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STEFANO BARTOLINI
LUIGI BONATTI

How Can the Decline in Social Capital be Reconciled with a Satisfactory Growth Performance?

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Abstract - We aim at reconciling Putnam's claim that social capital has declined in the U.S. in the last decades with the satisfactory growth performance of the U.S. economy over the same period. This puzzle originates from the fact that most literature on social capital emphasizes its role in enhancing factor productivity (mainly by reducing transaction costs). We model the hypotheses that the expansion of market activities (increased "marketization") weakens social capital formation, and that firms utilize more market services in response to the declining social capital. Within this framework, perpetual growth can be consistent with the progressive erosion of social capital.

Keywords: Endogenous growth, externalities, marketization, social assets.

JEL Classification numbers: O13, O41, Q20, Z13.

Stefano Bartolini, Dipartimento di Economia Politica, Università degli Studi di Siena

Luigi Bonatti, Dipartimento di Scienze Economiche, Università di Bergamo

1. INTRODUCTION

In accordance with a definition of social capital as those features of social organizations that facilitate coordination and cooperation (specifically, values and norms of reciprocity inhering in one's social networks), Putnam (2000) uses three broad measures of social capital, namely the intensity of political participation, the density of voluntarily associational activity and survey on levels of trust and mutual cooperation, to document the marked decline in social capital that has occurred in the United States in the last decades. In this paper, we take for granted that Putnam's conclusions about declining U.S. social capital are correct,[1] and we note that--especially in the 1990s--this fall in social capital does not appear to have been paralleled by a decline in the U.S. potential for economic growth. This stylized fact seems at odds with Putnam's statements that "norms and networks of civic engagement contribute to economic prosperity and are in turn reinforced by that prosperity" (1993, p. 180), and that social capital produces "aggregate economic growth" (2000, p.322-3).[2] However, some striking evidence presented by Putnam (2000) to support his claim that social trust has steadily declined in the US in the last thirty years, i.e. the evidence that documents the explosive increase in the society's expenditures in formal activities of social

[1] The general thesis on the decline in social capital in the United States, documented by Skocpol (1999) and Putnam (2000), was already presented in Putnam (1995), raising a critical debate. Some researchers (see, e.g., Ladd, 1996; Paxton, 1999) contested Putnam's conclusions. Subsequent studies tend to confirm the main Putnam's thesis (see, e.g., Costa and Kahn, 2003; Kolodinsky et al. , 2003; Keele, 2004).

[2] This point is stressed by Durlauf and Fafchamps (2004): "Putnam (2000), focusing on the U.S. experience since the 1950s, argues that social capital, defined as membership in formal and informal clubs, has declined monotonically since the 1950s. This is true for all states, all decades and all measures of social capital. However, he finds no relationship between the speed of the decline of social capital and economic performance across U.S. states or across time periods. Further, the relationship between social capital and socioeconomic outcomes is even harder to characterize when one looks at subperiods. For example, the 1990's were a period of rapid economic growth in the U.S. yet it is also a period of rapid decline in social capital, at least based on the sorts of measures he uses. To be clear, Putnam does attempt to

control and dispute resolution, is consistent with the hypothesis that the erosion of social capital stimulates the rapid growth of entire sectors of the economy, which are the sectors providing those services that economic agents use to protect themselves against increasing opportunistic and defiant behavior by others.[3] In the same time, one may claim that the progressive "marketization" of social life, the process through which market relationships become more pervasive, contributes to the diffusion of values, attitudes and behavior that do not favor the formation of social capital. Therefore, one cannot take for granted that social capital and GDP growth are positively correlated.

In spite of the stylized facts concerning the United States, cross-sectional studies appear to show the existence of a positive relation between social capital (generally measured in terms of generalized trust and associational activity) and economic growth (Knack and Keefer, 1997; La Porta et al., 1997; Zak and Keefer, 2001; Beugelsdijk et al., 2004; Beugelsdijk and Schaik, 2005). However, these studies have been subject to severe criticism (Durlauf, 2002a; Durlauf and Fafchamps, 2004).[4] Moreover, both Durlauf (2002b) and Bovenberg (2003) complained about the

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associate higher social capital with better socioeconomic outcomes, our point is that the relationship between the two for the United States is even at first glance relatively complicated" (p. 12).

