, q_t, w_t, and r_{t+1} as given, and with ε_t^W solved residually from (1). The optimal time allocated by individuals to social capital accumulation and market work are given by

$$\varepsilon_t^S = \frac{\eta_S \lambda^S (1-\sigma_t)(1-\varepsilon^H)}{\eta_C + \eta_S \lambda^S (1-\sigma_t)}, \tag{30}$$

$$\varepsilon_t^W = \frac{\eta_C (1-\varepsilon^H)}{\eta_C + \eta_S \lambda^S (1-\sigma_t)}, \tag{31}$$

where $\sigma_t \in (0,1)$ is the savings rate, defined as

$$\sigma_t = \frac{q_t}{(1+\rho)\eta_C + q_t} < 1. \tag{32}$$

From these expressions, it can be established that an autonomous increase in life expectancy raises the savings and time allocated to market work, and reduces time allocated to social capital accumulation. The first two results capture the standard life-cycle effect: a higher survival rate dictates a need for higher savings to finance consumption in old age, and thereby has a positive effect, *ceteris paribus*, on the savings rate and market work. The last effect is the direct consequence of the time constraint; given that time allocated to schooling is fixed, the increase in time allocated to market work requires a reduction in time that individuals devote to social capital accumulation. This channel is important for understanding the impact of public policy later on.

As also shown in the Appendix, the dynamics of the economy can be condensed into a nonlinear system of four first-order difference equations in $k_t^I = K_t^I/K_t^P$ (the public-private capital ratio), $h_t = H_t/K_t^P$ (the human capital-private capital ratio), $k_t^S = K_t^S/K_t^P$ (the social capital-private capital ratio) and $m_t = M_t/K_t^P$ (the technical knowledge-private capital ratio), together with static equations determining the behavior of the individual savings rate, life expectancy, and time allocated to social capital accumulation and market work (equations (25), (30), (31), and (32)). In the steady state, the growth rate of output, as well as the growth rates of human capital, private capital, public capital, and social capital, all grow at the same rate as the rate of imitation, that is, the growth rate of M_t. The expression for the steady-state growth rate is rather complex, and to understand the properties of the model and the role of public policy, we resort to numerical analysis.

5 Numerical Calibration

To examine the impact of public expenditure allocation, the model is calibrated for a low-income economy. On the individual side, the annual discount rate is set at a conventional value, 0.04. Interpreting a period as 20 years in this OLG framework yields an intergenerational discount rate of 0.456.

The survival probability is calibrated as follows. The World Health Organization (WHO) produces estimates of the probability of dying for various age tranches for a wide range of developing countries.[26] To be consistent with the model's structure (where the risk of death occurs at the end of middle age), we consider the probability of dying during the age bracket 35-39 years; using a control group of five low-income Sub-Saharan African countries yields a probability equal to 0.063.[27] The survival probability from middle age to old age can therefore be calibrated as $q = 1 - 0.063 = 0.937$.

In line with the evidence on private savings for low-income countries, the savings rate $\sigma = q/[\eta_C(1+\rho)+q]$ is set at 0.12, which corresponds to the average value for low-income countries reported in Agénor et al. (2012). Solving (32) backward for the preference parameter η_C yields, using the intergenerational discount factor and the estimate of the survival rate, $\eta_C = 3.136$.

In line with Sequeira and Ferreira-Lopes (2011), the steady-state share of time allocated to social capital accumulation, ε^S, is set equal to 0.08, and time devoted to human capital accumulation, ε^H, to 0.2.[28] This gives the equilibrium time allocated to market work, ε^W, as 0.72. Based on that value, and given the estimates above for σ, ε^H, η_C, as well as $\lambda^S = 0.1$ (see below), equation (31) can be solved backward for η_S; this gives $\eta_S = 3.959$.

In the final good sector, the elasticities of production of final goods with respect to public capital, private capital, and effective labor, ϵ, α, and β, respectively, are set equal to 0.14, 0.2, 0.65, respectively. The value of α is the average value reported in the empirical review of Bom and Ligthart (2011), whereas the value of β is consistent with the average share of labor income for developing countries estimated in a multitude of studies, including most recently by Guerriero (2012). Thus, production of manufacturing goods is intensive in labor. The estimates for α and β imply an elasticity with

[26] See http://apps.who.int/gho/data/view.main.61730?lang=en

[27] This group includes Benin, Burundi, Senegal, Tanzania, and Uganda. Data for these countries and for others in the region are fairly similar, so extending the number of countries would not have much effect on the results.

[28] Note that ε^H includes not only time allocated to schooling *per se* but also time devoted at the beginning of adulthood to accumulating human capital through other (mandatory) formal means, such as on-the-job training. In any case, the results are not highly sensitive to the initial values of ε^S and ε^H.

respect to intermediate inputs equal to $\gamma = 1 - \alpha - \beta = 0.15$.

In the intermediate goods sector, the coefficient θ (which measures the marginal cost of production) is set to 2.5, as in Garcia-Castrillo and Sanso (2002), whereas the parameter η (which determines the price elasticity of the demand for intermediate goods) is set to 0.61, similar to the value set by Chen and Funke (2012, Table 1). This implies an elasticity of substitution of about 2.6, which corresponds to the value found by Acemoglu and Ventura (2002).

In the human capital sector, the elasticity of flow output with respect to government spending on education services, ν_1, is set equal to 0.45, which is close to the implicit value used by De la Croix and Vander Donckt (2010). The elasticity with respect to the stock of imitations, ν_2, is set initially at a low value, 0.1. This implies that the elasticity with respect to the current stock of human capital is initially equal to 0.45. The elasticity with respect to time allocated to education, ν_H, is set at 0.3.[29] Sensitivity analysis with respect to both ν_1 and ν_2 is reported later on.

In the imitation sector, the growth rate of the international pool of blueprints available for imitation, ϑ, is set at 0.02, as in Chen and Funke (2012, Table 1). The elasticity with respect to the ratio of social capital to the stock of imitations, ϕ_1, is set equal to a relatively low value to begin with, 0.1. This implies that the direct elasticity of final good output with respect to social capital is $\gamma\phi_1 = 0.015$, which appears to be substantially lower than the estimate of the elasticity of aggregate output with respect to social capital of about 0.1 by Ishise and Sawada (2009); however, in our analysis general equilibrium effects (especially through human capital) are highly significant, implying that the overall effect of a change in the stock of social capital on output growth is much higher than what is implied by the value of $\gamma\phi_1$. The elasticity with respect to the public-private capital ratio, ϕ_2, is also taken to be initially small, 0.1. Thus, in the benchmark case access to public infrastructure plays only a moderate role in the promotion of imitation activities.

