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Social Capital, Innovation and Economic Growth

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Abstract

Multidisciplinary innovation is the engine of growth of an increasing number of economies. Innovation output depends increasingly on information sharing and cooperation between creative agents. Sharing and cooperation requires the existence of generalised trust. Social capital consists of trust and trust-based networks. Our main goal is to illustrate theoretically the importance of social capital to the growth of an innovation economy.

Keywords: Innovation, Social Capital, Economic Growth.

JEL Classification: O00, O31, O41

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1. Introduction

With this paper, we propose an endogenous growth model with which to frame and analytically convey the idea that social capital influences innovation and, through it, economic growth. Akçomak and Weel (2009) argue empirically that, by facilitating interaction, cooperation and sharing, social capital influences innovation activities, thereby impacting on economic growth. We provide a theoretical portrayal of this suggested chain of causality between social capital, innovation and economic growth.

Innovation has been the engine of growth in countries such as Austria, Finland, Sweden, the United Kingdom and the United States, between 1995 and 2006 (OECD, 2010), and, in their search for sustainable sources of economic growth, more industrialised and emerging nations are expected to become innovation economies. The *Europe 2020 Strategy* provides an example of this.

No longer confined in concept to the result of technological and scientific R&D activities, undertaken exclusively by academically formed researchers, innovation consists of the introduction of a new product or service, a new process, or a new method (Oslo Manual, 2005). Its multidisciplinary nature, growing complexity and costs require a productive structure that enables cooperation and information sharing between innovators. The success of such productive environment requires the existence of social capital in the innovation economy. We offer a theoretical illustration for this argument.

Routledge and Amsberg (2002) identify Hanifan (1916) as the first to use the term social capital in business and economics contexts. As reviewed by Beugelsdijk and Schaik (2005), a consensual definition of social capital has proved difficult to obtain, with Putnam et al. (1993) and Fukuyama (1995) together giving social capital its most generalised definition.

Putnam et al. (1993) define social capital as the set of norms and networks that facilitate cooperation and coordinated actions. Trust spreads transitively through networks. Trust increases cooperation, which increases trust, in a virtuous circle. The World Bank defines social capital as the set of norms and networks that enable collective action.

For Fukuyama (1995), social capital is generalised trust rooted on ethical and reciprocal moral habits and obligations common to all members of a society. Trust is one's expectation of another's reliability regarding obligations, cooperative behaviour and fairness in actions and negotiations (Paldam and Svendsen, 2000). In this sense, repeated trustful interactions between strangers within a country lead to higher levels of generalised trust (Crudelia, 2006).

Following Durlauf and Fafchamps (2005), we sum up and adopt the definition of social capital as the set of network-based processes, built upon generalised trust, that influence the ability of a country's inhabitants to share, cooperate and coordinate actions. In short, social capital is generalised trust and its networks.

Uzzi (1996) and Gulati (1998), for instance, find that through trust- networks, diverse and important information flows freely. Information is crucial for

multidisciplinary innovation activity, hence our wish to frame analytically the mechanisms through which social capital influences innovation and consequently influences economic growth.

The effects of social capital on economic growth can be theoretically modelled both at the individual and at the aggregate level. Regarding microeconomic channels, trust and cooperation within the firm, industry or market may lower transactions costs, help enforce contracts and improve credit access. In a macroeconomic perspective, according to Easterly and Levine (1997) for instance, social capital can increase the effectiveness of economic policies. Related empirical literature searches for evidence of a positive relation between social capital and economic growth, without distinguishing microeconomic from macroeconomic channels. In fact, most of the studies connecting social capital and economic growth use a definition of social capital at the aggregate level, using, as a proxy for social capital, a measure of trust provided by the World Bank. Fukuyama (1995), for example, finds cross-national differences in economic growth correlated with differences in national levels of trust. Knack and Keefer (1997) and Temple and Johnson (1998) also obtain a positive relationship between trust and economic growth. Dinda (2008) identifies more studies documenting a positive relation between trust and growth, such as Heller (1996), Ostrom (2000), Rose (2000), Bertrand and Mullainathan (2000), Beugelsdijk and Smulders (2004), Bjornskov (2006), Glaeser et al. (2000), Alesina and Ferrara (2002), Miguel (2003), Sobel (2002), Tau (2003), Rupasingha (2000), Zak and Knack (2001).