[3] Bowles and Jayadev (2004) present data showing the significant secular increase in the resources devoted in the United States to the execution of contracts and defence of property rights.

[4] Even admitting the existence of a positive cross-sectional relationship between social capital and income, other studies find evidence of a reverse causation going from economic growth to social capital, since they do not find that high initial levels of social capital are good predictors of future economic development (see Miguel et al., 2001). One may argue that also the theoretical relationship between social capital and economic growth is ambiguous because of the "downside" of social capital (see Olson, 1982; Portes and Landolt, 1996; Stolle and Rochon, 1998; Annen, 2003; Knack, 2003): strong and long-standing groups may hinder growth by their rent-seeking activities aiming at controlling a disproportionately large share of domestic resources, or by placing heavy obligations on members that make more difficult for them to increase their economic opportunities by joining larger social networks. With regard to this point, one can fruitfully distinguish between "bridging" social capital—that is generated in networks spanning different communities and may be positive for growth—and "bonding" social capital—that arises among close friends or

absence of theoretical models that define precisely the mechanisms through which endogenous and exogenous variables interact and co-determine the time profile of social capital and of other indicators of economic performance.[5] We contribute to fill this void by presenting an endogenous growth model linking social capital formation to the decisions by which economic agents determine their working time, accumulate physical capital and substitute intermediate goods for the declining endowment of social capital. The model combines the idea that knowledge and productivity gains are achieved by each firm through (physical) capital utilization and spill over across all firms and the idea that the expansion of market production by each firm has negative externalities on the formation of social capital.[6] Hence, this set-up helps capturing the self-feeding process whereby the dynamics of per capita GDP and the evolution of the stock of social capital influence each other.

By recognizing that a larger endowment of social capital allows to use the existing resources more efficiently, we accept the approach of the so-called "new economic sociology" (see Woolcock, 1998), according to which the members of communities with high stocks of social capital tend to be more able to costlessly monitor one another's behavior, reach informal understanding and agreements, enforce contracts, resolve disputes amicably. In such communities, one would expect a low incidence of litigations, corruption, conflicts and crime.

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members of the same family and that is generally negative for growth. On the relationship between economic growth and social capital see also Dasgupta (2000).

[5] A recent theoretical model focusing on the relation between social capital and economic growth is Beugelsdijk and Smulders (2004), which accounts for the possible trade off between social capital formation and GDP growth. Indeed, the authors assume that the participation in intercommunity networks ("bridging" social capital) enhances growth by reducing the incentives for rent seeking and cheating, and it depresses growth by reducing the time devoted by people to market activities.

[6] Our model follows the "social" approach to social capital, according to which social capital exists within a community and has to be considered as the (unintended) by-product of a large number of individual choices (see Bowles and Gintis, 2000; Routledge and von Amsbergh, 2003).

By admitting that the greatest danger to the social capital, which is so important for market efficiency, arises from the market system itself, we refer to an idea that has a long history behind. Some authors went so far as to claim that capitalism contains within itself the mechanism of its own destruction (see Hirsch, 1976; Hirschman, 1982): the decline of the values (honesty, business ethics, trust…) that prevent the spread of the opportunism generated by a market society will end up by destroying the latter.[7] In other words, they argued that even the survival of the market system can be jeopardized by that progressive weakening of its cultural and ethical base which is a consequence of its evolution and success, since the individualistic and competitive values system connected with the expansion of a market economy is the greatest threat to the efficient functioning of markets. Also the socio-economic transformations that according to Putnam (2000) may have negatively affected the formation of social capital in the United States in the last decades can be considered a by-product of the process of marketization. Indeed, he identifies some possible determinants of the decline in the U.S. social capital in the rising female participation in the labor market, in the increase in geographical mobility, in "the replacement of the corner grocery by the supermarket" and in the "privatizing" or "individualizing" of the leisure time (mainly due to the TV and more in general to the diffusion of home-entertainment technologies). In particular, the documented increase in hours worked per adult that has occurred in the United States in the last thirty years—in contrast with almost all other industrialized countries (see, e.g., Freeman and Schettkat, 2005)—is probably important for explaining both the decrease in social capital and the acceleration of growth that has characterized the U.S. economy in recent years. With this regard, it is significant that the model

