ERC ECONOMICS RESEARCH CENTER

ISCTE
Lisbon University Institute

An Endogenous Growth Model with Human and Social Capital Interactions

Tiago Neves Sequeira
Alexandra Ferreira-Lopes

ISCTE - Lisbon University Institute
UNIDE - ECR
AV FORÇAS ARMADAS
1649-126 LISBON-PORTUGAL
http://erc.unide.iscte.pt

Working Paper - 09/08

An Endogenous Growth Model with Human and Social Capital Interactions*

Tiago Neves Sequeira† and Alexandra Ferreira Lopes‡

Abstract

Social capital has recently been introduced in the economic literature as a growth factor. In this paper we study the interactions between social and human capital, and their contributions to economic growth in an endogenous growth model. In particular, we are interested in comparing the results from our theoretical framework with the empirical evidence already found by other authors. The model indicates a correlation between human and social capital throughout time, as suggested by the data. Furthermore, an increasing in the relative importance of human capital when compared to social capital is always evident throughout the development process of the economy.

JEL Classification: $O15$, $O41$, $O47$.

Keywords: Human Capital, Social Capital, Economic Growth.

*Codes and results stated in the text but not presented for space reasons, are available from the corresponding author: sequeira@ubi.pt. We thank the useful comments of Catarina Roseta Palma. The usual disclaimer applies.

†UBI and INOVA, UNL. sequeira@ubi.pt. Management and Economics Department. Universidade da Beira Interior. Estrada do Sineiro, 6200-209 Covilhã, Portugal. Tiago Neves Sequeira acknowledges the financial support from POCI/FCT.

‡ISCTE and UNIDE. alexandra.ferreira.lopes@iscte.pt. ISCTE, Economics Department, Avenida das Forças Armadas, 1649-026, Lisbon, Portugal. Phone: +351 217903456, Fax: +351 217903933.

1 Introduction

Social capital is a recent concept in economic literature and is usually defined as in Putman (1993:167): "social capital ... refers to features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating co-ordinated actions". Social capital has been pointed out as a potential source of economic growth, and most of the literature on this topic has been centered on the empirical level. In this work we study the relationship between social capital, human capital, and economic growth in an endogenous growth model.

One of the most important empirical tools for those working on social capital is the World Values Survey. This survey covers 29 market economies and is based on the construction of a measure of trust. The World Bank (2006) also defines trust as a measure of social capital, as well as the ability of people to work together to achieve common goals. The Bank uses social capital as one of several types of capital which it uses to calculate intangible capital. It also studies the relationship between the different types of capital (among them social capital) and economic growth. Among other studies, Knack and Keefer (1997) establish a causal relationship between trust and growth, but do not find a very robust association. Controlling for initial income per head, a human capital variable, and the relative price of investment goods, they find that a level of trust that is 10 percentage points higher is associated with an annual growth rate that is higher by 0.8 percentage points. Temple and Johnson (1998) use several measures of social capital which compose an index, and found those measures useful for predicting economic growth. Most followers in empirical studies estimate a robust relationship between social capital and growth (e.g. Beugelsdijk et al., 2004; Whiteley, 2000; and Rupasinga, 2000) but with a wide interval of point estimates. A recent article from Berggren et al. (2007) found non-robust half-sized estimates from trust on growth, when outliers were taken into account. Also recently, Betz (2008) estimated returns from social capital that range from 4% to 10%, being the higher value obtained in estimates within firm jobs.

Putnam (2000) shows wide evidence according to which social capital had decreased in the USA in the second half of the twentieth century. This is an opposite trend to what happened in the first half of the century. Halpern (2005) in consistence with the findings of many scholars stated that "by almost all measures, social capital declined in the USA over the period from 1960 to 2000...(but) this decline follows an earlier period of growth in US social capital stretching back to the beginning of the twentieth century" (p. 210).

A less developed, but still very important issue, is the interaction between human and social capital and their joint effects on economic growth.[1] Glaeser et al. (2002) found a strong empirical relationship between human capital and membership of a given social organization (the proxy used to measure social capital). Coleman (1988) and Teachman et al. (1997) pointed out that social capital is important in the creation of human capital. These last authors found that a wide range of social capital indicators determine school continuation. Our contribution follows these empirical references in considering both social and human capital in a single theoretical framework. Moreover, it is known that human capital has increased throughout the twentieth century in the United States (e.g. Tamura, 2006).

From these references, some facts related to social capital can be summarized. First, there are complementarities between social and human capital and a positive correlation between both. This correlation may be caused by double-sided causality. Second, as a society or country develops, social capital decreases its importance when compared with human capital. Third, social capital decreases with mobility. Fourth, social capital first increases with age and then decreases, and finally, social capital may imply a positive effect on growth if it is employed in social networks, and a negative effect if it is employed in cheating and rent-seeking.

Cálvo-Armengol and Jackson (2004, 2007) pointed out that better connected individuals spend less time unemployed and are paid better in two important contributions for labor economics. However, few articles to date have addressed the contribution of social capital to economic growth in theoretical frameworks. In Smulders and Beugelsdijk (2004) agents have a preference for socializing, which they trade off against material well-being. Participation in social networks is time-consuming and comes at the cost of participation in the formal economic sphere and working time. Hence, through this channel, higher levels of social capital may decrease economic growth. In addition, participation in intercommunity networks reduces the incentives for rent seeking and cheating. Through this channel, higher level of networking, social capital may enhance economic growth. Bartolini and Bonatti (2007) using an endogenous growth model, found a negative correlation between the expansion of market related activities and social capital, and in their model economic growth and social capital have a negative relationship. Moreover, this model accounts for the fact found by Putnam (2000), according to which social capital has been declining in the US, although the country has been growing. Routledge and Amsberg (2002) modelled social capital as the social structure which facilitate cooperative trade as an equilibrium. However, most of

[1] For a survey of the empirical literature on this subject see Piazza-Georgi (2002).

other previous works modelled social capital as an accumulable asset that contributes to production (e.g. Glaeser et al, 2002; Bisin and Guaitoli, 2006).