As Rupasingha et al. (2006) observe, few attempts have been made to explain analytically how social capital accumulates - the few theoretical contributions concerning mostly microeconomic level effects. This adds to our motivation for developing a model that explains analytically how social capital grows, how it influences innovation activity and consequently how it is linked to economic growth.

With Akçomak and Weel (2009) as our main reference, we portray an innovation economy with a non-scale, two-sector, idea-based growth model with complementarities between intermediate goods and services in the aggregate production function. The assumption of complementarities strikes us as ideal for capturing an innovation economy's nature, in that rent-seeking firms benefit from cooperating and sharing. Building on Thompson (1998), we reinterpret R&D activities as innovation activities, and develop a two-sector productive structure, i.e. with different production functions for output and new innovations. In the introduced production function for new innovations, we assume that social capital increases innovators' productivity. We also specify that the innovation growth rate decreases with the level of innovation. A fixed innovation's depreciation rate is considered.

Additionally, we introduce social capital and its accumulation function into the model. Knack (2002) distinguishes between government social capital and civil social capital. Government social capital represents government principles and institutions. Civil social capital consists in common values, norms and trust-based networks. In this paper, we choose not to attribute any responsibility for the accumulation of social capital to the government. Hence, this model contemplates only civil social capital.

When thinking of our stylised innovation economy's stock of social capital, unlike Akçomak and Weel (2009), we do not give much deterministic relevance to History, as our wish is to emphasise the possible existence of an automatic, continuous mechanism linking monopolistic competitor's profits to social capital accumulation. We assume then that social capital accumulation does not depend on government's decisions nor on firms' decisions. It depends positively and automatically on: (i) monopolistic competitors' profits; and (ii) the economy's existing stock of social capital.

Our main finding is that the equilibrium long run growth rate depends positively on the output-workers to innovators ratio. Despite being an innovation economy, whose engine of growth lies in the innovation sector, the proportion of output-workers to innovators must rise if there is to be higher economic growth. As Jones (1995, 2002) points out, this prediction meets the empirical evidence that long run growth does not grow proportionally with the number of researchers,.

The paper is structured in 4 Sections. After this Introduction, in Section 2, we set up the model. Section 3 contains the general equilibrium solution and a discussion of our main findings. The paper is closed with some Final Remarks.

2. The Model

We frame the long run growth of an innovation economy with a non-scale, two-sector, idea-based, growth model with complementarities between intermediate goods & services in the aggregate production function. Introducing social capital to our

stylised innovation economy, we assume that social capital enhances innovators' productivity. Social capital accumulation depends automatically and positively on intermediate firms' profits, as well as on its own level.

Our goal is to illustrate analytically the mechanisms through which social capital influences innovation, consequently impacting on long run economic growth.

2.1. Production Side – The Technology Equation

2.1.1. Aggregate Output – Final Good

The economy's aggregate output is the final good $Y(t)$ produced, using as inputs, output-workers $L_y(t)$ and the intermediate goods & services $x_i(t)$ of a number $A(t)$ of intermediate firms i ($i = 0 \dots A$). Each differentiated intermediate good or service is associated with one innovation i . In this horizontal-differentiation model, once in existence, each intermediate firm remains in the market forever, with exclusivity in the production and commercialisation of its good or service.

2.1.2. Complementarities between Intermediate Goods & Services

Intermediate firms $i = 0 \dots A$ contribute to final output $Y(t)$ with differentiated goods & services, each one of these associated with one innovation $i = 0 \dots A$. The presence of complementarities between intermediate inputs in the aggregate production function means that the increase in one intermediate firm's production increases the marginal productivity, hence returns, of the other intermediate firms. This assumption of complementarities is made to frame the idea that cooperation and sharing of information and knowledge are beneficial for profit-seeking firms and

essential to the growth of an innovation economy.

Accordingly, the aggregate production function is:

$$Y(t) = L_Y(t)^{1-\alpha} \left(\int_0^{A(t)} x_i(t)^\gamma di \right)^\phi, \quad \phi\gamma = \alpha, \dots \phi > 1. \quad (1)$$