[7] Fukuyama (1995) fully embraces the idea that capitalism tends to erode social capital but offers an optimistic view of its ability to regenerate that capital. The perception that there is a conflict between a development strategy advocating a stronger role for social capital and an agenda emphasizing market incentives and material values is present also in the current policy debates (see, e.g., Heyer et al., 2002). In the same time, the idea that any development process brings destruction of social capital has been recently challenged by studies focusing on specific episodes and experiences (see, e.g., Miguel et al., 2001).

presented here generates an equilibrium path along which the relative decline in social capital is accompanied by the households' tendency to increase their time devoted to market activities.

The paper is organized as follows: section 2 presents the model, section 3 characterizes the equilibrium trajectories of the economy and section 4 concludes.

2. THE MODEL

We consider an economy in discrete time with an infinite time horizon. In this economy there are firms and households.

2.1 The firms

For simplicity and without loss of generality, it is assumed that there is a fixed and large number (normalized to be one) of perfectly competitive firms that are identical and produce the single good existing in this economy. The representative firm produces its output Y_t according to the technology

$$Y_t = (S_t + X_t)^{1-\alpha-\beta} L_t^{\alpha} K_t^{\beta} A_t, \ \alpha>0, \beta>0, \alpha+\beta<1, \tag{1}$$

where S_t is the stock of social capital existing in the economy in period t, X_t is the amount of Y_t used as intermediate good by the firm in t,[8] L_t are the units of labor employed by the firm in t, K_t is the amount of (physical) capital rent by the firm in t and A_t denotes the state of technology in t. Note that the value added generated by each firm is given by

$$GDP_t=Y_t-X_t, \tag{2}$$

where Y_t is the numeraire of the system and its price is set to be one.

In (1) it is assumed that a high level of social capital boosts total factor productivity and that each firm can use private resources as (perfect) substitutes for S_t: following Bowles and Jayadev (2005), we may interpret S_t as a measure of the level of trust, work ethics, honesty, effective

[8] It is immaterial in this context if the firm buys X_t from some other firm or if it employs as intermediate good a portion of its own output.

protection from confiscation and the like existing in the society at time t, and consistently we may interpret X_t as a measure of the resources that each firm devotes to the execution of contracts and the defense of property rights in t.[9] It is also assumed that A_t is a positive function of the stock of physical capital existing in the economy: $A_t = K_t^{\alpha}$ (consistently with this formal set-up, one can interpret technological progress as labor augmenting). This assumption combines the idea that learning-by-doing works through each firm's (physical) capital utilization and the idea that knowledge and productivity gains spill over instantly across all firms (see Barro and Sala-i-Martin, 1995). Therefore, in accordance with Frankel (1962), it is supposed that although A_t is endogenous to the economy, each firm takes it as given, since a single agent's investment decisions have only a negligible effect on the aggregate stock of physical capital.

In each t, the representative firm chooses X_t, L_t and K_t in order to maximize its profits, which are given by

$$\pi_t = Y_t - X_t - W_t L_t - R_t K_t, \tag{3}$$

where R_t is the capital rental rate and W_t is the wage rate.