In the social capital sector, the elasticity with respect to time allocated to building that type of capital by individuals, λ_S, is set at 0.1, whereas the elasticity with respect to the public-private capital ratio, λ_I, is set initially at 0.3. The elasticity with respect

[29] Given that ε^S is fixed, the value of ν_H matters little for the simulation results reported here.

to government spending on social capital, λ_1, is also set initially at a relatively low value, 0.3, implying that the elasticity with respect to the (aggregate) stock of social capital is 0.7. Sensitivity analysis with respect to all three of these parameters is reported later on.

Regarding the government, the effective tax rate on wages, τ, is calculated by dividing the average ratio of tax revenues to GDP for low-income countries estimated by Baldacci et al. (2004, Table 1), equal to 15.1 percent for the period 2001-08, by the average share of labor income, $\beta = 0.65$, to match the model's definition. Thus, the effective tax rate is $\tau = 23.2$ percent. To estimate the initial share of government investment on infrastructure, υ_I, the ratio of total public investment to GDP in low-income countries calculated by Gupta et al. (2011, Table 1) for the period 2000-09 is used as a starting point. Because public investment includes non-infrastructure related outlays, it is assumed, based on the evidence reported in Foster and Briceño-Garmendia (2010), that only about 40 percent of that amount (or 1.4 percent) really consists of infrastructure investment. The share υ_I can therefore be estimated by 0.014/0.232, that is, $\upsilon_I = 6.1$ percent. The initial share of government spending on education, υ_H, is set at 0.171, as in Agénor and Alpaslan (2013). The initial share of government spending on social capital-related activities, υ_S, is set at a very low value initially, 0.01. These values imply from the budget constraint (23) that the share of spending on other items is $\upsilon_O = 0.758$. The efficiency parameter φ is set at 0.4, which corresponds to the median value estimated by Dabla-Norris et al. (2012).

The parameter that characterizes the curvature of the survival rate function, ν_Q, is set in the benchmark case at unity, whereas parameter q_L is set at 0.8. To ensure that q converges to a maximum value of 0.937, the limit condition mentioned (that is, $\lim_{h_t^A \to \infty} q_t = q_L + \bar{q}$) is solved backward for $\bar{q}$; this gives $\bar{q} = 0.137$. For the predicted value of (25) to match the calibrated value of q with $h = 1$ initially, a multiplicative constant is also introduced in that equation.

Benchmark parameter values are summarized in Table 1. As noted earlier, the dynamic model consists of a nonlinear system of first-order difference equations and a set of static equations; its stability cannot be assessed analytically. To do so it is therefore solved numerically, using the parameter values displayed in Table 1 and for

starting values for the dynamic variables, k_t^I, m_t, h_t, and k_t^S. A variety of starting values were used, but in all cases they were such that the social capital-human capital ratio, k_t^S/h_t, and the technical knowledge-human capital ratio, m_t/h_t, were equal to unity. In all cases the model proved to be stable, with the solutions converging toward constant values for the four dynamic variables (the public-private capital ratio, the technical knowledge-private capital ratio, the human capital-private capital ratio, and the social capital-private capital ratio), as well as, by implication, the social capital-human capital ratio and the technical knowledge-human capital ratio. The steady-state value of the public-private capital ratio, for instance, is $\tilde{k}^I = 0.0636$. Thus, the equilibrium is that of a country where agents have relatively limited access to public infrastructure.

The convergence of the growth rate of the social capital stock, K_t^S, as well as individual time allocated to social capital accumulation, ε_t^S, is illustrated in the upper panel of Figure 2. In the first case, the growth rate converges to a (normalized) growth rate of 3.3 percent per annum, the average growth rate of real GDP in Sub-Saharan Africa over the period 1990-2010 (see Agénor and Dinh (2013)). The lower panel of the figure also shows the convergence process for the technical knowledge-human capital ratio (which is monotonic) and the social capital-human capital ratio (which is nonmonotonic).[30] While convergence is achieved relatively fast for the first variable (less than 12 periods), it takes about 20 periods for the second variable and the growth rate of final output. This reflects, of course, the slower convergence process of the social capital stock.

6 Policy Experiments

The key issue that this paper wants to explore is the extent to which an increase in government spending on social capital (such as spending on institutions that help to build such capital, for instance community associations) can help to increase growth—even if it is accompanied by a reduction in spending on another productive component

[30] The nonmonotonic pattern of the social capital-human capital ratio in this model differs from the results in Sequeira and Ferreira-Lopes (2011), who found that the relative importance of human capital, when compared to social capital, tends to increase over time. However, this is essentially a matter of choosing an alternative set of initial values. More importantly, our purpose here is only to establish convergence to a steady state, not to replicate a particular path of that ratio.

of public expenditure, either spending on education or infrastructure—and to what extent knowledge externalities associated with imitation matter. To do so we consider a permanent increase in the share of spending on social capital, υ_S, from 1 percent to 2 percent, financed by either a reduction in spending on education (such that $d\upsilon_S + d\upsilon_H = 0$) or on infrastructure ($d\upsilon_S + d\upsilon_I = 0$).[31] For comparative purposes, we also consider the case where the increase in υ_S is offset by a reduction in the share of unproductive spending ($d\upsilon_S + d\upsilon_O = 0$), in which case there are no trade-offs.[32] We focus first on the long-run (steady-state) effects and then discuss the transitional dynamics.