The joint consideration of social and human capital in models of economic growth, the main focus of our paper, is still scarce in the theoretical literature: to our knowledge, this has only been done in the working-paper of Bisin and Guaitoli (2006) in an OLG framework. They are concerned with the different roles human and social capital have in rural and urban societies. We consider an endogenous growth model, in which we assume that the economy accumulates both human and social capital. Our objective is to explore the quantitative features of such a model and discuss how reasonable they are, according to the empirical evidence summarized above. We assume that there is an opportunity cost of accumulating social capital in terms of human capital and foregone earnings, and that social capital accumulation can be easier with higher levels of social capital, as empirical evidence suggest. This captures the idea according to which, social capital can be positively dependent on the already existing networks, and human capital is mostly constructed by individuals. The data calibration of an endogenous growth model with both human and social capital, and the analysis of the behavior of a decentralized economy with these features are our main contribution to the literature.

In the next section, we present the model. In Section 3, we describe the calibration exercise and present several numerical simulations which aim to characterize the evolution of the economy and assess the quality of the model in replicating some of the empirical evidence. Section 4 concludes.

2 The Model

2.1 Production of Production Factors and Final Goods

2.1.1 Accumulation of Human Capital

Human capital H is produced using human capital allocated to schools H_H (as in Lucas, 1988) and the total amount of social capital S:

$$\dot{H} = \xi H_H + \alpha S - \delta_H H \tag{1}$$

where $\xi > 0$ is a parameter that measures productivity inside schools, $\alpha \geq 0$ measures the sensitivity of human capital accumulation to the stock of social capital, and $\delta_H \geq 0$ is the depreciation of human capital. This expression captures the idea of Coleman (1988) and

Teachman et al. (1997) according to which social capital is important to the production of human capital. This can be translated into the idea according to which social interactions may improve embodied knowledge.

Individual human capital is divided into working hours in the final good sector (H_Y), school hours at the education sector (H_H), networking hours in the social capital accumulation sector (H_S). Human capital is supplied inelastically and thus $H = H_Y + H_H + H_S$.

2.1.2 Accumulation of Social Capital

Social capital is produced using human capital allocated to its production (H_S) and also the existing stock of social capital.

$$\dot{S} = \gamma H_S + \Omega S \tag{2}$$

where γ measures the productivity of human capital in the production of social capital and $\Omega \lesseqgtr 0$ measures the net effect of the positive impact of social capital in its own production and of the depreciation of social capital. If $\Omega > 0$ the exogenous growth effect dominates, as increases in social capital can only occur because existing networks are sufficiently strong to overcome depreciation. If $\Omega < 0$ the depreciation effect dominates.

2.1.3 Production of the Final Good

The final good Y is produced with a Cobb-Douglas technology:

$$Y = K^{\beta} S^{\eta} H_Y^{1-\beta-\eta},\ 0 < \beta, \eta < 1 \tag{3}$$

where K is physical capital, which is accumulable:

$$\dot{K} = Y - C - \delta_K K \tag{4}$$

where C is consumption and δ_K is the physical capital depreciation.

Whether human capital and social capital are complementary in the production of the final good, they are substitutes in the production of each other. Thus, the economy needs physical capital, human capital, and networking (or trust) to produce the consumption good. However, growth of human capital can be done at schools or only through networking, but growth of social capital can happen if people dedicate some time to networking (endogenous choice) or if people already have a stock of social capital (exogenous growth of social capital).

As factor and final goods sectors are assumed to be competitive, returns equal marginal productivities as follows:

$$
\begin{aligned}
r &= \frac{\beta Y}{K}; && (5)\\
w_S &= \frac{\eta Y}{S}; && (6)\\
w_Y &= \frac{(1-\beta-\eta)Y}{H_Y}. && (7)
\end{aligned}
$$

Where r is the return of physical capital, w_S is the return of social capital, and w_Y is the market wage.

2.2 Households

Consider a closed economy inhabited by a constant population, normalized to one, of identical infinitely-lived households that maximize the intertemporal utility function:

$$
\int_0^\infty \frac{C^{1-\theta}}{1-\theta} e^{-\rho t} dt, \ \rho > 0, \ \theta > 0, \tag{8}
$$

(where ρ is the time-discount rate and θ is the relative risk aversion coefficient) subject to the budget constraint and the accumulation technologies (1) and (2). The budget constraint is the following:

$$
\dot{a} = (r - \delta_K)\, a + w_Y (H - H_H - H_S) + w_S S - C \tag{9}
$$

where a represents the family physical assets.[2]

Solving the consumer problem, we reach the following equations that derive from the first order conditions:

$$
\begin{aligned}
g_C &= (r - \rho - \delta_K)/\theta && (10)\\
g_{w_Y} &= r - \xi + \delta_H - \delta_K && (11)
\end{aligned}
$$

which describe, respectively, the dynamics of consumption and of the market wage.

[2] We consider that the family internalizes all benefits of social capital, as our objective is not the study of eventual distortions in the market economy. The family earns specific returns from social capital (networking) as have been pointed out, e.g., by Cálvo-Armengol and Jackson (2004, 2007) and Betz (2008).

Additionally, a constant ratio of social capital return and the market wage is obtained:

$$\frac{w_S}{w_Y} = \frac{\xi - \delta_H - \Omega - \frac{\alpha\gamma}{\xi}}{\gamma} \tag{12}$$

This equation states our first important result: the return of social capital, when compared to the market return, increases with the productivity of human capital at schools, but decreases with the depreciation of human capital, decreases with the productivity of human capital in producing social capital (networking hours), and decreases with all the interaction terms between human capital and social capital. Furthermore this ratio implies that the growth rates of both returns are equal: $g_{w_Y} = g_{w_S}$.

2.3 Dynamics and the Steady-State

From (4) and (10), we reach an equation that describes the dynamics of C/K:

$$g_{C/K} = \left(\frac{1}{\theta} - \frac{1}{\beta}\right) r + \frac{C}{K} - \frac{\rho + \delta_K}{\theta} + \delta_K \tag{13}$$

