Innovation, Growth and Quality of Life: a Theoretical Model and an Estimate for the Italian Regions

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ABSTRACT. This paper carries out an explanatory investigation into the relationship between socio-institutional conditions, quality of life indicators and economic growth in the Italian regions. Previous studies stress the importance of institutional quality, social capital and social conditions in determining disparities between richer and poorer regions. Building on this literature, we consider a three-sector model of semi-endogenous growth with negative externalities depending on structural and institutional factors that affect the innovative capacity of regional systems (the "social externalities hypothesis"). Simulations based on the scaled stationary system confirm that endogenous socio-economic conditions are crucial for the successful translation of innovation into economic growth. It is suggested that generating a development strategy designed to improve social conditions and well-being in the poorer regions may yield dividends in terms of the effectiveness of public policy and economic development.

Keywords: Development, growth, regional disparities, well-being.
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1. Introduction

As documented in numerous studies, the convergence between the regions of Southern and Central-Northern Italy developed at a steady pace in the period 1950–70 and then slowed down before coming to a halt in the 1980s (Daniele and Malanima 2007). It is our contention that the analysis of this failure to converge should be addressed in a long-term perspective and take into account the adjustments currently altering the cornerstones of the model of Italian economic development under the pressure of technical progress and the disruption of the global value chain.

The basis of our study is the work of Stefano Fenoaltea on Italy's economic development during the Liberal period. Fenoaltea identifies the forces driving the growth of the regions in the "industrial triangle" as natural resources – namely water and hydroelectric energy or "white coal" – during the first industrial revolution (*c.*1830–80) and human capital, which came to predominate during the second (1880–1915) (Fenoaltea 2007). Emanuele Felice has broadened the temporal scale of this analysis to show that human capital became still more important during the 20th century (until 1970 in overall terms), after which social capital (social networks and institutional efficiency) assumed primacy as a factor of growth in the post-Fordist phase (Felice 2010). The importance of social capital as a driving force of development lies at the root of the economic takeoff of the regions in the North, East and Centre, which owe their wealth to the success of the industrial districts. The social networks and institutions located in these districts made possible the common use of specific public assets, from infrastructures to the informal rules that cut transaction costs, thus fostering the expansion of flexible, territorially integrated firms specialising in the sectors of light industry and strongly oriented towards foreign markets.

In a nutshell, these analyses show that the driving forces of growth changed together with the characteristics of technology, leading in Italy first to the takeoff of the Northwest and then to the convergence of the regions in the North, East and Centre. The factors guiding the growth of the central and northern regions are a mixture of fixed resources, linked to the territory, and mobile resources, which can also come from outside. The former include natural resources (sources of energy and ease of transport), which are crucial in the initial phase, and social capital, which then becomes the main driver behind growth.

For the regions of the South, the period of intense growth coincided instead with the development of the Italian economy as a whole and was supported by the Intervento Straordinario, a special plan to develop infrastructures and productive activities in the South.

The Intervento Straordinario channelled huge flows of resources from the North to the South so as to increase the latter's endowment of technical and financial capital. Local labour-intensive activities such as light industry and tourism were, however, neglected or crowded out, there was no improvement in technical and higher education, the supply of services fell increasingly behind the requirements of firms and citizens, and social capital was eroded due to the expansion of rent-seeking activities designed to intercept the flow of public resources.

Fenoaltea and Felice argue that the Intervento Straordinario failed because it focused almost exclusively on exogenous resources, namely public spending and the technology incorporated in imported machinery and the investments of firms based in the Centre and North as well as a small number of foreign firms. This model of externally "forced" development had temporary effects that gradually faded with the increasing importance of immaterial factors of growth, which are primarily local by nature but absent or very weak in Southern Italy.

While the analysis of Fenoaltea and Felice stops at the end of the 1980s, the framework of fixed and mobile resources can also be applied to the last twenty years. With the interruption of the national policy of development (the Intervento Straordinario) and the launching of a policy of European cohesion (the Nuova Programmazione), the 1990s saw the transformation of the South into a sort of laboratory for replication of the model of diffuse industrialisation of Central and Northern Italy. The decentralisation of regional policy was supposed to increase the effectiveness of spending, but this was not achieved due to the limited managerial capacity of the southern regions (D'Antonio and Scarlato 2008).