2.2 The law of motion of the social capital

Across the social sciences, a recurring hypothesis is that the expansion of market activities may undermine the society's ability to regenerate its social assets. According to this thesis, the level of generalized trust, civic engagement, public ethics and personal honesty may suffer because of the increased "marketization" of social life, which brings about as a by-product the diffusion of attitudes and values like grid, cynicism and opportunism. We use the volume of goods and services

[9] The model is also open to the interpretation of S_t as an environmental asset. Consistently with this interpretation, one may suppose that an increasing amount of current output has to be used to preserve factor productivity as environmental quality worsens (for instance, more fertilizers and irrigation are needed to preserve land fertility as the global climate becomes less favorable to farming, or more medical care is needed to preserve labor productivity as air quality deteriorates).

that are produced for monetized exchange by profit-maximizing firms as a proxy of the degree of marketization. It is also assumed that the larger this volume, the higher has to be the stock of social capital in order to offset the detrimental effect of this greater degree of marketization on the level of generalized trust, civic engament, public ethics and personal honesty. In other words, the stock of social capital declines whenever the ratio S_t/Y_t tends to fall below a critical thresholds. Hence, we may summarize this discussion by modeling the evolution in time of the stock of social capital as follows:

$$\frac{S_{t+1} - S_t}{S_t} = \rho\left(\frac{S_t}{Y_t} - \xi\right),\ \rho > 0, \xi > 0\ ,\ S_0 \text{ given.} \qquad (4)$$

It is worth to emphasize that Y_t is the aggregate market output in period t: a single firm has only a negligible effect on the evolution of S_t.[10]

2.3 The households

For simplicity and without loss of generality, it is assumed that the population is constant and that each household contains one adult, working member of the current generation. Thus, there is a fixed and large number (normalized to be one) of identical adults who take account of the welfare and resources of their actual and prospective descendants. Following Barro and Sala-i-Martin (1995) we model this intergenerational interaction by imagining that the current generation maximizes utility and incorporates a budget constraint over an infinite future. That is, although individuals have finite lives, we consider immortal extended families ("dynasties").[11] Finally, we assume that agents' expectations are rational, in the sense that they are consistent with the real

[10] If one interprets S_t as an environmental asset affecting productivity, equation (4) may model the negative effect of production on the nature's absorption capacity, namely on its capacity of preserving a certain level of environmental quality.

[11] As Barro and Sala-i-Martin (1995, p. 60) point out, "this setting is appropriate if altruistic parents provide transfers to their children, who give in turn to their children, and so on. The immortal family corresponds to finite-lived individuals who are connected via a pattern of operative intergenerational transfers that are based on altruism".

processes followed by the relevant variables. In this framework, in which there is no source of random disturbances, this implies perfect foresight.

In each period t, the utility of the representative household is an increasing function of consumption and leisure:

$$U_t=\ln(C_t)+\gamma\ln(1-L_t),\ \gamma>0,\ L_t\leq 1, \tag{5}$$

where C_t is consumption in t and $1-L_t$ is the time devoted to leisure by the representative household (the total amount of time available to the household in each t is normalized to be one).

The period budget constraint of the representative household is the following:

$$K_{t+1}+C_t=K_t(1-\delta)+\pi_t+R_tK_t+W_tL_t,\ 0<\delta<1,\ K_0 \text{ given}, \tag{6}$$

where δ is a parameter capturing capital depreciation. It is assumed that each household is entitled to receive an equal share of the firms' profits.

The problem of the representative household amounts to choose $\{K_{t+1}\}_0^\infty$, $\{C_t\}_0^\infty$ and $\{L_t\}_0^\infty$ in order to maximize

$$\sum_{t=0}^{\infty}\theta^t U_t,\ 0<\theta<1, \tag{7}$$

subject to (6), where θ is a time-preference parameter.

2.4 Market-clearing conditions

Equilibrium in the market for the product implies

$$K_{t+1}+C_t= K_t(1-\delta)+Y_t-X_t. \tag{8}$$

Equilibrium in the markets for labor and for physical capital implies, respectively

$$L_t^d = L_t^s \tag{9}$$

and

$$K_t^d = K_t^s. \tag{10}$$

3. THE EQUILIBRIUM DYNAMICS OF THE ECONOMY

3.1 Characterization of a general equilibrium path

By solving the optimization problem of firms and households, one obtains the system of difference equations in L_t and $D_t \equiv \frac{S_t}{K_t}$ that governs the evolution of the economy along an equilibrium trajectory (see the Appendix):