Using the growth rate versions of (3) and of (5)-(7) together with equation (11), we obtain the equation that describes the dynamics of r:

$$g_r = -\frac{1-\beta}{\beta}(r - \xi + \delta_H - \delta_K) \tag{14}$$

Finally, we derive a differential equation for the social to human capital ratio. To this end, we first use (6) and (7) to write:

$$u_Y = \frac{1-\beta-\eta}{\eta} \frac{w_S}{w_Y} \frac{S}{H} \tag{15}$$

where $\frac{w_S}{w_Y}$ can be detailed using (12) and u_Y is equal to $\frac{H_Y}{H}$. This equation can give us the main intuition for an important result of the article. As $\frac{w_S}{w_Y}$ is constant, a decreasing u_Y due to human (and social) capital investments will put pressure on the decrease of $\frac{w_S}{w_Y}$. For this wage ratio to be kept constant, the economy needs to increase the relative supply of human capital. Thus, a decreasing social to human capital ratio is obtained throughout the transition to the steady-state. This is also an important result in comparison with empirical evidence. In fact, most scholars had shown evidence of the decline of social capital in the second half of 20^{th} century (e.g. Putman, 2000 and Halpern, 2005) and some others had shown that human capital continues growing at that time (e.g. Tamura, 2006). Then, we use (2) to obtain the following equation:

$$u_S = \frac{H_S}{H} = \frac{g_S - \Omega}{\gamma}\frac{S}{H} \tag{16}$$

Taking the resource constraint $1 = u_Y + u_S + u_H$, where $u_H = \frac{H_H}{H}$, into account and the previous two equations, one can derive the differential equation that describes the dynamics of the social to human capital ratio:

$$g_{\frac{S}{H}} = \frac{\xi - \delta_H + \delta_K}{\beta} - \delta_K - \frac{C}{K} - \xi\left(1 - \frac{1-\beta-\eta}{\eta}\frac{\xi - \delta_H - \Omega - \frac{\alpha\gamma}{\xi}}{\gamma}\frac{S}{H} - \frac{g_S - \Omega}{\gamma}\frac{S}{H}\right) - \alpha\frac{S}{H} + \delta_H. \tag{17}$$

Equations (13), (14), and (17) constitute the system of differential equations that describe the dynamics of the model.

The steady-state of this economy is obtained setting g_r, $g_{C/K}$, and $g_{S/H}$ to zero. The following theorem states the result.

Theorem 1 *Let $\xi > \delta_H + \rho$, $\xi > \delta_H + \rho + \theta\left(\Omega + \frac{\alpha\gamma}{\xi}\right)$, and $\theta > 1$. Then, an unique steady-state exists and is characterized by the following stable and positive long-run values for r, C/K, and S/H.*

$$r^* = \xi - \delta_H + \delta_K \tag{18}$$

$$\frac{C}{K}^* = \frac{\rho}{\theta} - r\left(\frac{1}{\theta} - \frac{1}{\beta}\right) - \delta_K\left(1 - \frac{1}{\theta}\right) \tag{19}$$

$$\frac{S}{H}^* = \frac{\xi - \delta_H - g_H}{\xi\left[\frac{1-\beta-\eta}{\eta}\frac{\xi-\delta_H-\Omega-\frac{\alpha\gamma}{\xi}}{\gamma} + \frac{g_S-\Omega}{\gamma} - \frac{\alpha}{\xi}\right]} \tag{20}$$

where $g_S = g_H = g_K = g_C = g_Y = \frac{r-\rho-\delta_K}{\theta}$.

Proof. Consider the system (13), (14), and (17) and set the growth rates to zero. Then we reach a positive long-run growth rate if and only if $\xi > \delta_H + \rho$. The consumption-capital ratio is positive if and only if $\rho > (1-\theta)(r-\delta_K) - \theta\left(\frac{1-\beta}{\beta}\right)r$, which is always true for $\theta > 1$. This same condition ($\theta > 1$) guarantees that $\xi - \delta_H > g_H$. For an interior solution, we must have positive shares of human capital allocated to human capital accumulation, social capital accumulation, and the final good ($u_H > 0$, $u_S \geq 0$, $u_Y \geq 0$). $\xi > \delta_H + \rho + \theta\left(\Omega + \frac{\alpha\gamma}{\xi}\right)$ is sufficient for positive shares and for the positivity of S/H. ■

It is worth noting that the last condition for a feasible steady-state would be always verified, under the first two conditions, if social capital did not contribute to the production of human capital ($\alpha = 0$) and to the production of social capital ($\Omega \leq 0$), and both depreciations were set to zero. Under these conditions, the sufficient conditions for positivity of the shares and of the social to human capital ratio would be also sufficient conditions for positive long-run growth.

The following theorem states that the steady-state is saddle-path stable.

Theorem 2 *The steady-state is saddle-path stable.*

Proof. To analyze the saddle-path stability of steady-state, we state the Jacobian of the system composed by differential equations (13), (14) and (17):

$$\begin{pmatrix} -\frac{1-\beta}{\beta}r^* & 0 & 0 \\ \left(\frac{1}{\theta}-\frac{1}{\beta}\right)\frac{C}{K}^* & \frac{C}{K}^* & 0 \\ 0 & -\frac{S}{H}^* & \xi\left[\frac{1-\beta-\eta}{\eta}\frac{\xi-\delta_H-\Omega-\alpha\gamma/\xi}{\gamma}+\frac{g_S-\Omega}{\gamma}-\frac{\alpha}{\xi}\right] \end{pmatrix} \tag{21}$$

The eigenvalues of this Jacobian are the elements of the diagonal, which means that we always have one negative eigenvalue $-\frac{1-\beta}{\beta}r^*$ and two positive eigenvalues. To see this note that $\frac{C}{K}^* > 0$ and that the last diagonal element must be positive for $\frac{S}{H}^* > 0$, as it corresponds to the denominator of $\frac{S}{H}^*$ (see Theorem 1). ■

3 Numerical Exercises

3.1 Calibration

It is not easy to take a model with social capital to data, as research dealing with social capital is still scarce. Some parameters on our model are standard in the literature: the intertemporal substitution parameter ($\theta = 2$), the intertemporal discount factor ($\rho = 0.02$), and the share of physical capital in income ($\beta = 0.36$), hence we are not discussing them. For others, there are a range of plausible values: the depreciation rates (δ_K, δ_H), the productivity of human capital accumulation (ξ), and the contribution of social capital to economic growth (η). For these values, we discuss our options. For other parameters (γ, α, Ω) there is greater uncertainty. For those, we do sensitivity analysis.