Constant returns to scale in the production function require the parameter restriction that $\gamma\phi = \alpha$. Additionally, assumption $\phi > 1$ is made so that intermediate goods & services x_i are complementary to one another; i.e., so that the increase in the quantity of one input increases the marginal productivity of the other inputs. In order to obtain a balanced growth path (BGP) solution, a parameter restriction is imposed:

$$\xi = \frac{\phi - 1}{1 - \alpha}. \quad (2)$$

Assuming that it takes one unit of physical capital $K(t)$ to produce one physical unit of any input, the stock of physical capital is related to intermediate goods & services by the rule:

$$K(t) = \int_0^{A(t)} x_i(t) di. \quad (3)$$

Final-good producers are price takers in the market for intermediate goods & services. In equilibrium, they equate the price of each input $R_j(t)$ to its marginal productivity. The price of $Y(t)$ is normalised to one. The inverse demand function faced by each intermediate firm is, then:

$$\frac{\partial Y(t)}{\partial x_j(t)} = R_j(t) = \phi \gamma L_Y(t)^{1-\alpha} x_j(t)^{\gamma-1} \left(\int_0^{A(t)} x_i(t)^\gamma di \right)^{\phi-1}. \quad (4)$$

In expression (4), we can see the complementarities effect, i.e. the increase in one input's quantities increases the demand for all the other intermediate goods &

services.

2.1.3. Intermediate Firms

Each intermediate firm makes two decisions: (i) whether or not to enter the market as a monopolistic competitor; and (ii) once in the market, to maximise its profits in each period of time. Regarding the first decision, in each period of time t , in order to enter the market, an intermediate firm must buy an innovation's patent. Like in Evans et al. (1998), followed by Thompson (2008), each patent's price consists of an up-front cost of $P_A(t)i(t)^\xi$, where $P_A(t)$ is the standard cost of every new innovations, and $i(t)^\xi$ represents an additional cost specific to innovation i , meaning that the higher the index i of a new innovation, the higher its innovation cost. Entering the market, intermediate firm i will become a monopolistic producer of a differentiated intermediate good or service. The intermediate firm's decision to enter the market requires comparison between the innovation patent price paid up-front at time t , for the A_{th} innovation, and the discounted value of the stream of profits $\pi_i(t)$ obtained from t onwards. Intermediate firm's dynamic zero-profit condition is, hence:

$$P_A(t)A(t)^\xi = \int_{\tau=t}^{\infty} e^{-r(\tau-t)} \pi_i(\tau) d\tau,$$

whose, time-differentiation (assuming no bubbles) gives:

$$\left(P_A(t)A(t)^\xi \right) \dot{} = r P_A(t)A(t)^\xi - \pi_i,$$

equivalent to:

$$g_{PA} + \xi g_A = r - \frac{\pi_i}{P_A A^\xi}. \quad (5)$$

Having decided to enter the market, an intermediate firm's second decision is to maximise its profits in each period of time. The physical production of one unit of each input requires one unit of physical capital. Hence, in each period, the monopolistic intermediate firm maximises profits, taking as given the inverse demand function (4) for its good:

$$\max_{x_i(t)} \pi_i(t) = R_i(t)x_i(t) - rx_i(t),$$

which leads to mark-up rule:

$$R_i = \frac{r}{\gamma}. \quad (6)$$

The model's symmetry implies that $R_i(t) = R(t)$, $x_i(t) = x(t)$ and $\pi_i(t) = \pi(t)$.

Then $R(t)$ is rewritten as:

$$R = \alpha L_Y^{1-\alpha} A^{\phi-1} x^{\alpha-1}, \quad (7)$$

while $x(t)$ becomes:

$$x = L_Y A^\xi \left(\frac{\alpha}{R} \right)^{\frac{1}{1-\alpha}}. \quad (8)$$

Profits $\pi(t) = (1-\gamma)R(t)x(t)$ are given by:

$$\pi = (1-\gamma)\alpha L_Y^{1-\alpha} A^{\phi-1} x^\alpha. \quad (9)$$

The model's symmetry implies also that equation (3) simplifies to $K = Ax$, and production function (1) becomes:

$$Y = L_Y^{1-\alpha} A^\phi x^\alpha. \quad (10)$$

2.1.3 Physical Capital Accumulation

In this closed economy without government, investment in physical capital is, in each period of time, financed by family savings, which correspond to what is left of aggregate output after consumption. Assuming zero capital depreciation, for simplicity, physical capital accumulation is given by:

$$\dot{K}(t) = Y(t) - C(t). \quad (11)$$

2.1.4. Innovation Sector

Multidisciplinary innovation is undertaken by innovators $L_A(t)$ whose productivity depends on the economy's stock of social capital $S(t)$. Such assumption is made under the belief that innovation processes involve cooperation and sharing of information, which requires the existence of trust between innovators. Their source of knowledge is the stock of already invented innovations, whose patent manuals are in a free-access library. We assume that the higher the stock of existing inventions, the more difficult it is to create additional innovations, more specifically we assume that the growth rate of innovations depends negatively on $A(t)^\xi$. We also assume, for further realism, a fixed depreciation rate, d , for the innovations stock. The production function for new innovations that we propose is:

$$\dot{A}(t) = \delta A(t)^{1-\xi} S(t) L_A(t) - dA(t), \quad (12)$$

where parameter δ represents efficiency in the innovation's sector.