Moreover, the forms of action taken have remained unchanged with respect to the past. The area is no more than a passive receptacle for new flows of public expenditure. The participation of local actors manifests itself in the proliferation of proposals and agreements regarding the distribution of public resources for the indiscriminate support of firms and citizens' incomes (Pigliaru 2009, Scarlato 2010). The structural funds have made no impact on regional disparities in terms of labour productivity (Aiello and Pupo 2009). There has been no effect on the endowment of human and social capital and collective services and no appreciable effort to improve the efficiency of public and private institutions (Cannari 2009, De Blasio and Nuzzo 2010). On the contrary, progressive deterioration of the social and environmental indicators is taking place in the southern regions and the disparity with respect to the Centre and North in terms of collective services is now greater than the disparity in terms of per capita product (DPS 2010). It should be pointed out in this connection that the investigations into public services carried out over the last few years by the Bank of Italy (summarised in Bripi et al.

2011) show that the territorial disparities in performance are due not to lower public spending per capita but rather to differences in the efficiency of the organisational models adopted.

This brings us to our diagnosis of the halt in convergence with the Centre and North. The Intervento Straordinario, based on pumping in resources from outside, worked because it was easier in the past for technology to be incorporated in physical capital, understood as imported machinery and the monolithic plants of major corporations located in the South.

In the present-day scenario, technology is instead dematerialized and transversal, requiring local skills and excellence capable of adding specific advantages to the product, links with the advanced tertiary sector, the ability to govern the networks of knowledge scattered over the territory and outside the local system, and strong coordination of the actions of a host of small firms (Rullani 2009, Federico 2010). These are the elements emphasised in recent theoretical studies on innovation. Knowledge emerges as the result of collective activity, the production of which goes beyond the efforts of the single firm and derives rather from the interaction of economic agents through formal and informal mechanisms and a variety of flows of connections outside the firm (Quatraro 2010, Iammarino 2005). As a result, the regional capacity for innovation proves highly idiosyncratic and bound up with conditions of the economic and institutional environment that are hard to replicate in other regions.

While the last few years have seen a return to the centrality of natural resources in economic analyses, their importance regards aspects that are very different with respect to the past, such as a healthy environment, amenities, collective services, affordable housing, good quality of life and connections between urban centres equipped with advanced services (Glaeser and Gottlieb 2008, Glaeser and Resseger 2010). These factors of intangible and localised advantage constitute "territorial capital" (Camagni 2009) and prove crucial in determining the potential capacity of regions to attract investment and human capital (Farole et al. 2011). On the other hand, numerous studies show that the presence of intangible disadvantages of context in the less developed regions cannot be offset by a system of financial or fiscal incentives (Daniele 2007, Barba Navaretti et al. 2009).

The weakness of territorial capital in the South of Italy means limited capacity to attract mobile resources. For example, human capital is an exclusively outwardly mobile resource in the South for reasons that go beyond the difficulties of access to the job market (few job opportunities for qualified young people without networks of family and friends, poor quality of life, and the attraction of university education in the Centre and North, which is superior and provides qualifications taken more seriously by prospective employers) (D'Antonio and Scarlato 2007, Mocetti and Porello 2010).

Finally, the primary fixed resources, namely social and institutional capital, have become increasingly important as regards territorial response to external shocks because the capacity for governance and coordination of the supply of the collective factors that determine growth (knowledge, environment and networks) depends largely on the quality of formal and informal institutions (Dasgupta 2005, Acemoglu 2009, Trigilia and Burroni 2009).

In addition to these extra-economic factors, it has been argued that the social conditions affect long-term expectations and hence incentives for investment, decisions for the allocation of resources, confidence and the generation of networks (Thorbecke 2007, Ravallion 2010). For example, Crescenzi and Rodríguez-Pose (2009) analyse the variables that act as a "social filter" and affect the territorial disparities between the European regions so as to enhance or reduce the competitiveness of regional systems of innovation. Royuela et al. (2011) instead show that the quality of life[1] in the major cities of a territory has a very strong effect on the economies of agglomeration and hence the growth prospects of a regional system of innovation.