For the depreciation of physical capital, a value of 0.05 is often used. However, in previous articles that simultaneously consider human and physical capital accumulation, a zero depreciation is considered. As is evident from our model, most effects of depreciation cancel out if rates for physical and human capital depreciation are equal. We consider $\delta_K = \delta_H = 0$, $\delta_K = 0.05$ and $\delta_H = 0$ and $\delta_K = \delta_H = 0.05$ in different exercises. For each of these exercises, we set the steady-state economic growth rate to be equal to 1.85%, which gives us a value for ξ. This procedure yields us $\xi = 0.057$ or $\xi = 0.107$, which is in the range used by human capital literature (e.g. Funke and Strulik, 2000). For the impact of social capital in economic growth, we use a lower bound estimate of 0.08 as in Knack and Keefer (1997), for whom a 10% increase in trust implied a 0.8% increase in the economic growth rate. We also use a high bound for $\eta = 1 - \beta - \eta = 0.32$, suggested by the evidence in Whiteley (2000) that points out an effect of social capital as big as the effect of human capital and the evidence on World Bank (2006) that pointed out a share of 0.78 to intangible capital, which included both human and social capital. To have some guidance in the value of the productivity of human capital in accumulating social capital, we set the steady-state share of human capital in social capital accumulation to 0.08. Taking into account other values for parameters ($\delta_K = \delta_H = 0$, $\xi = 0.057$, $\alpha = \Omega = 0.01$), we reach $\gamma = 0.18934$. We consider this an upper bound value. For Ω we consider two alternative values, one negative (-0.01) and one positive (0.01). For α, we consider a small value of 0.01. Small changes in these two parameters values would not change our results.

Table 1 below summarizes the calibration values. Underlined values show changes to the benchmark calibration.

Table 1: Calibration Values

parameter	Benchmark		Higher η	Higher δ_H
θ	2		2	2
β	0.36		0.36	0.36
ρ	0.02		0.02	0.02
δ_H	0		0	$\underline{0.05}$
δ_K	0	0.05	0	0
ξ	0.057	0.107	0.057	0.057
γ	0.057		$\underline{0.18934}$	0.057
α	0.01		0.01	0.01
Ω	-0.01/0.01		0.01	0.01
η	0.08		$\underline{0.32}$	0.08

Stability analysis indicates that the balanced growth path is one-dimensional and saddle-path stable.[3] Moreover, with the parameter values mentioned in Table 1, convergence speed oscillates from 8.28% to 17.17%. In particular the first value is obtained from low values for the depreciation rates. This means that the convergence speed does not change very much when compared to the Lucas simpler model and it is consistent with panel estimates by Caselli et. al. (1996). We begin by presenting a simple evolution with just one stage. In the last sub-section we generalize the analysis to an economy with two stages of development.

[3]This analysis is available upon request.

3.2 A One-Stage Economy

As we are interested in describing the evolution of the economy, we implement a numerical exercise to observe the economy, not only in steady-state, but also during the transition to the steady-state. We divide this section according to the different calibrations that we presented in Table 1. All results are based in the integration of the differential equations system, using the method of backward integration, developed by Brunner and Strulik (2002). We have considered a maximum discreterization error of 10^{-14} in the initial deviation from the steady-state, until the economy reaches (backward thinking) a sufficiently high value for the social to human capital ratio.[4]

We begin the presentation of the results by considering a low share of social capital in the final good production (0.08). In the next subsection, we consider the cases for low and high depreciation of physical capital (0.05 and -0.05), and for positive exogenous growth or depreciation of social capital (0.01 and -0.01).

3.2.1 Benchmark Calibration

For each exercise we present the evolution of the social to human capital ratio (S/H), the shares of human capital in the different sectors (u_H, u_Y, and u_S), and the evolution of the interest rate and of the growth rates (g_Y, g_H, and g_S). With this we will assess if the model describes the correlation between social and human capital, and the social capital decrease as the economy develops, together with a positive growth rate.

[4]We consider a value for $S/H_0 = 5\,(S/H)^{ss}$, where $(S/H)^{ss}$ is the steady-state value for the variable. No significant change would occur if the final criteria was governed by other variable.

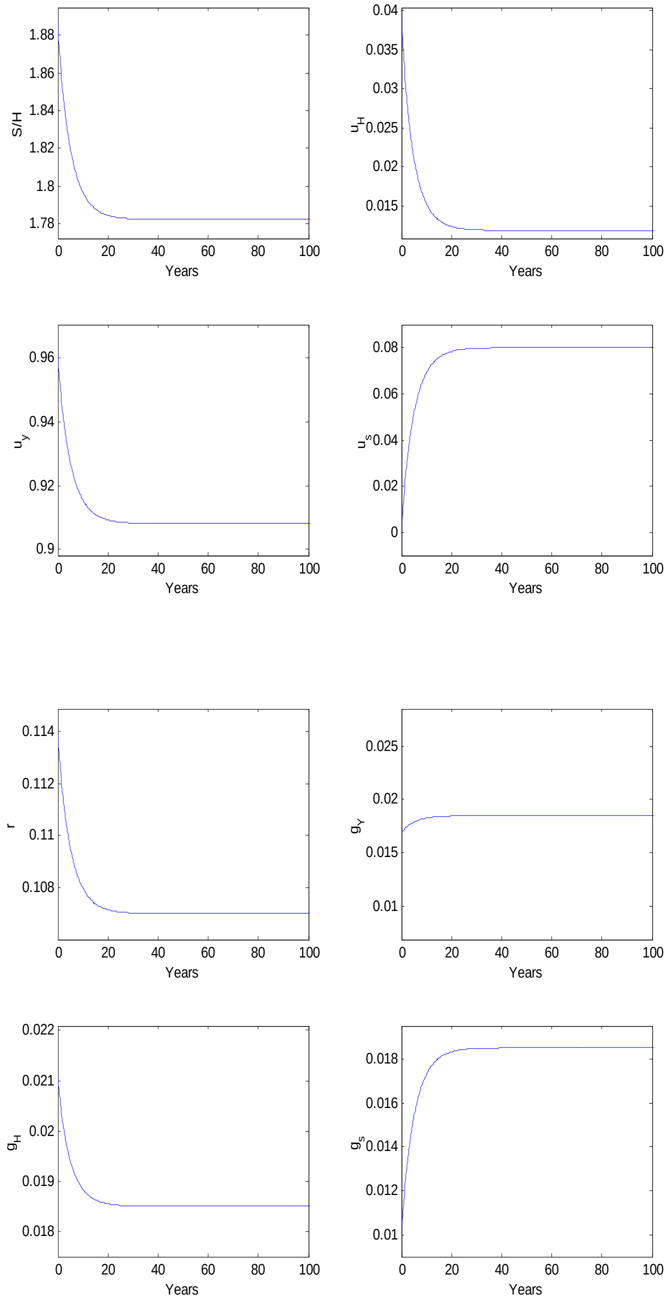

Figure 1: Transition Paths for Representative Variables with depreciation in K ($\delta_K = 0.05$) and positive exogenous growth in S (omega=0.01)