2.1.5. Social Capital Accumulation

We do not wish to specify social capital formation as a direct result of optimization decisions of either the government or any other economic agents. Nor do we intend to assume it to grow exogenously, without explanation. Hence we

assume that social capital accumulation depends positively and automatically on intermediate firms' profits. It also depends positively on its own stock, in a self-reinforcing way. The equation for social capital accumulation here proposed is:

$$\dot{S}(t) = \psi S(t) + \pi(t), \quad (13)$$

where parameter ψ stands for the economy's propensity towards trust building.

2.1.6. Labour Market

Total population L , assumed constant, choose whether to work in real output production or in innovation:

$$\bar{L} = L_Y + L_A, \quad (14)$$

Equation (14) implies that:

$$g_{LY} = -\frac{L_A}{L_Y} g_{LA},$$

Final-good producers' profit maximisation condition, $\frac{d\pi_Y}{dL_Y} = 0$, gives output-workers wage:

$$w_Y = \frac{dY}{dL_Y} = (1 - \alpha)L_Y^{-\alpha} A^\phi x^\alpha. \quad (15)$$

Innovators' profit maximisation condition, $\frac{d\pi_A}{dL_A} = 0$, gives innovators' remuneration:

$$w_A = P_A A^\xi \frac{d\dot{A}}{dL_A} = P_A A^\xi \delta A^{1-\xi} S = \delta P_A A S. \quad (16)$$

Equilibrium in the labour market is achieved with the indifference condition that labour remuneration is equal across sectors:

$$w_Y = w_A \Leftrightarrow P_A = \frac{(1 - \alpha)L_Y^{-\alpha} A^{\phi-1} x^\alpha}{\delta S}. \quad (17)$$

2.1.7. Technology Equation

The Technology Equation unites the pairs of constant growth rates and interest rates (g, r) for which the production side of the economy is in its balanced growth path (BGP) equilibrium. As will become evident later on, in a BGP equilibrium, the interest rate is constant and hence so is $R = \frac{r}{\gamma}$. Then, log-time-differentiation of expression (8) says that:

$$g_x = g_{LY} + \xi g_A, \quad (18)$$

from which follows that physical capital grows at the rate: $g_K = (1 + \xi)g_A$. Log-time-differentiation of production function (10) gives us the growth rate of output:

$$g_Y = (\phi + \alpha\xi)g_A = (1 + \xi)g_A.$$

Innovation's growth rate is derived from equation (12):

$$g_A = \frac{\dot{A}}{A} = \frac{\delta L_A S}{A^\xi} - d, \quad (19)$$

which says that in a BGP solution it must be that: $g_S = \xi g_A - g_{LA}$.

Social capital's growth rate is given by equation (13):

$$g_S = \frac{\dot{S}}{S} = \psi + \frac{\pi}{S},$$

which means that, in the BGP solution, intermediate firms' profits and social capital, grow at the same rate:

$$g_\pi = g_S = \xi g_A - g_{LA} \quad (20)$$

Log-time-differentiation of expression (17) gives us the growth rate of innovation's standard price:

$$g_{P_A} = -\alpha g_{LY} + (\phi - 1)g_A + \alpha g_x - g_S,$$

which, recalling equation (18), is equivalent to:

$$g_{P_A} = (\phi - 1 + \alpha \xi - \xi)g_A + g_{LA},$$

equivalent, recalling restriction (2), to:

$$g_{PA} = g_{LA} \tag{21}$$

We proceed by developing the dynamic zero-profit condition (5):

$$g_{PA} + \xi g_A = r - \frac{\pi}{P_A A^\xi}. \tag{22}$$

Equations (21) and (22) together imply that a BGP solution entails the following equality:

$$g_\pi = g_{PA} + \xi g_A = g_{LA} + \xi g_A. \tag{23}$$

Equations (22) and (19) together mean that:

$$g_{LA} = 0 \implies g_{LY} = 0. \tag{24}$$

It then follows that:

$$g_{PA} = 0 \text{ and } g_S = g_\pi = g_x = \xi g_A.$$

Recalling that $g_Y = (1 + \xi)g_A$, equation (22) becomes then our Technology Equation:

$$g_Y = \frac{(1 + \xi)}{\xi} \left[r - \frac{\pi}{P_A A^\xi} \right],$$

which, using equations (9), (17) and (19), is equivalent to:

$$g_Y = \left(\frac{1 + \xi}{\Omega \frac{L_Y}{L_A} + \xi} \right) \left[r - \Omega \frac{L_Y}{L_A} d \right], \quad (25)$$

Where constant $\Omega = \frac{(1-\gamma)\alpha}{(1-\alpha)}$.