Table 2 reports the results of these experiments for the benchmark calibration as well as alternative values for some key parameters. Consider first the case where the increase in υ_S is financed by a cut in *unproductive* spending, υ_O. In the long run, a higher υ_S allows individuals to increase their social capital stock, which improves imitation and the accumulation of technical knowledge. Through the learning externality associated with imitation, the rate of human capital accumulation rises, which tends to increase life expectancy, thereby raising both the time allocated to market work and the savings rate. However, the increase in market work occurs at the detriment of time devoted to social capital accumulation; this tends to mitigate the initial benefit of higher government spending on individual social capital. At the same time, the increase in the savings rate raises the private capital stock, which in turns raises output of final goods and lowers the public-private capital ratio, due to congestion. Figure 3 illustrates the time path of some key variables—the savings rate, life expectancy, the public-private private capital ratio, the social capital-private capital ratio, the technical knowledge-private capital ratio, and the growth rate of final output—in the benchmark case where ϕ_1, the sensitivity of imitation activities to social capital, is equal to 0.1. The steady-state effects on the savings rate, life expectancy, and the public-private

[31] Offsetting cuts in education or infrastructure spending could affect outcomes in ways that are not fully captured in the model. For instance, cuts in pay or outlays on school supplies could affect the productivity of teachers and children and therefore the quality of human capital accumulated through education. A more useful way to think about these cuts is to view them as involving reductions in wasteful spending on an inefficient or corrupt bureaucracy, either in the delivery of education services or the management of infrastructure projects.

[32] All experiments are conducted from period $t + 41$ to ensure that the economy is initially in a steady-state equilibrium.

capital ratio are negligible, and so is the impact on time allocation. Both the social capital-human capital ratio and the technical knowledge-human capital ratio are also higher than in the baseline scenario. The steady-state effect on final output growth is positive and of the order of 0.8 percentage points per annum.

The figure also shows the time paths for an alternative, higher value of $\phi_1 = 0.4$. The differences, compared to the benchmark case where $\phi_1 = 0.1$, are fairly significant. Because the stock of technical knowledge rises considerably more as a result of higher government spending on social capital, the existence of a learning externality means that the stock of human capital rises by more as well; as a result, the social capital-human capital ratio increases by less than in the benchmark experiment. More importantly, life expectancy goes up by more than in the benchmark case. Consequently, the individual savings rate increases by more as well. Even though the public-private capital ratio falls by more than in the benchmark experiment in the long run (as a result of a stronger congestion effect), the net effect on growth is again positive but substantially higher. Put differently, even if an increase in spending on social capital is offset by a reduction in spending on another productive component of government outlays, the net benefit for growth can be highly positive—depending on the strength of the impact of social capital on imitation activities, and the externality of technical knowledge on human capital.

Consider now the case where the increase in spending on social capital is financed by a cut in *productive* spending, namely, education outlays ($d\upsilon_S + d\upsilon_H = 0$). Compared to the transmission channel highlighted above, the key new element is that now the fall in government spending will tend to reduce the rate of human capital accumulation, thereby mitigating the benefit associated with the imitation-based learning externality. Depending on the relative strength of the parameters ν_1 and ν_2 (which measure the response of human capital with respect to government spending and technical knowledge, respectively), human capital may actually fall, thereby lowering life expectancy, the savings rate, and time devoted to market work; however, the effect of the latter is to increase time allocated to social capital, which therefore mitigates the negative growth effect associated with a lower stock of human capital. Thus, in theory, the net effect on growth of an increase in spending on social capital, financed by a cut in

spending on education, is in general ambiguous.

The long-run effects of alternative values for these parameters, as well as ϕ_1 as discussed earlier, are illustrated in Table 2. In the benchmark case of $\nu_1 = 0.45$ and $\nu_2 = 0.1$, the net effect on long-run growth is negative (-1.7 percentage points). With a lower $\nu_1 = 0.2$, the growth effect is muted but still negative (-0.9 percentage points). A higher value of $\nu_2 = 0.2$ does not generate a positive growth rate, whereas a value of $\nu_2 = 0.8$ does. A higher value of $\phi_1 = 0.4$ also generates positive growth. A combination of lower values of $\nu_2 = 0.6$ and $\phi_1 = 0.3$ achieve the same results (due to complementarities), with a steady-state growth rate of final output of about 0.9 percentage points.

Suppose instead that the increase in spending on social capital is financed by a reduction in infrastructure investment ($dv_S + dv_I = 0$). As shown in Table 2, in the benchmark case the net effect on growth is negative, and remains so with a lower $\nu_1 = 0.2$, a higher $\nu_2 = 0.2$, and a higher $\phi_1 = 0.15$. Again, with further increases in ν_2 and ϕ_1, the growth rate turns positive, but less so than in the education-financed case. The reason is that the cut in infrastructure investment, and thus in the public capital stock, reduces directly activity in both manufacturing and imitation; this tends to offset the benefits associated with a higher social capital stock. Again, with a combination of smaller increases in ν_2 and ϕ_1 (to 0.6 and 0.3, respectively) the net effect on growth is positive, but of order of 0.5 percentage points only. A strategy to promote social capital accumulation at the expense of spending on infrastructure is less effect at promoting growth than a strategy that entails offsetting cuts in education.

What about the transitional dynamics? These are fairly similar across experiments involving offsetting changes in productive expenditure components, so the case of higher spending on social capital financed by a cut in spending on education is sufficient to illustrate what happens. On impact, the reduction in public spending on education reduces the rate of human capital accumulation. This tends to lower life expectancy and the savings rate, while at the same time increasing time allocated to social capital accumulation—which occurs at the expense of market work. Thus, despite the fact that the increase in the stock of social capital boosts activity in the imitation sector, which in turn promotes production of final goods, the drop in time allocated to market

work (which compounds the reduction in effective labor supply due to the reduction in the human capital stock) tends to lower the growth rate on impact. Over time, these effects are partially reversed; the reason is that the learning externality associated with the higher stock of imitation knowledge on human capital mitigates, and eventually offsets, the adverse effect of lower government spending on education. As a result, the initial declines in life expectancy, the savings rate, and time allocated to market work are also reversed. Because the increase in the stock of social capital and technical knowledge are fairly large, both the social capital-human capital ratio and the technical knowledge-human capital ratio increases monotonically to their steady-state values. Output growth, by contrast, remains permanently lower in the benchmark case.

Under alternative parameter values, the main differences is that the initial adverse effects are more than offset by the externalities associated with higher activity in the imitation sector and its spillover effects on human capital accumulation. If the strength of these spillovers (as measured by the parameters ν_2 and ϕ_1, either individually or in combination) is sufficiently strong, the net effect on output growth in the long run becomes positive. This is well illustrated in Figures 4 and 5, which show deviations in the steady-state growth rate of final output for values of ν_2 and ϕ_1 ranging from 0.1 to 0.8.