$$\phi(D_{t+1}, D_t, L_t) = D_{t+1}[1 + \mu(L_t, D_t)] - D_t - D_t\rho\left[\frac{D_t}{L_t^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}} - \xi\right] = 0, \qquad (11)$$

$$\psi(L_{t+1}, D_t, L_t) = Z(L_{t+1})[1 + \mu(L_t, D_t)] - Z(L_t)\theta\left[1 - \delta + \beta L_{t+1}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}\right] = 0, \qquad (12)$$

where

$$\mu_t \equiv \frac{K_{t+1} - K_t}{K_t} = \mu(L_t, D_t) = D_t - \delta - Z(L_t) + (\alpha+\beta)L_t^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}, \qquad (13)$$

$$Z_t \equiv \frac{C_t}{K_t} = Z(L_t) = \frac{\alpha(1-L_t)L_t^{\frac{-\beta}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}}{\gamma}. \qquad (14)$$

Together with (11)-(14), an equilibrium path must satisfy the transversality condition

$$\lim_{t\to\infty} \theta^t [Z(L_t)]^{-1} = 0. \qquad (15)$$

3.2 Balanced growth paths

A balanced growth path (BGP) can be characterized by setting $L_{t+1}=L_t=L$ and $D_{t+1}=D_t=D$ in the system (11)-(12). There may exist at most two BGP, (L°, D°) and (L^*, D^*), where $L^\circ > L^*$ and $D^\circ = 0 < D^*$ (see the Appendix). Assuming that the parameter values are such that both these BGP exist (see the Appendix), the following proposition holds:

Proposition 1. Per capita GDP grows faster along the BGP characterized by more time worked per household and by a lower social capital to physical capital ratio.

Proof: One can check that $0<\mu^\circ=\mu(L^\circ,D^\circ)>\mu^*=\mu(L^*,D^*)$ $\left(\text{entailing } g^\circ > g^*,\ g_t \equiv \frac{GDP_{t+1}-GDP_t}{GDP_t}\right)$ (see the Appendix).

Proposition 1 states that the economy is relatively poorer in social capital along the long-run equilibrium trajectory where the rate of economic growth is greater and the households devote more time to market activities, namely along (L°,D°). This reflects the self-feeding process whereby a fast growing market production induces the firms to rapidly increase their demand for the intermediate good in response to the relative decline in social capital brought about by this fast growth, which--in the same time--induces the households to accumulate more physical capital and to supply more labor in response to the increased labor demand and to the relative fall in the profits distributed by the firms. It is worth to emphasize, indeed, that the relative decline in the social asset has a negative impact on firms' profitability, since firms have to incur an increasing cost to offset the effects of this decline.

One can also prove the following proposition:

Proposition 2. The cumulative process that is ignited when the stock of social capital is low relatively to the volume of market activities leads the economy to converge asymptotically to (L°,D°).

Proof: By linearizing (11)-(12) in a neighborhood of (L°,D°) and (L^*,D^*), one can check that (L°,D°) is saddle-path stable, while (L^*,D^*) is unstable (see the Appendix). Hence, it is necessarily the case that if $D_0\in(D^\circ, D^\circ+\varepsilon)$, $\varepsilon>0$, the social capital-physical capital ratio tends to approach $D^\circ=0$ as $t\to\infty$.

3.3 Transition path

We focus on the transition path of this economy by studying the linearized system that governs the saddle path converging to (L°,D°):

$$D_t = e_{11}D_0\chi_1^t,\ 0<\chi_1<1, \tag{16}$$

$$L_t - L^\circ = e_{21} D_0 \chi_1^t, \tag{17}$$

where $\begin{bmatrix} e_{11} \\ e_{21} \end{bmatrix}$ are the characteristic vectors associated with the stable root χ_1. The system (16)-(17) is such that the following proposition holds:

Proposition 3. Along the path converging asymptotically to (L°,D°), the social capital-physical capital ratio decreases monotonically and the time worked per household increases monotonically.

Proof: One can check that $e_{11}=1$ and $e_{21}<0$ (see the Appendix).