2.2. Consumption Side - The Euler Equation

Globally connected, well informed and participative, citizens contribute to innovation economies with labour, ideas and concrete demands regarding consumption. They desire innovative goods and services, which are aggregated in the form of final good Y . We can then capture consumers' decisions with the standard intertemporal consumption specification. Consumers being immortal and homogeneous, their representative wishes to maximise, subject to a budget constraint, the discounted value of utility:

$$\max_{C(t)} \int_0^{\infty} e^{-\rho t} \frac{C(t)^{1-\sigma}}{1-\sigma} dt \quad (26)$$

$$s.t. \quad \dot{E}(t) = rE(t) + w(t)L - C(t), \quad (27)$$

where $C(t)$ is consumption of $Y(t)$ in period t ; $\rho > 0$ is the rate of time preference; and $\sigma^{-1} > 0$ is the elasticity of substitution between consumption at two periods in time. Total assets are $E(t)$; r is the interest rate; $w(t)$ is the wage rate, and it is assumed that each citizen provides one unit of labour per unit of time. The transversality condition is $\lim_{t \rightarrow \infty} \mu(t)E(t) = 0$, $\mu(t)$ being the shadow price of assets, and consumers' decisions are described by the Euler Equation:

$$g_c = \frac{\dot{C}}{C} = \frac{1}{\sigma}(r - \rho), \quad (28)$$

according to which the interest rate, r , is constant in a BGP equilibrium.

3. General Equilibrium

We have already asserted that $g_S = g_\pi = g_x = \xi g_A$, and that capital $K(t)$ grows at the same rate as output $Y(t)$: $g_K = g_Y = (1 + \xi)g_A$. The economy's budget constraint (11) in turn says that, because $g_K = g_Y$, a constant g_K requires that $C(t)$ grows at the same rate as $K(t)$ and $Y(t)$. That is:

$$\frac{\dot{K}}{K} = \frac{Y}{K} - \frac{C}{K} \Rightarrow g_K = 0 \Leftrightarrow \left[\frac{\dot{Y}}{Y} \right] = \left[\frac{\dot{C}}{C} \right] \Leftrightarrow g_C = g_K.$$

With labour constant, the per-capita economic growth rate is equal to:

$$g_C = g_Y = g_K = g = (1 + \xi)g_A.$$

3.1. The Steady-State Equilibrium

The BGP general equilibrium solution is obtained by solving the system of two equations, (25) and (28), in two unknowns, r and g :

$$\left\{ \begin{array}{l} g = \frac{1}{\sigma}(r - \rho) \\ g = \left(\frac{1 + \xi}{\Omega \frac{L_Y}{L_A} + \xi} \right) \left[r - \Omega \frac{L_Y}{L_A} d \right], \Omega = \frac{(1 - \gamma)\alpha}{(1 - \alpha)} \end{array} \right. \quad (29)$$

Restriction $r > g > 0$ is imposed so that: (i) present values are finite; and (ii) our

solution(s) have positive interest and growth rates.

Proposition *Existence of a unique steady-state solution for $\sigma > \left(\frac{1 + \xi}{\Omega \frac{L_Y}{L_A} + \xi} \right)$ and*

$$\Omega \frac{L_Y}{L_A} d > \rho.$$

Proof. As Figure 1 represents, in the space (r, g) , the linear Euler equation (28) has gradient $\frac{\partial r}{\partial g} = \sigma > 0$, the value it assumes on the vertical axis is $r = \rho$ and the value it takes on the horizontal axis is $g = -\frac{\rho}{\sigma}$. To ensure that $r > g$, we impose $\sigma > 1$ so that the Euler equation lies above the 45° line (e.g., Rivera-Batiz and Romer, 1991). The Technology equation is also positively sloped. Hence, if: (i) the value it takes on the vertical axis, $r = d\Omega \frac{L_Y}{L_A}$, is greater than ρ ; and (ii) its slope, $\frac{dr}{dg} = \frac{\xi + \Omega \frac{L_Y}{L_A}}{\xi + 1}$, is smaller than σ , then the Euler and the Technology equations cross only once in the first quadrant of the (r, g) space, and the BGP equilibrium is unique.