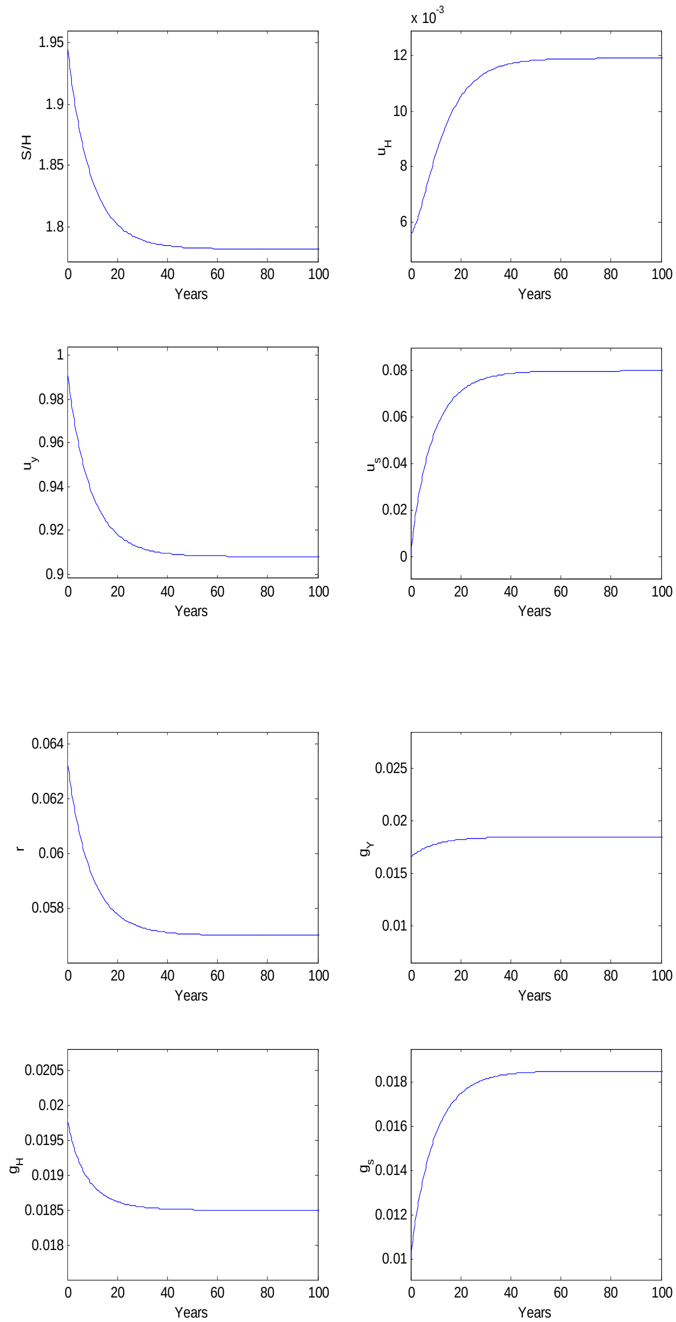

Figure 2: Transition Paths for Representative Variables with no depreciation in K ($\delta_K = 0$) and positive exogenous growth in S (omega=0.01)

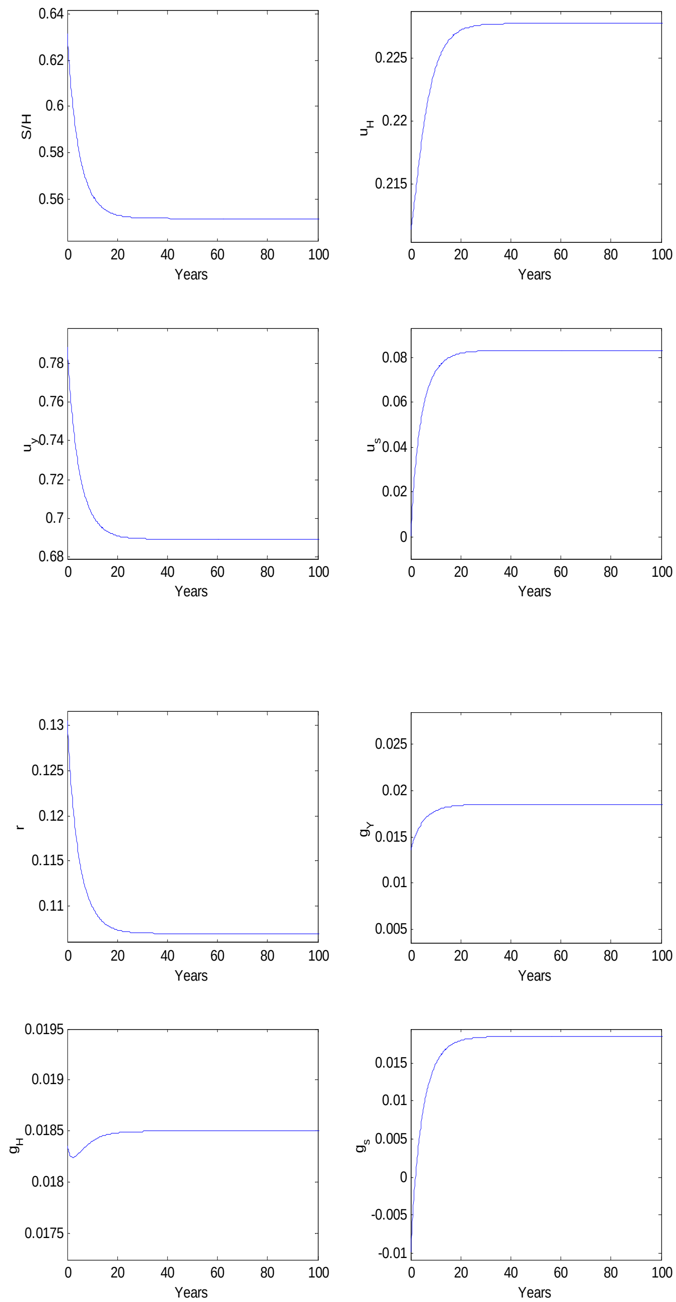

Figure 3: Transition Paths for Representative Variables with depreciation in K ($\delta_K = 0.05$) and depreciation in S (omega=-0.01)

The pattern showed that the evolution of the economy matches the decreasing social to human capital ratio until the steady-state values, meaning that more developed societies have more human capital when compared to social capital, as already predicted by empirical evidence. The social to human capital ratio can be decreasing from nearly 20 years to more than 60 until it stabilizes. As already said, the social to human capital ratio is decreasing as an answer to the pressure to the increasing market value of human capital. Arbitrage condition between human and social capital leads to a constant wage ratio. This leads to the need of supplying relatively more human capital in the economy. Thus this feature is endogenously linked with a human capital driven-growth in this economy.