Proposition 3 establishes the negative relation linking the social capital-physical capital ratio and the households' working time along an equilibrium trajectory converging asymptotically to the BGP: as time passes, D_t tends to fall while L_t tends to increase approaching asymptotically its long-run equilibrium value.

4. CONCLUSIONS

In this paper we have insisted on an interpretation of social capital as a resource connected with group membership and social networks (Bourdieu, 1986) which tends to deteriorate as market activities become more pervasive. The deterioration of this resource can be interpreted as a decline in social cohesion and general trust that forces economic agents to raise their expenditure aimed at self-protecting from increased opportunism and defiant behavior. To shed light on the dynamics of an economy where social capital has these characteristics, we have augmented a Solow-Ramsey growth model by including: i) social capital enhancing factor productivity, ii) negative externalities affecting social capital formation and increasing with the level of economic activity, iii) the possibility for economic agents to substitute private goods for social capital, iv) positive externalities affecting total factor productivity and increasing with the aggregate stock of physical capital, and v) a labor-leisure choice.

Within this framework, it is shown that i) the economy may have two balanced growth paths and the balanced growth path along which per capita GDP grows faster exhibits the lower ratio between social

capital and physical capital, ii) the economy converges asymptotically to the balanced growth path along which per capita GDP grows faster, the households devote more time to market activities and the social capital to physical capital ratio is lower, and iii) along the transition trajectory converging to the balanced growth path the social capital-physical capital ratio decreases monotonically and the time worked per household increases monotonically.

The harmful impact of the destruction of social capital reduces individual welfare but not necessarily the prospects of GDP growth, which may be enhanced. As social capital declines, a larger share of GDP is used to prevent the erosion of social capital from seriously lowering factor productivity. Following Weitzman (1976), the cost of maintaining total factor productivity as social and environmental assets are eroded should be subtracted from gross output in calculating a welfare relevant concept of net national product (see Bowles and Jayadev, 2004).

The model presented here is consistent with the view that capitalism tends to erode the socio-cultural sediment on which it rests, but it does not share the view that this erosion imperils the growth prospects of the economy. In any case, we need systematic empirical evidence in order to assess how important are the impact of the expansion of market activities on social capital formation and the effects of the decline in social capital on the demand for market services that can substitute for it.

Appendix

1. Derivation of the system (11)-(12)

One can solve the firms' problem by maximizing (3) with respect to X_t, L_t, and K_t, thus obtaining:

$$X_t = L_t^{\frac{\alpha}{\alpha+\beta}} (1-\alpha-\beta)^{\frac{1}{\alpha+\beta}} K_t - S_t, \qquad \text{(A1)}$$

$$W_t = L_t^{\frac{\alpha}{\alpha+\beta}-1} \alpha(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}} K_t, \qquad \text{(A2)}$$

$$R_t = L_t^{\frac{\alpha}{\alpha+\beta}} \beta (1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}. \quad (A3)$$

Given (A1)-(A3), one has:

$$\pi_t = S_t, \quad (A4)$$

$$Y_t = L_t^{\frac{\alpha}{\alpha+\beta}} (1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}} K_t, \quad (A5)$$

$$GDP_t = (\alpha+\beta) L_t^{\frac{\alpha}{\alpha+\beta}} (1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}} K_t + S_t. \quad (A6)$$

By using (A5), one can derive (11) from (4).

Moreover, one can solve the households' problem by maximizing $\sum_{i=0}^{\infty} \theta^i \{\ln(C_{t+i}) + \gamma \ln(1-L_{t+i}) + \lambda_{t+i}[(1-\delta)K_{t+i} + \pi_{t+i} + W_{t+i}L_{t+i} + R_{t+i}K_{t+i} - C_{t+i} - K_{t+i+1}]\}$ with respect to C_t, L_t, K_{t+1} and the Lagrangean multiplier λ_t, and then by eliminating λ_t, thus obtaining:

$$\frac{W_t}{C_t} = \frac{\gamma}{(1-L_t)}, \quad (A7)$$

$$C_{t+1} = \theta C_t (1-\delta+R_{t+1}), \quad (A8)$$

$$K_{t+1} = (1-\delta)K_t + \pi_t + W_t L_t + R_t K_t - C_t. \quad (A9)$$

By using (A2)-(A4), one can derive (12) from (A8), (13) from (A9) and (14) from (A7).