It is important to note that the steady-state results discussed earlier do *not* rely on an arbitrarily low elasticity of human capital with respect to government spending on education; if anything, the benchmark value used here, $\nu_1 = 0.45$, is substantially higher than the values used in a variety of studies (see, for instance, Glomm and Ravikumar (2003)). A lower value of ν_1 means that an increase in spending on social capital offset by a cut in spending on education would magnify the benefit of this policy in terms of economic growth. At the same time, as the results in Table 2 clearly illustrate, a lower value of ν_1 does *not*, by itself, lead to a positive growth effect. In the same vein, the fact that achieving a positive growth effect by financing higher spending on social capital through a cut in infrastructure investment does not depend on having high values of the parameters that capture the externalities associated with public capital (namely, ϵ and ϕ_2). While there may be some debate as to the value of ϕ_2, the literature review by Bom and Ligthart (2011) provides some confidence with

respect to the value of ϵ. Moreover, setting $\phi_2 = 0$ does not substantially alter the results reported in Table 2 when $dv_S + dv_I = 0$. Put differently, what really drives the results is the combination of the externalities associated with social capital for imitation activity, and imitation activity for human capital accumulation.

7 Concluding Remarks

The purpose of this paper was to study the links between social capital, human capital, and product imitation in an overlapping generations (OLG) model of endogenous growth. In the model, the key benefit of social capital is that it helps to promote imitation. At the same time, there is a two-way interaction between imitation and human capital. Social capital, just like human capital, is constructed by individuals; and building social capital (which brings direct utility in the model) requires time. In particular, 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 may create social capital by raising the level of generalized trust in the community, as argued by Bourdieu (1986) and Putnam (1993). In the model, each agent therefore faces a trade-off between allocating time to building social capital (which promotes imitation) and market work (which increases effective labor supply). Because life expectancy is endogenously related to human capital, time allocated to market work and other activities is endogenously determined—and so is the savings rate. Finally, social capital accumulation and access to infrastructure are gross complements, which implies that the marginal product of time allocated to building social capital is enhanced with improved access to roads, telecommunications, and so on. The model is then calibrated and used to study the quantitative effects of an increase in government spending aimed at improving access to social capital.

The main results of the paper were summarized in the introduction and need not be repeated here. Their main policy implication is rather clear: for low-income countries engaged in imitation activities, a policy that helps to promote social capital accumulation (including through industrial clusters, as discussed by Dinh et al. (2013)) may be very effective to foster economic growth—even though the policy may involve cuts

in other government spending, including on education. Indeed, rather than investing significantly in tertiary education, as many countries do now, they may be better off, in a first stage, by reallocating their resources toward outlays on institutions that may help to promote social capital, especially in the form of networks of relationships and generalized trust.[33] By promoting imitation activities (which do not require high levels of skills to begin with), the accumulation of social capital will help to accumulate human capital indirectly as well. At the same time, however, maintaining infrastructure investment at sufficiently high levels may be essential to sustain economic growth.

The analysis in this paper could be extended in several directions. One possibility is to account for a direct, two-way interaction between social capital and human capital, as in some existing studies. However, this is unlikely to change the qualitative nature of the results emphasized here; on the contrary, assuming that the human capital technology depends also on the (average) stock of social capital of the previous generation would strengthen our conclusions regarding the importance of that type of capital, at least in the early phases of development. A second extension is to determine the welfare-maximizing allocation of government spending. Because social capital (like infrastructure capital) has public good characteristics, it is likely to be under-produced because of incomplete collective internalization of the positive externalities inherent in its formation. Even though a formal analytical solution may not be provided (given the complexity of the model), a numerical analysis can be performed.

[33] To the extent that offseting cuts in education expenditure come from spending reductions on an inefficient or corrupt bureaucracy—a common feature of education systems in low-income countries (see for instance UNESCO (2009, Chapter 3))—they would achieve the same growth-enhancing effects.

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Figure 1
Structure of the Model