Moreover, it indicates that both human capital allocated to human capital accumulation (schools) and to social capital accumulation (networking) increase as the economy develops. This can be seen in Figures 2 and 3 that show that as the economy develops more people spend time in schools and networking (see the evolution of u_H and u_S).

In Figure 3, the positive correlation between social and human capital can also be seen in growth rates as those are both increasing, as well as the overall economy growth rate. While this economy develops, physical capital is decreasing in its importance (as its growth rate is decreasing throughout transition - see the evolution of the interest rate r) and social and human capital are gaining importance as growth factors. Finally, another important lesson to be taken from the figures is that an increasing economic growth rate is consistent with a decreasing social to human capital ratio and thus the economy grows faster when S/H is smaller, which is also consistent with the USA evidence.

3.2.2 High Depreciation ($\delta_H = 0.05$)

In this section we present the cases for higher depreciation of human capital. Thus, $\delta_K = \delta_H = 0.05$ and $\Omega = 0.01/-0.01$. Here we only present figures for the social to human capital ratio (S/H) and the shares of human capital in the different sectors (u_H, u_Y, and u_S). Other results do not have influence in our conclusions.

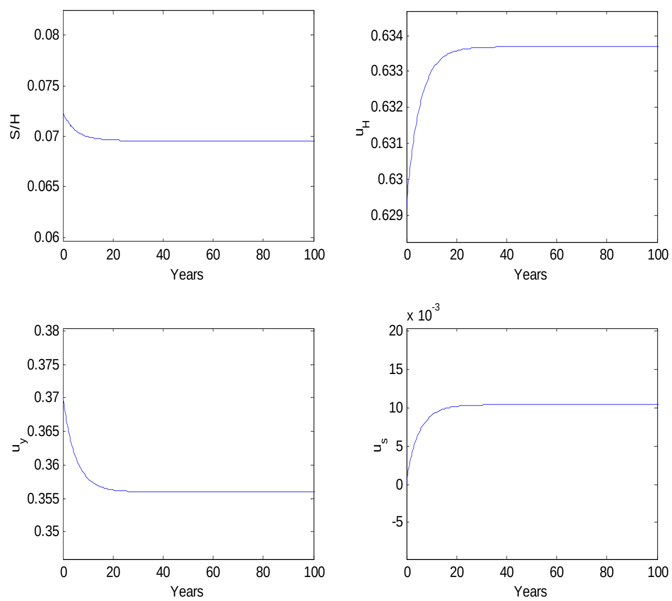

Figure 4: Transition Paths for Representative Variables with depreciation in K ($\delta_K = 0.05$) and positive exogenous growth in S (omega=0.01)

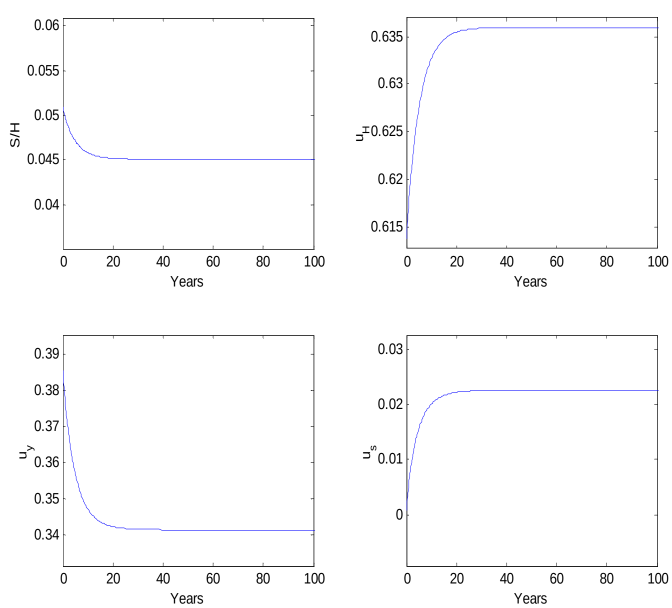

Figure 5: Transition Paths for Representative Variables with depreciation in K ($\delta_K = 0.05$) and depreciation in S (omega=-0.01)

With a 5% depreciation rate of human capital, the share of human capital in schools would be extremely high (even when compared to reasonable values), and the share of human capital in social capital accumulation would be lower than before. Apart from this, all the pattern is maintained: decreasing social capital to human capital ratio and a positive correlation between human capital and social capital during transition, that can be seen both in the evolution of the shares and of the growth rates.

3.2.3 High Share of Social Capital

In this section we present two representative examples of simulations of the transition path of the economy with a higher share of social capital in the final production ($\eta = 0.32$).

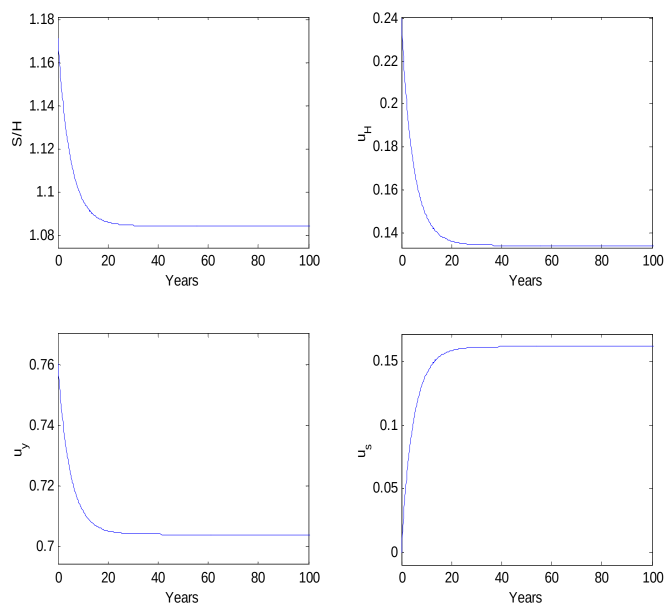

Figure 6: Transition Paths for Representative Variables with depreciation in K ($\delta_K = 0.05$) and positive exogenous growth in S (omega=0.01)