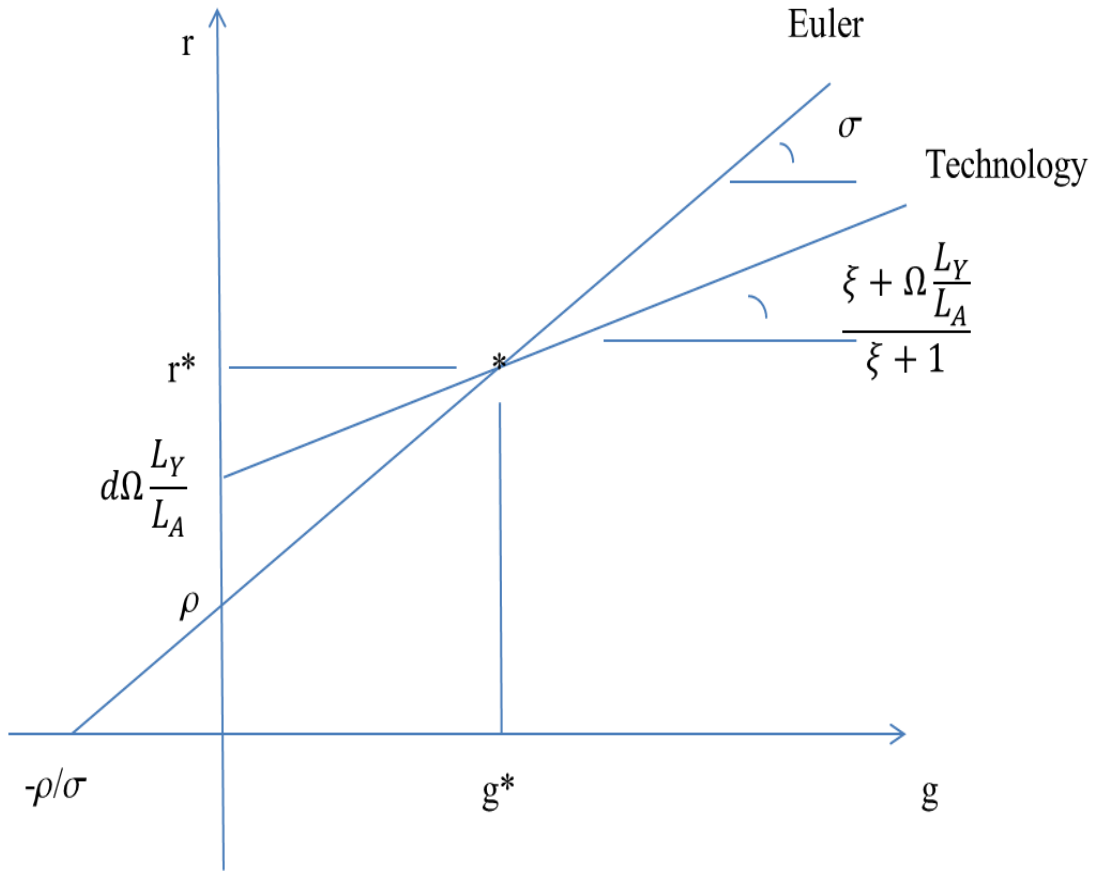


Figure 1. Analytical BGP general equilibrium unique solution

The general equilibrium growth rate is given by:

$$g^* = \frac{d\Omega \frac{L_Y}{L_A} - \rho}{\sigma - \frac{\xi + \Omega \frac{L_Y}{L_A}}{\xi + 1}} \quad (30)$$

At this point, it seems relevant to make an observation regarding the scale-effects prediction, present in many growth models, according to which long run

growth depends on the size of the country, given by its population, \bar{L} . This prediction stems analytically from having constant \bar{L} in the aggregate production function. As this is not empirically validated, many growth models, reviewed by Jones (1999), include in the model another function of \bar{L} , so that the scale-effects prediction is annulled.

The proposed model, despite considering constant population in the aggregate production function, and without doing any deliberate analytical moves in order to remove it from the general equilibrium solution, does not exhibit the scale-effects prediction, as we can see in solution (30). It is a self-made-nonscale growth model.