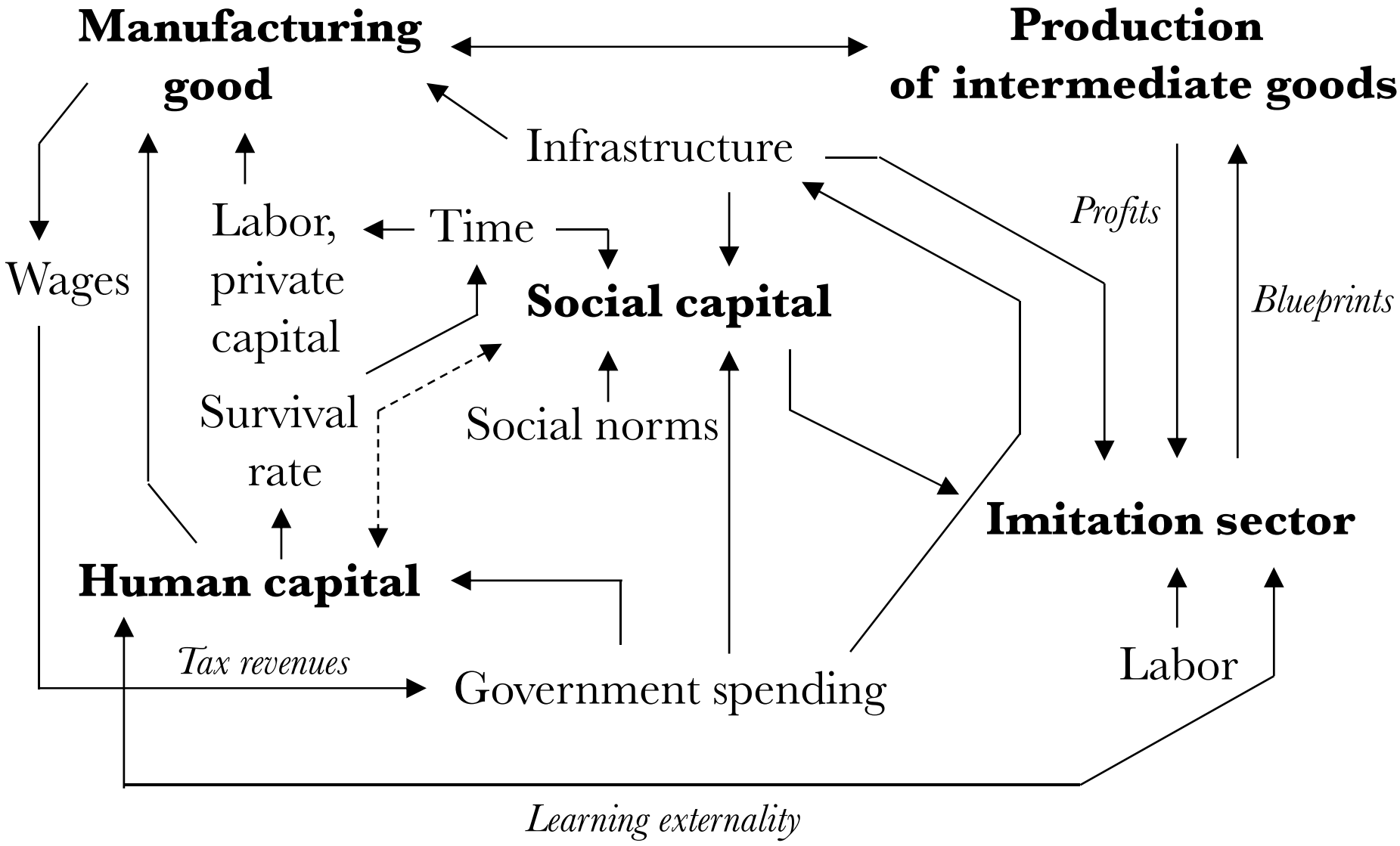
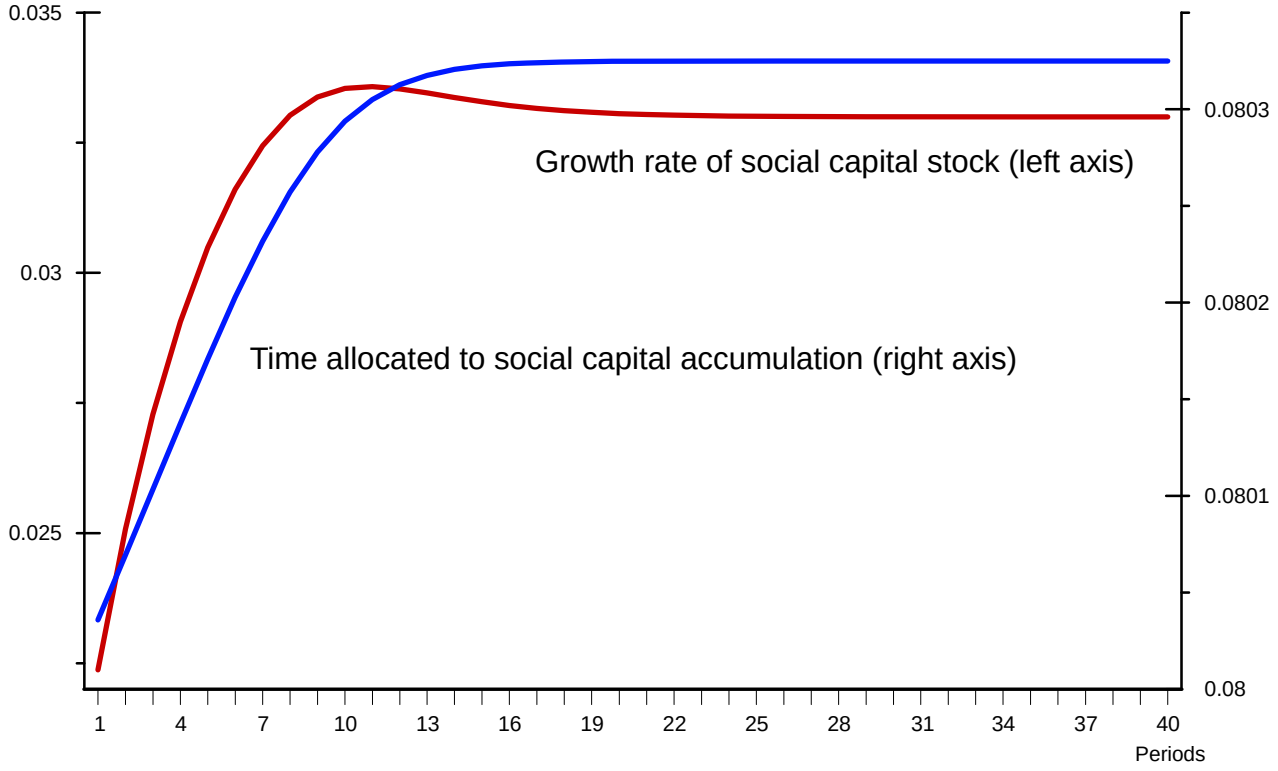


Figure 2
Convergence of Growth Rate and Key Ratios
(Benchmark calibration)