The purpose of this study ~~is~~ provide empirical evidence in support of the thesis that the institutional and social variables and quality of life – factors specifically linked to the regional contexts – play a key part in determining the effective ability of firms to translate the resources and technology available into increased competitiveness. Adopting the evolutionary approach to technological change, we argue that technological skills are the result of interaction between individuals, firms and organizations within a specific socio-economic and institutional context (Iammarino et al. 2009, Von Tunzelmann and Wang 2007). We thus maintain that socio-institutional conditions generate an externality affecting the capacity for the absorption of knowledge and the economic growth of regional systems, and that this accounts for the persistence of territorial disparities between the Italian regions despite the major efforts made since the post-war period by national policy and European regional policy.

Taking the considerations outlined above, which are drawn from the literature on regional divides in Italy and various investigations into economic growth and development, as its starting point, our study seeks to combine the traditional driving forces of growth and those linked to institutions and social conditions in a unified theoretical framework. Our hypothesis is that the low quality of the human capital and collective services in the regions of the South of Italy, which

[1] Quality of life is defined here by means of objective indicators regarding public assets, collective services and other socio-economic aspects that increase the satisfaction of those living in a place. See Gasper (2010) for the various definitions of quality of life.

provide an approximate yardstick of the weakness of the regional context as regards social and institutional conditions, acts as a negative externality that limits the dissemination of knowledge in the economic system, thus obstructing growth and innovation. The paper is organised as follows. The first section presents a model of endogenous growth that generate the externalities linked to socio-institutional factors and shows how these hinder the transmission of knowledge and growth prospects. The second describes the econometric methodology used to test our hypotheses on the Italian regions in the period 1998–2008 and discusses the results obtained. The third states the conclusions and suggests some implications for policy making.

2. An illustrative model

2.1 The assumptions of the model

We consider a representative household that maximises an intertemporal utility deriving from private consumption. The instantaneous utility function u(c) is presented as a constant elasticity of substitution (CES) function in the following form:

$$\max_{c(t)} \int \frac{c^{1-\sigma}}{1-\sigma} e^{-\rho t} dt \tag{1}$$

where σ is the elasticity of intertemporal substitution of private consumption, ρ the intertemporal discount rate, and $c = C / L$ the share of private consumption per worker. The representative houseold is a consumer and producer of the sole final good at the same time. This final good is produced by means of a Cobb-Douglas technology, described as follows:

$$Y = \left(AL_Y\right)^{\alpha} \int_0^A x_i^{1-\alpha} di \tag{2}$$

where L_Y is the number of workers employed in the production of final goods and x_i is the single kind of intermediate good employed in production.

The production function thus described is characterised by the presence of technological progress, manifested as an increase in the variety of intermediate goods (Dixit and Stiglitz 1977, Ethier 1982). Invention corresponds to the discovery of a new kind of method making it possible to produce the final good described by equation (2) in an alternative (and more efficient) way. In this formulation, decreasing returns disappear due to the discovery of new kinds of intermediate goods, which then tend to increase total productivity.

As production in the sector of final goods takes place through a technology with constant returns to scale, it is possible to consider a single price-taking firm in determining the optimal quantity of the final good produced. The firm operates in the perfectly competitive sector of the production of final goods (SFG). This means that when the price of Y is normalised to 1 at every moment of time, the profit maximisation leads to the following conditional demand function:

$$w = \alpha \frac{Y}{L_Y} \quad \textbf{(3)}$$

and

$$p(x)_i = (1-\alpha)\frac{Y}{x_i} \forall i \quad \textbf{(4)}$$

where w is the unit wage paid to workers in the sector of final goods and $p(x)_i$ the return of the kind i of intermediate good. It is important to note that equations (3) and (4) enable us to characterise the parameters α and $(1-\alpha)$ in terms of the elasticity of the factors L_Y and x_i with respect to total production[2].