3.2. Effects on Economic Growth

Our main finding is that the equilibrium growth rate depends positively on the output-workers to innovators ratio, i.e. $\frac{\partial g}{\partial \left(\frac{L_Y}{L_A}\right)} > 0$. In this stylised innovation economy, whose engine of growth is innovation, the proportion of output-workers to innovators must increase if there is to be higher economic growth. This result is in agreement with empirical findings that long run growth does not grow proportionally with the number of researchers, as Jones (1995, 2002) notes.

The here introduced model also predicts that the equilibrium growth rate is positively influenced by the innovations' depreciation rate, i.e. $\frac{\partial g}{\partial d} > 0$. We can reason this effect with the thought that a higher innovation's depreciation rate increases the innovation activities and output, leading to higher economic growth.

Another result worth mentioning, we believe, concerns the fact that both the innovation efficiency parameter and the parameter representing the economy's propensity for accumulating social capital are determined endogenously. As can be derived from equations (12) and (13), these two parameters depend on the equilibrium growth rate, as well as on the economy's levels of knowledge and social capital. Such result accentuates the self-contained, self-solved character of the here introduced growth model.

4. Final Remarks

A growing number of industrialised and emerging economies are assuming the character of innovation economies, their main engine of economic growth being multidisciplinary innovation.

Multidisciplinary innovation consists of the introduction of a new product or service, a new process, or a new method. It is increasingly competitive, complex and costly, compelling innovators to cooperate and share information. The higher the innovator's ability to share and cooperate, the higher the innovation's output, hence the higher the economic growth rate. The ability to share and cooperate can be enhanced by the existence of trust and trust-based networks, that is, by the economy's stock of social capital.

The main purpose of this paper has been to highlight the importance of social capital in the growth process of an innovation economy. We have developed a growth model that provides an analytical illustration of the mechanisms linking social capital

to innovation activity, and innovation activity to economic growth.

We have portrayed a stylised innovation economy and its long run growth through a non-scale, two-sector, idea-based growth model, with complementarities between intermediate inputs in the aggregate production function, in which we have introduced social capital.

Our main finding is that the equilibrium growth rate depends positively on the output-workers to innovators ratio. That is, higher economic growth requires an increase in the output-workers to innovators ratio. As observed by Jones (1995, 2002), this result meets empirical findings that long run growth does not grow proportionally with the number of researchers.

The proposed framework is fairly complete, encompassing production of aggregate output; production of differentiated intermediate goods and services; two types of workers in different productive sectors; accumulation of knowledge, of physical capital and of social capital. Knowledge, physical capital and social capital are all fundamental in this stylised innovation economy. Their growth reveals strict interdependence, in an endogenous fashion, and this enables the model to deliver an equilibrium growth rate that depends, very simply, on the proportion of output-workers relative to innovators.

References

- Akçomak, I.L., Weel, B., 2009. Social Capital, innovation and growth: Evidence from Europe. *European Economic Review* 53, 544–567.
- Alesina, A., La Ferrara, E., 2002. Who trusts others? *Journal of Public Economics* 85,

207–234.

- Barro, R., Sala-i-Martin, X., 2004. *Economic Growth*, McGraw-Hill.
- Bertrand, M., Luttmer, E.F.P., Mullainathan, S., 2000. Network effects and welfare cultures. *Quarterly Journal of Economics* 115 (3), 1019–1055.
- Beugelsdijk, S., Smulders, S., 2004. *Social Capital and Economic growth*. Working paper.
- Bjornskov, C., 2006. The multiple facets of social capital. *European Journal of Political Economy* 22, 22–40.
- Beugelsdijk, S., van Schaik, T., 2005. Social capital and growth in European regions: an empirical test. *European Journal of Political Economy* Vol. 21, 301–324.
- Europe 2020 Strategy*. A Strategy for Smart, Sustainable and Inclusive Growth, Communication from the Commission Brussels. 3.3.2010 COM(2010) 2010 Final. Available: http://ec.europa.eu/economy_finance/structural_reforms/europe_2020/
- Crudelia, L., 2006. Social capital and economic opportunities. *Journal of Socio-Economics* 35 (5), 913–927.
- Dinda, S., 2008. Social Capital in the creation of Human Capital and Economic Growth: A Productive Consumption Approach. *Journal of Socio-Economics* 37 (5), 2020-2033.
- Durlauf, S.N., Fafchamps, M., 2005. Social capital. In: Aghion, P., Durlauf, S.N. (Eds.). *Handbook of Economic Growth* vol.1B. Elsevier, North-Holland, Amsterdam, 1639–1699.
- Easterly, W., Levine, R., 1997. Africa's Growth Tragedy: Policies and Ethnic Divisions. *Quarterly Journal of Economics* 112, 1203–50.
- Evans, G., Honkapohja, S., Romer, P., 1998. Growth Cycles. *American Economic Review* 88(3), 495-515.
- Fukuyama, F., 1995. *Trust. The Social Virtues and the Creation of Prosperity*. Free Press, New York.