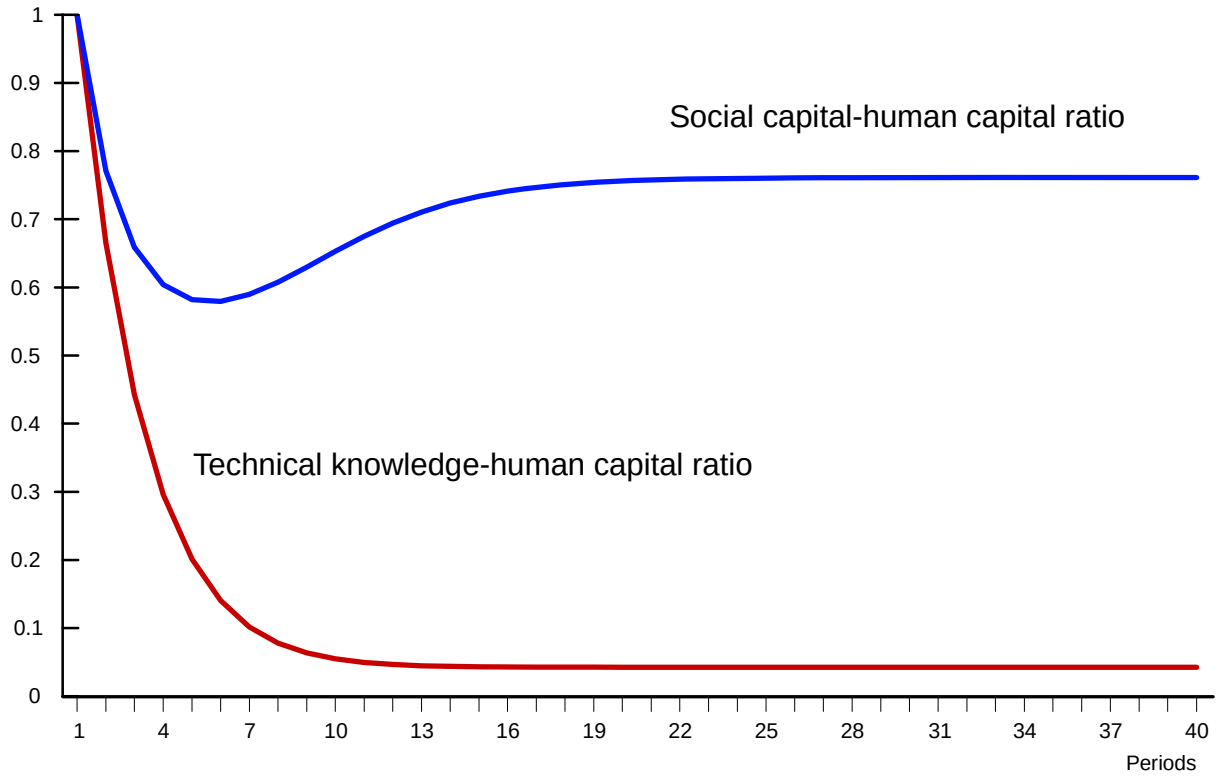


Figure 3
Permanent Increase in Share of Government Spending on Social Capital
Financed by a Cut in Unproductive Spending
(Absolute deviations from baseline)