The second sector, SIG, is devoted to the production of intermediate goods and made up of an infinite number of firms in the interval between 0 and A whereas the third one, defined as research and development sector SR&D, is characterised by perfect competition. Through the purchasing of a project (or patent) from the SR&D, every firm in the SIG becomes the only one capable of producing that particular kind of intermediate good and therefore operates in monopoly conditions. It is assumed for simplicity that the intermediate firm (which bought the project from the SR&D) can transform every unit of capital acquired into one unit of the intermediate good. As this transformation is assumed to be reversible, the intermediate good can be turned back into capital at the end of the period. Each SIG firm will therefore pursue the goal of maximising its profit at every moment of time by solving the following problem:

$$\max_{x_i} p(x)_i x_i - r x_i \quad \textbf{(5)}$$

where $p(x)_i$ is the price of the kind *i* of intermediate good and r the return on capital per unit of time. Solving the problem of profit maximisation makes it possible to obtain the conditions of

[2] This property depends on the assumption that the firms producing final goods operate in conditions of perfect competition and are characterised by constant returns to scale.

optimality expressed by the equations of the prices and the quantities supplied by the firm, described as follows:

$$\hat{p}(x)_i = \hat{p} = \frac{r}{(1-\alpha)} \forall i \quad \textbf{(6)}$$

and

$$\hat{x}_i = \hat{x} = \left[\frac{(1-\alpha)L_Y^{\alpha}}{\hat{p}}\right]^{1/\alpha} \forall i \quad \textbf{(7)}$$

where equation (5) is inserted into (6) in order to obtain the two relations and where $\hat{x}$ and $\hat{p}$ are respectively the optimal price and quantity set by the monopolist in the sector of intermediate goods. The result, described in (7) and (8), represents a standard problem of profit maximisation in monopoly conditions with constant marginal costs and constant elasticity of demand. On inserting the optimal prices and quantities into the monopolist's profit function (5), its optimal profit can be derived as:

$$\hat{\pi}_{\mathrm{i}} = \hat{\pi} = \alpha(1-\alpha)\frac{\mathrm{Y}}{\mathrm{A}} \quad \textbf{(8)}$$

Equations (6), (7) and (8) show that every firm operating in the SIG sets the same price and sells the same quantity of the durable good it produces. Together with the fact that the intermediate goods and capital are linked by the relation $K = \int_0^A \hat{x}\,di = A\hat{x}$, this consideration leads to the rewriting of (2) as:

$$Y = \left(L_Y A\right)^{\alpha} K^{(1-\alpha)} \quad \textbf{(9)}$$

Finally, it is shown through the combination of (7) and (8) that the return on the capital invested in the SIG (in monopoly conditions) is lower than it would be in conditions of perfect competition, thus compensating the work carried out in the SR&D. While the value of the return on capital invested in conditions of perfect competition is given by $r = (1-\alpha)Y / K$ the return of the SR&D is described as:

$$r = (1-\alpha)^2 \frac{Y}{K} \quad \textbf{(10)}$$

We shall now take up the primary innovation of the growth model of Jones (1995), namely the technology accumulation function, which does not follow a linear functional form, as it does in Romer (1990). In accordance with the assumptions of the model, the growth rate of the stock of knowledge or technology in the economy depends in fact to a decreasing (rather than constant) degree on the levels of knowledge and employment in the sector. This assumption means that the function of technology accumulation is no longer linear but convex.

If A is the level of acquired knowledge and L_A the level of employment in the sector, the technology accumulation function can be written as follows:

$$\dot{A} = \delta L_A^{\lambda} A^{\varphi} \quad \textbf{(11)}$$

where δ represents the externalities linked to the level of acquired knowledge and the workforce employed in the SR&D, while ϕ and λ respectively represent the productivity of the level of acquired knowledge in the economic system and of the workforce employed in the production of new technology.

Three distinct situations can be identified according to the assumptions adopted on the parameters ϕ and λ: 1) $\phi = 1$ and $\lambda = 1$, in which case equation (12) is reduced to $\dot{A} = \delta L_A A$, the functional form described by Romer (1990)[3]; 2) $\phi = 0$ and $\lambda = 1$, or $\phi = 1$ and $\lambda = 0$ in which case, respectively, the accumulation of technology is independent either of acquired knowledge or of the workforce employed in the SR&D; 3) $\phi < 1$ and $\lambda < 1$, where the accumulation of technology is decreasing with respect to the two factors.