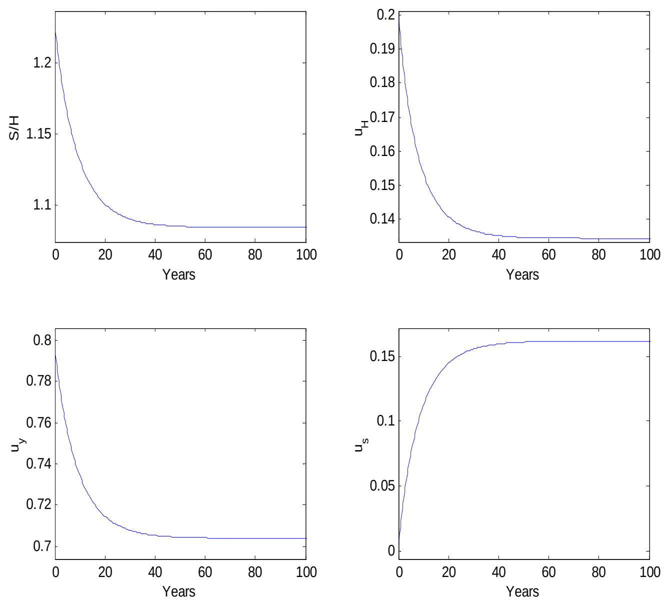

Figure 7: Transition Paths for Representative Variables with no depreciation in K ($\delta_K = 0$) and positive exogenous growth in S (omega=0.01)

With a higher share of social capital in the economy one can not observe the correlation between social capital and human capital in shares and in growth rates. Nevertheless, we can continue to say that a more developed economy have accumulated more human and social capital (in levels). The interesting feature is that the economy continues to exhibit a decreasing social to human capital ratio, indicating a superior role for human capital as the economy develops. Transition to the steady-state takes some more time when the share of social capital is bigger.

As the economy with higher depreciation rate for human capital exhibits exactly the same pattern, and the comparison between it and that without depreciation in human capital can be directly derived from the previous section, we have decided not to present the figures for these exercises.

3.3 An Economy with Two Stages of Development

In this section we want to explore the possibility that this economy can be described with two different stages of economic growth with endogenous transition between stages.[5] This

[5] An economy that can be described with stages of development can be seen in Funke and Strulik (2000).

suggests that before the stage described above, we can describe another stage in which social capital only grows exogenously, i.e., the agent would not allocate any effort to networking, but he would benefit from the stock of social capital. What is the intuition for this outcome? In a less developed economy if people began to invest in human capital (but not in social capital), human capital would grow at small rates, possibly lower than those of the exogenous growth of social capital. At this stage returns of human capital in the final good can grow more than the returns of social capital. As human capital grows, its return begins to grow at a slower pace, until both returns tend to equalize, as in equation (12). This would be the second stage of development, where people allocate human capital to both human and social capital accumulation. In this stage, as returns to both allocations of human capital (besides schooling) are growing at the same rate, the only way to face a decreasing share of human capital to the final good (and thus a pressure on final good sector wages) would be a relative increase in the human capital supply of the economy.

This story implies an increasing social to human capital ratio in the beginning of transition and then the inversion of the relationship. In fact, this would lead to a relationship that resembles an inverted U, as indeed was suggested by Putman (2000) and Halpern (2005).[6] To emphasize this result, we have considered a similar calibration to one of those described in Table 1. To be precise, we considered $\theta = 2$, $\beta = 0.36$, $\rho = 0.02$, $\delta_K = \delta_H = \alpha = 0$, $\xi = 0.057$, $\gamma = 0.18934$, $\Omega = 0.011$, $\eta = 0.08$. The figures presented below show the evolution of the same variables as in the benchmark exercise.

[6] An inverted U relationship between social capital and the age of respondent people had been reported by Glaeser et al. (2002:448).

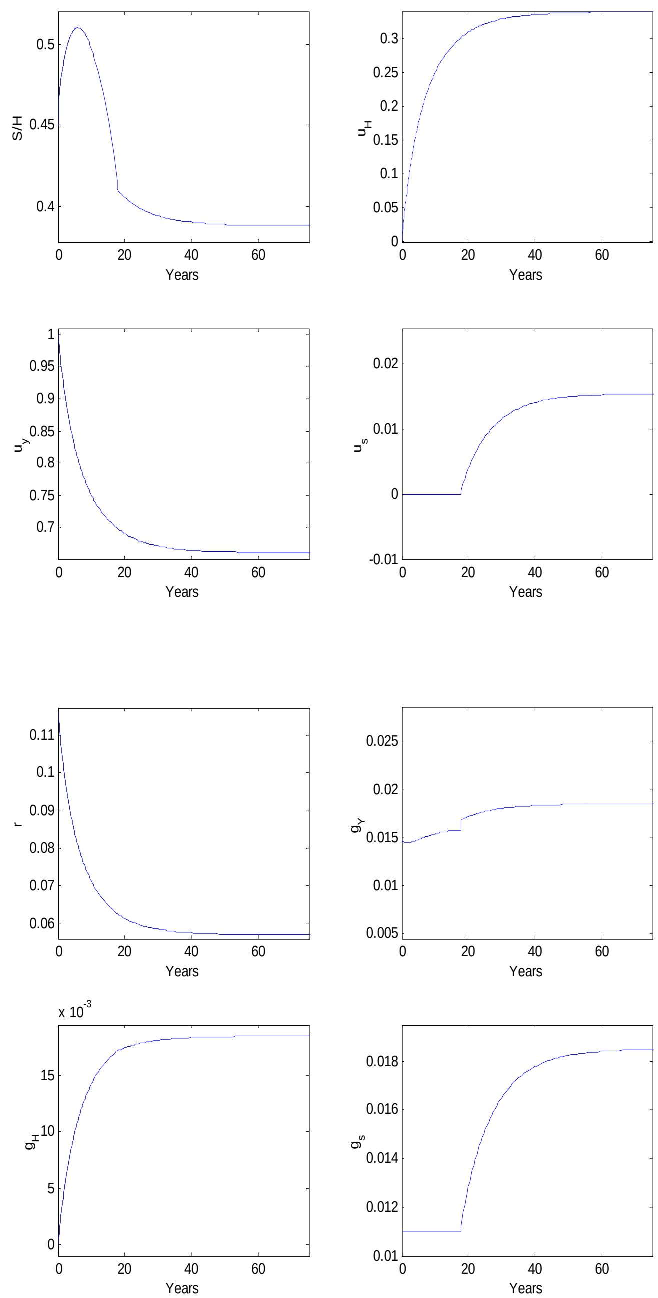

Figure 8: Transition Paths for Representative Variables in a two-stages economy

These figures show us that the first stage lasts nearly 20 years, and afterwards the second stage begins. The first stage is characterized by an increasing social to human capital ratio (lasting approximately 6 years), as the exogenous growth rate of social capital is higher than the endogenously determined growth rate of human capital at early years. Then, yet during the first stage, the social to human capital ratio inverts its tendency and begins to decrease. At the first stage, the growth rate of social capital is constant, increasing after the beginning of the second stage. Both human and social capital increase the shares of used human capital in the second stage. Overall, the economic growth rate is always increasing, as well as the human and the social capital growth rates in the second stage.