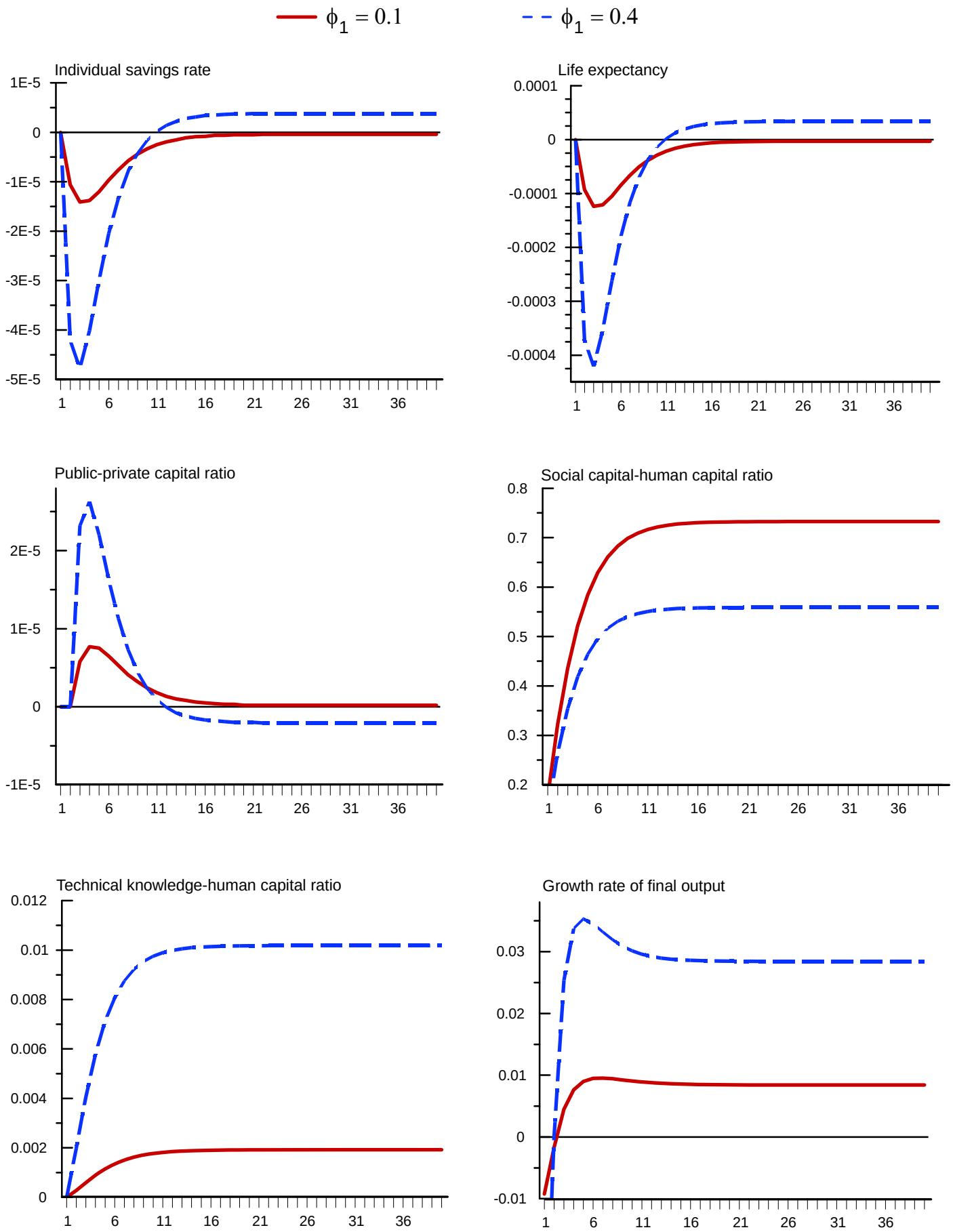
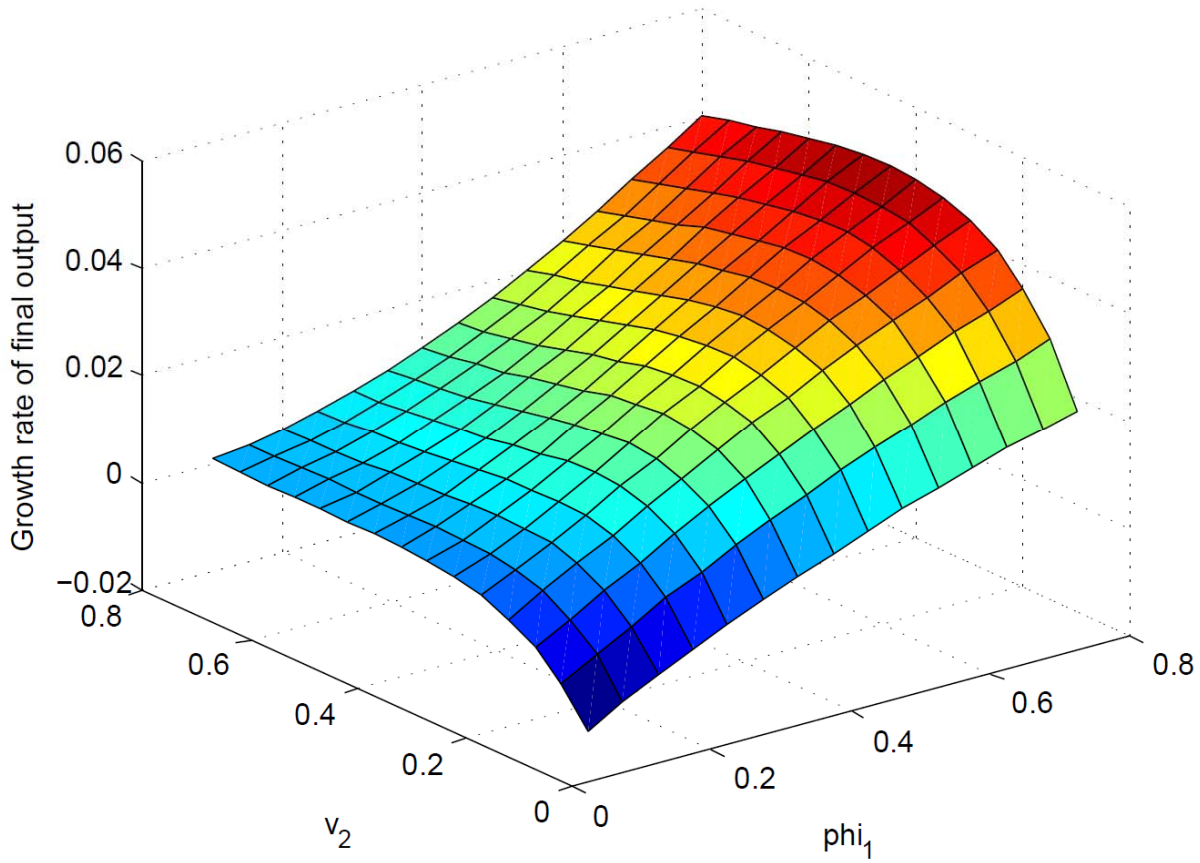
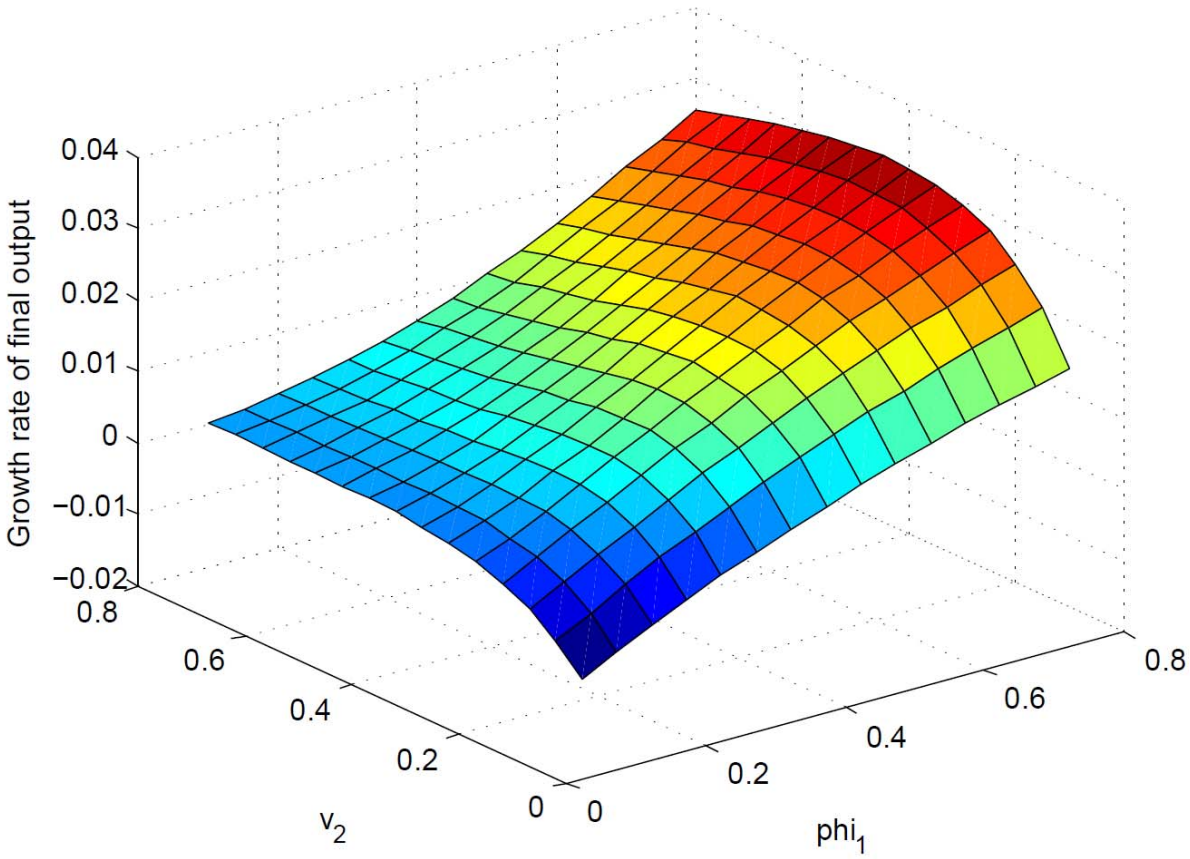


Figure 4
Increase in Spending on Social Capital
Financed by a Cut in Spending on Education
(Absolute deviations from baseline)



Note: ν_1 is the elasticity of human capital with respect to government spending on education and ϕ_1 is the elasticity of imitation activity with respect to social capital.

Figure 5
Increase in Spending on Social Capital
Financed by a Cut in Infrastructure Investment
(Absolute deviations from baseline)



Note: ν_1 is the elasticity of human capital with respect to government spending on education and ϕ_1 is the elasticity of imitation activity with respect to social capital.