Finally, by eliminating λ_t, the transversality condition that an optimal path must satisfy is:

$$\lim_{t\to\infty} \theta^t \frac{K_t}{C_t} = 0, \quad (A10)$$

which can be rewritten as in (15).

2. Proof that there may exist at most two BGP, (L°,D°) and (L,D*), where L°>L* and D°=0<D**

Considering (11)-(14), one has that D° and L° are those values of D and L which satisfy, respectively, D=0 and

$$f(L) = 1-\delta-Z(L) + (\alpha+\beta)L^{\frac{\alpha}{\alpha+\beta}} (1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}] - \theta\left[1-\delta+\beta L^{\frac{\alpha}{\alpha+\beta}} (1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}\right] = 0. \quad (A11)$$

Since $\frac{df(\mathrm{L})}{d\mathrm{L}} > 0$, $0 \leq \mathrm{L} \leq 1$, it is apparent that only one value of L, L=L°, can satisfy (A11).

Again, considering (11)-(14), one has that L* and D* are those values of L and D which satisfy both

$$h(\mathrm{L}) = 1 - \delta - Z(\mathrm{L}) + D(\mathrm{L}) + (\alpha+\beta)\mathrm{L}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}] - \theta\left[1 - \delta + \beta\mathrm{L}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}\right] = 0 \quad \text{(A12)}$$

and

$$\mathrm{D} = D(\mathrm{L}) = \mathrm{L}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}\left\{\frac{\theta}{\rho}\left[1 - \delta + \beta\mathrm{L}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}\right] - \frac{1}{\rho} + \xi\right\} > 0\,. \quad \text{(A13)}$$

Since $\frac{dD(\mathrm{L})}{d\mathrm{L}} > 0$ and $\frac{dh(\mathrm{L})}{d\mathrm{L}} > 0$, $0 \leq \mathrm{L} \leq 1$, it is apparent that only one pair of values of L and D, L=L* and D=D*, can satisfy (A12)-(A13).

Finally, one can verify by comparing (A11) and (A12)--and by considering that $\frac{df(\mathrm{L})}{d\mathrm{L}} > 0$ --that the value of L satysfying (A11), L=L°, must be strictly greater than the value of L satisfying (A12), L=L*.

3. *Numerical example showing the existence of (L°,D°) and (L*,D*)*

Let α=0.6; β=0.3; δ=0.09; γ=0.5238455; θ=0.9441046; ρ=0.288516; ξ=0.002. Given these parameter values, L°≈0.618; D°=0; μ°≈0.018; L*≈0.6; D*≈0.03; μ*≈0.015.

4. *Proof of Proposition 1*

By considering (12), one can easily check that along a BGP the growth rate of $\mathrm{K_t}$ is given by $\mu = \theta\left[1 - \delta + \beta\mathrm{L}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}\right] - 1$, which is strictly increasing in L. Hence, since L°>L*, one must have μ°>μ*. To verify that μ°>μ* entails g°>g*, consider that along a BGP g=μ. In its turn, this can be verified by considering that (A6) can be rewritten as $\mathrm{GDP_t} = \left[(\alpha+\beta)\mathrm{L_t}^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}} + \mathrm{D_t}\right]\mathrm{K_t}$. Thus, along a BGP one has:

$$g = \frac{\left[(\alpha+\beta)L^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}+D\right]K_t(1+\mu)-\left[(\alpha+\beta)L^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}+D\right]K_t}{\left[(\alpha+\beta)L^{\frac{\alpha}{\alpha+\beta}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{\alpha+\beta}}+D\right]K_t} = \mu .$$