- Glaeser, E.L., Laibson, D.I., Scheinkman, J.A., Soutter, C.L., 2000. Measuring trust. *Quarterly Journal of Economics* 115 (3), 811–846 (FLA 00335533 MIT Press Copyright 2000 MIT Press).
- Gulati, R., 1998. Alliances and Networks. *Strategic Management Journal* 19, 293–317.
- Hanifan, L. J., 1916. The Rural School Community Center. *New Possibilities in Education. Annals of the American Academy of Political and Social Science* 67, 130-138.
- Heller, P., 1996. Social capital as a product of class mobilization and state intervention: industrial workers in Kerala. *India World Development* 24 (6).
- Jones, C.I., 1995. R&D-based models of economic growth. *Journal of Political Economy* (4), 759–784.
- Jones, C., 1999. Growth: With or Without Scale Effects? *American Economic Review* 89(2), 139-144.
- Jones, C.I., 2002. Sources of U.S. economic growth in a world of ideas. *American Economic Review* 92 (1), 220–239.
- Knack, S., 2002. Social capital, growth and poverty: a survey of cross-country evidence. *World Bank MPRA Paper No. 24893*.
- Knack, S., Keefer, P., 1997. Does social capital have an economic payoff? A cross-country investigation. *Quarterly Journal of Economics* 112 (4), 1251–1288.
- Miguel, E., 2003. Comment on social capital and growth. *Journal of Monetary Economics* 50, 195–198.
- OECD, 2010. Ministerial report on the OECD Innovation Strategy. May 2010. Available online at: www.oecd.org/innovation/strategy
- Oslo Manual, 2005. Guidelines for Collecting and Interpreting Innovation Data. Joint Publication OECD and Eurostat. 3rd Edition. Available at: http://www.uis.unesco.org/Library/Documents/OECD Oslo Manual 05_en.pdf
- Ostrom, E., 2000. Collective action and the evolution of social norms. *Journal of Economic Perspectives* 14 (3), 137–158.

- Paldam, M., & Svendsen, G.T., 2000. An essay on social capital: Looking for the fire behind the smoke. *European Journal of Political Economy* 16: 339-366
- Putnam, R.D., 1993. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton University Press, Princeton, NJ.
- Rivera-Batiz, L., Romer, P., 1991. Economic Integration and Endogenous Growth. *Quarterly Journal of Economics* CVI (425), 531-555.
- Rose, R., 2000. In: Dasgupta, P., Serageldin, I. (Eds.). *Getting Things Done in Antimodern Society: Social Capital Networks in Russia in Social Capital: A Multifaced Perspective*. The World Bank.
- Routledge, B.R., Amsberg, J., 2002. *Social Capital and Growth*. Carnegie-Rochester Conference Series on Public Policy.
- Rupasingha, A., 2000. Social Capital and Economic Growth: A County-Level Analysis. *Journal of Agricultural and Applied Economics* 32(3), 565-72.
- Rupasingha, A., Goetz, S.J., Freshwater, D., 2006. The production of social capital in U.S. countries. *The Journal of Socio-Economics* 35, 83–101.
- Sobel, J., 2002. Can we trust social capital? *Journal of Economic Literature* XL, 139–154.
- Tau, L.M., 2003. Investing social capital to stimulate economic growth and trade in Africa, Paper presented at the Biennial conference of the economic society of S. Africa.
- Temple, J., Johnson, P.A., 1998. Social capability and economic growth. *Quarterly Journal of Economics* 113 (3), 965–990.
- Thompson, M., 2008. Complementarities and Costly Investment in a Growth Model. *Journal of Economics* 94(3), 231-240.
- Uzzi, B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *Amer. Soc. Rev* 61, 674–698
- Zak, P.J., Knack, S., 2001. Trust and growth. *Economic Journal* 111, 295–321.

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