Table 1

Calibrated Parameter Values: Benchmark Case

Parameter	**Value**	**Description**
Individuals		
ρ	0.04	Annual discount rate
σ	0.12	Individual savings rate
ε^H	0.2	Time allocated to human capital accumulation
ε^S	0.08	Time allocated to social capital accumulation
η_C	3.156	Preference parameter, consumption
η_S	3.959	Preference parameter, social capital
Final good		
ϵ	0.14	Elasticity wrt to public-private capital ratio
α	0.2	Elasticity wrt private capital
β	0.65	Elasticity wrt effective labor
Intermediate goods		
θ	2.5	Units of final good used to produce intermediates
η	0.61	Parameter determining price elasticity
Human capital		
ν^H	0.3	Elasticity wrt time allocated to schooling
ν_1	0.45	Elasticity wrt public spending on education
ν_2	0.1	Elasticity wrt to stock of imitated goods
Imitation sector		
ϑ	0.02	Growth rate of "imitable" goods from abroad
ϕ_1	0.1	Elasticity wrt social capital
ϕ_2	0.1	Elasticity wrt public-private capital ratio
Social capital		
λ_S	0.1	Elasticity wrt to time spent on social capital
λ_I	0.3	Elasticity wrt to public infrastructure
λ_1	0.3	Elasticity wrt to public spending on social capital
Government		
τ	0.232	Tax rate on output of final good
υ_I	0.065	Share of spending on infrastructure
υ_H	0.171	Share of spending on education
υ_S	0.01	Share of spending on social capital-related activities
φ	0.4	Efficiency parameter of spending on infrastructure
Survival rate		
$\bar{q}$	0.137	Shift parameter, survival rate function
q_L	0.8	Minimum value, survival rate function
ν_Q	1.0	Curvature parameter of the survival rate function

Table 2

Increase in Share of Government Spending on Social Capital 1/

	$d\upsilon_S+d\upsilon_U = 0$		$d\upsilon_S+d\upsilon_H = 0$		$d\upsilon_S+d\upsilon_I = 0$	
Benchmark Values	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000001	0.000000	-0.000007	-0.000004	0.000004	0.000007
Public-private capital ratio	0.0000	0.0000	0.0000	0.0000	-0.0104	-0.0104
Social capital-human capital ratio	0.3217	0.7327	0.3698	0.8495	0.2701	0.5112
Technical knowledge-human capital ratio	0.0002	0.0019	0.0020	0.0047	0.0005	0.0023
Growth rate of final output	-0.0017	**0.0084**	-0.0172	**-0.0176**	0.0005	**-0.0116**
Experiment: $\nu_1 = 0.2$ 2/	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000001	-0.000001	-0.000004	-0.000002	0.000005	0.000008
Public-private capital ratio	0.0000	0.0000	0.0000	0.0000	-0.0104	-0.0105
Social capital-human capital ratio	0.6243	1.4382	0.6651	1.5151	0.5083	0.9256
Technical knowledge-human capital ratio	0.0003	0.0035	0.0020	0.0066	0.0005	0.0032
Growth rate of final output	-0.0041	**0.0050**	-0.0087	**-0.0031**	0.0058	**-0.0026**
Experiment: $\phi_1 = 0.15$ 3/	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000001	0.000000	-0.000008	-0.000004	0.000004	0.000007
Public-private capital ratio	0.0000	0.0000	0.0000	0.0000	-0.0104	-0.0104
Social capital-human capital ratio	0.3094	0.6938	0.3557	0.8055	0.2598	0.4852
Technical knowledge-human capital ratio	0.0004	0.0030	0.0023	0.0061	0.0007	0.0032
Growth rate of final output	-0.0021	**0.0122**	-0.0182	**-0.0141**	0.0012	**-0.0091**
Experiment: $\phi_1 = 0.4$	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000004	0.000000	-0.000010	-0.000004	0.000001	0.000007
Public-private capital ratio	0.0000	0.0000	0.0000	0.0000	-0.0104	-0.0104
Social capital-human capital ratio	0.2648	0.5587	0.3046	0.6515	0.2221	0.3939
Technical knowledge-human capital ratio	0.0019	0.0101	0.0046	0.0147	0.0023	0.0086
Growth rate of final output	0.0001	**0.0284**	-0.0185	**0.0007**	0.0097	**0.0015**
Experiment: $\nu_2 = 0.2$ 4/	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000001	-0.000001	-0.000006	-0.000002	0.000004	0.000008
Public-private capital ratio	0.0000	0.0000	0.0000	0.0000	-0.0104	-0.0105
Social capital-human capital ratio	0.6761	1.5293	0.7706	1.6868	0.5677	1.0297
Technical knowledge-human capital ratio	0.0002	0.0021	0.0042	0.0094	0.0011	0.0051
Growth rate of final output	-0.0030	**0.0086**	-0.0105	**-0.0068**	0.0001	**-0.0053**
Experiment: $\nu_2 = 0.8$	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000001	-0.000007	-0.000002	-0.000004	0.000004	0.000009
Public-private capital ratio	0.0000	0.0000	0.0001	0.0000	-0.0103	-0.0104
Social capital-human capital ratio	0.8872	2.1827	0.9610	2.1517	0.7449	1.2996
Technical knowledge-human capital ratio	-0.0014	-0.0094	0.0226	0.0199	0.0091	0.0131
Growth rate of final output	-0.0040	**0.0018**	0.0025	**0.0008**	-0.0001	**0.0002**
Experiment: $\phi_1 = 0.3$ with $\nu_2 = 0.6$	Impact	Long run	Impact	Long run	Impact	Long run
Time allocated to market work	-0.000003	-0.000017	-0.000005	-0.000014	0.000002	0.000000
Public-private capital ratio	0.0000	0.0001	0.0000	0.0001	-0.0104	-0.0104
Social capital-human capital ratio	0.9807	2.4533	1.0811	2.4472	0.8228	1.4890
Technical knowledge-human capital ratio	-0.0020	-0.0176	0.0176	0.0092	0.0052	0.0046
Growth rate of final output	-0.0118	**0.0120**	-0.0085	**0.0086**	-0.0046	**0.0051**

1/Increase in υ_S from 0.01 to 0.02 financed by a concomitant cut in υ_U, a cut in υ_H, and a cut υ_I, respectively.

2/ν_1 is the elasticity of human capital with respect to government spending on education and set equal to 0.45 in the benchmark case.

3/ϕ_1 is the elasticity of imitation sector with respect to social capital and set equal to 0.1 in the benchmark case.

4/ν_2 is the elasticity of human capital with respect to externality of knowledge and set equal to 0.1 in the benchmark case.

Source: Authors' calculations.