5. *Proof of Proposition 2*

To verify that (L°,D°) is saddle-path stable and (L*,D*) is unstable, consider that the characteristic equation of the sytem obtained by linearizing (11)-(12) around (L,D) is

$$\chi^2 + \left[\frac{\phi_{D_t}}{\phi_{D_{t+1}}} + \frac{\psi_{L_t}}{\psi_{L_{t+1}}}\right]\chi + \frac{\phi_{D_t}\psi_{L_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} - \frac{\phi_{L_t}\psi_{D_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} = 0, \qquad \text{(A14)}$$

where χ_1 and χ_2 are the characteristic roots, $\left[\frac{\phi_{D_t}}{\phi_{D_{t+1}}} + \frac{\psi_{L_t}}{\psi_{L_{t+1}}}\right] < -2$, $\frac{\phi_{D_t}\psi_{L_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} - \frac{\phi_{L_t}\psi_{D_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} > 1$ and all derivatives are evaluated at (L,D).

Given (A14), one has that (L,D) is $\begin{Bmatrix}\text{saddle - path stable } (0<\chi_1<1, \chi_2>1)\\ \text{unstable } (\chi_1>1, \chi_2>1)\end{Bmatrix}$ whenever

$$1 + \left[\frac{\phi_{D_t}}{\phi_{D_{t+1}}} + \frac{\psi_{L_t}}{\psi_{L_{t+1}}}\right] + \frac{\phi_{D_t}\psi_{L_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} - \frac{\phi_{L_t}\psi_{D_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} \begin{Bmatrix}<\\ >\end{Bmatrix} 0, \qquad \text{(A15)}$$

where $\phi_{D_{t+1}}\psi_{L_{t+1}} < 0$. Moreover, one can check that

$$\frac{-(\phi_{D_t}+\phi_{D_{t+1}})}{\phi_{L_t}} \begin{Bmatrix}<\\ >\end{Bmatrix} \frac{-\psi_{D_t}}{\psi_{L_t}+\psi_{L_{t+1}}} \text{ at } \begin{Bmatrix}(L^\circ, D^\circ)\\ (L^*, D^*)\end{Bmatrix}, \qquad \text{(A16)}$$

where $\phi_{L_t} > 0$ and $\psi_{L_t} + \psi_{L_{t+1}} > 0$, which implies

$$1 + \left[\frac{\phi_{D_t}}{\phi_{D_{t+1}}} + \frac{\psi_{L_t}}{\psi_{L_{t+1}}}\right] + \frac{\phi_{D_t}\psi_{L_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} - \frac{\phi_{L_t}\psi_{D_t}}{\phi_{D_{t+1}}\psi_{L_{t+1}}} \begin{Bmatrix}<\\ >\end{Bmatrix} 0 \text{ at } \begin{Bmatrix}(L^\circ, D^\circ)\\ (L^*, D^*)\end{Bmatrix}. \qquad \text{(A17)}$$

Hence, (L°,D°) is saddle-path stable and (L*,D*) is unstable.

6. *Proof of Proposition 3*

To find the eigenvectors associated with the system (11)-(12) linearized in a neighborhood of (L*,D*), one must solve $\begin{bmatrix} \frac{-\phi_{D_t}}{\phi_{D_{t+1}}} & \frac{-\phi_{L_t}}{\phi_{D_{t+1}}} \\ \frac{-\psi_{D_t}}{\psi_{L_{t+1}}} & \frac{-\psi_{L_t}}{\psi_{L_{t+1}}} \end{bmatrix} \begin{bmatrix} e_{11} & e_{12} \\ e_{21} & e_{22} \end{bmatrix} = \begin{bmatrix} e_{11} & e_{12} \\ e_{21} & e_{22} \end{bmatrix} \begin{bmatrix} \chi_1 & 0 \\ 0 & \chi_2 \end{bmatrix}$, thus obtaining $e_{11}=1$ and $e_{21} = \dfrac{\frac{-\psi_{D_t}}{\psi_{L_{t+1}}}}{\chi_1 + \frac{\psi_{L_t}}{\psi_{L_{t+1}}}}$, where $0<\chi_1<1, \frac{-\psi_{D_t}}{\psi_{L_{t+1}}} > 0$ and $\frac{\psi_{L_t}}{\psi_{L_{t+1}}} < -1$, which entails $e_{21}<0$.

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