4 Conclusions

We build an endogenous growth model with both human and social capital accumulation in which social capital can grow exogenously and endogenously. We describe the model steady-state and its dynamics. We show that the social to market wage ratio must be constant. Thus, when human capital accumulation takes place, the market value for market human capital suffers a pressure to increase. The only way the economy has to keep the wage ratio constant is to provide the economy with more human capital. This leads to a decreasing social to human capital ratio in the economy. Our mechanism is intrinsically linked with human capital driven-growth. Thus, this may explain some different robustness results when the relationship between social capital and growth is taken to the data. This may suggest that this relationship may be studied empirically taking into account both the contribution of human and of social capital to growth.

We also implement a number of numerical exercises in order to describe the evolution of the theoretical economy during transition to the steady-state. The most robust feature of the model is the increasing relative importance of human capital when compared with social capital throughout the development process. The model transition also mimics a positive correlation between social and human capital throughout time, indicating that more developed economies with more human capital, have also more social capital. In a specific numerical exercise we mimic an inverted U-shaped relationship of the social to human capital ratio throughout time. Moreover, in this last exercise, an increasing economic growth rate is consistent with both an increasing and a decreasing social to human capital ratio. These features of the model resembles empirical facts regarding social capital and the evolution of the economy, namely: the decreasing social capital ratio in the late twentieth century in the USA, the consistence of this fact with a growing economy and the positive correlation between social and human capital.

Our contribution follows the suggestions of previous empirical works in considering the interactions between human and social capital in a theoretical framework. This allowed us to draw several conclusions on the possible evolution of a theoretical economy that overall mimics what we already know from the empirical studies on social capital and economic growth. As the the most important variable in the model is the social to human capital ratio, it can be suggestive for future empirical work to include this variable in the regressions explaining economic growth.

References

[1] Bartolini, S. and L. Bonatti (2007), "Endogenous Growth, Decline in Social Capital and Expansion of Market Activities", *MPRA Working-Paper 3341*.

[2] Betz, F. (2008), *Returns to Sociability*, paper presented at 15^{th} International economic Association World Congress, Istanbul, June.

[3] Beugelsdijk, S., H. Groot, and A. van Schaik (2004), "Trust and Economic Growth: A Robustness Analysis", *Oxford Economic Papers*, 56, 118-134.

[4] Bisin B. and D. Guaitoli (2006), "Social Capital, Modernization and Growth", ASSET Conference 2006, *mimeo*.

[5] Berggren, N., M. Elinder, and H. Jordahl (2007), "Trust and Growth: A Shaky Relationship", *Empirical Economics*, on-line earlier, DOI 10.1007/s00181-007-0158-x.

[6] Brunner, M. and H. Strulik (2002), "Solution of Perfect Foresight Saddlepoint Problems: A Simple Method and Applications", *Journal of Economics Dynamics and Control*, 25(5):737-753, May.

[7] Cálvo-Amengol, A. and M. Jackson (2004), "The Effects of Social Networks on Employment and Inequality", *American Economic Review*, Vol. 94, No. 3, pp. 426-454.

[8] Calvó-Armengol, A. and M. Jackson (2007) "Networks in Labor Markets: Wage Dynamics and Inequality" *Journal of Economic Theory*, Vol. 132, No. 1, 27-46.

[9] Caselli, F., G. Gerardo and F. Lefort (1996), "Re-opening the Convergence Debate: A New Look at Cross Country Growth Empirics", *Journal of Economic Growth* 1: 363-389.

[10] Coleman, J. (1988), "Social Capital in the Creation of Human Capital", *American Journal of Sociology*, 94, S95-S120.

[11] Funke, M. and H. Strulik (2000), "On Endogenous Growth with Physical Capital, Human Capital and Product Variety", *European Economic Review*, 44, 491-515.

[12] Glaeser, E.L., Laibson, D., and B. Sacerdote (2002), "An Economic Approach to Social Capital", *Economic Journal*, 112, F437-F458.

[13] Halpern, D. (2005), *Social Capital*, Polity Press, Cambridge, United Kingdom.

[14] Knack, S. and P. Keefer (1997), "Does Social Capital Have an Economic Payoff? A Cross-Country Investigation", *Quarterly Journal of Economics*, 112, 1251-88.

[15] Lucas, R. (1988), "On the Mechanics of Economic Development", *Journal of Monetary Economics*, 22, 3-42.

[16] Piazza-Georgi, Barbara (2002), "The Role of Human and Social Capital in Growth: Extending our Understanding", *Cambridge Journal of Economics*, 26, 461-479.

[17] Putman, R. (1993), *Making Democracy Work: Civic Traditions in Modern Italy*, Princeton, Princeton University Press.

[18] Putman, R. (2000), *Bowling Alone: The Collapse and Revival of American Community*, New York: Simon and Schuster.

[19] Routledge B. and J. Amsberg (2002), "Social Capital and Economic Growth", *Carnegie-Rochester Conference Series on Public Policy.*

[20] Rupasinga A. (2000), "Social Capital and Economic Growth: A County-Level Analysis", *Journal of Agricultural and Applied Economics*, 32(3), 565-72.

[21] Smulders S. and S. Beugelsdijk (2004), "Social Capital and Economic Growth", Tilburg University, Department of Economics, *mimeo.*

[22] Tamura, R. (2006), "Human Capital and Economic Development", *Journal of Development Economics,* vol. *79, 1, 26-72,* February.

[23] Teachman J. D., K. Paasch, and K. Carver (1997), "Social Capital and the Generation of Human Capital", *Social Forces*, 75(4), 1343-1359.

[24] Temple, J. and P.A. Johnson (1998), "Social Capability and Economic Growth", *The Quarterly Journal of Economics*, 113(3), 965-990.

[25] Whiteley, P. (2000), "Economic Growth and Social Capital", *Political Studies*, 48(3), 443-466.

[26] World Bank (2006), "Where is the Wealth of Nations? Measuring Capital for the 21^{st} Century", The World Bank, Washington D.C.