An alternative structure to the one described above, proposed by Steger (2005) and others, suppose a linear functional form for the tecnology accumulation function as in Romer (1990), which allowed to interpret the parameters ϕ and λ in terms of the elasticity of factors within the technology accumulation function[4]. On this interpretation, the process of technology accumulation has constant returns to scale, so that $\phi + \lambda = 1$. However, given that the discovery of new ideas may give rise to duplications of discoveries already acquired (something known as the “fishing out” effect), there is a negative externality affecting the knowledge already

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[3] The formulation of technology with constant returns to scale means that the production of final goods takes place with increasing returns to scale, thus generating explosive growth.

[4] It is important to note that since the SR&D is perfectly competitive, the function has constant returns to scale and the parameters φ and λ can be interpreted in terms of the elasticity of factors with respect to technology.

accumulated. Under this new assumption, even if $\phi + \lambda = 1$, by taking into account the negative externality (defined as $e_\phi < 0$), we obtain that $\phi + e_\phi + \lambda < 1$.

The primary advantage of this theoretical formulation lies in the possibility of interpreting the parameters ϕ and λ once again in terms of the elasticity of the factors A and L_Y. As previously mentioned, this interpretation is possible solely in the case of perfectly competitive market structures and hence constant returns to scale. The formulation adopted makes it possible to keep the returns to scale constant while avoiding the generation of explosive growth.

If we adopt formulation (11), assume that the project created in the SR&D is sold on the market of intermediate goods at a price equal to P_A and bear in mind the fact that the SR&D is a sector of perfect competition, it follows that every worker will move into this sector until the wage received is no longer as much as the wage that would be received in the SFG. This means that:

$$\mathrm{w} = \mathrm{P_A} \frac{\dot{\mathrm{A}}}{\mathrm{L_Y}} \tag{12}$$

where w is contemporary the unit wage paid in the manufacturing sector (see equation 4) and in the SR&D. Equalisation of the two equations gives the following:

$$P_A = \frac{\alpha}{\delta} A^{\alpha-\varphi} (L - L_A)^{\alpha-1} L_A^{1-\lambda} K^{1-\alpha}, \tag{13}$$

where it is shown that the price paid for every project is an increasing function of the intensity of capital *K*. This means that if innovations are to be implemented, a quantity of capital must be invested. The greater the intensity of the capital employed in the creation both of intermediate goods and of new technology, the smaller its compensation will be (11) and hence the higher the profit of the monopolist in the SIG.

Moreover, since the decisions of firms in the SIG as regards the production of a new kind of good depend on the difference between the cost of buying the project (patent) from the SR&D (P_A), and the monopoly return, the firm operating in the SR&D will set the price of the patent so as to equal the discounted value of profits in the SIG. Since every kind of intermediate good gives all the firms the same profit at every moment of time, this means that the equation governing arbitrage must always be satisfied:

$$r = \frac{\hat{\pi}}{P_A} + \frac{\dot{P}_A}{P_A} \quad \textbf{(14)}$$

This equation can be interpreted as meaning that the firm in the SR&D will adjust the price of a project until the decision whether to purchase it and embark on the production of a new kind of intermediate good becomes a matter of indifference to the monopolist in the SIG.

2.2. The solution of the model

The main characteristic of semi-endogenous growth models is the ineffectiveness of policy actions with respect to the long-term rate of growth. As shown by Steger (2005), the solutions of the market and the social planner coincide in terms of long-term growth but tend instead to diverge as regards the rate of balanced growth, in which case the latter gives better results in terms of welfare. Given the purpose of this analysis, however, we shall present only the market solution.[5]

In accordance with the above observations, we shall now outline the decentralised solution of the semi-endogenous model of Jones (1995), solving the problem of consumption utility maximisation (1) under the constraint of the accumulation of capital, described as follows:

$$\dot{K} = Y - C, \quad \textbf{(15)}$$

where $\dot{K}$ is the growth rate of capital. It is easy to show that equation (15) can be rewritten in terms of costs of factors of production $\dot{K} = rK + wL + P_A\dot{A} + A\pi - C$.

The solution of the problem of the representative consumer as regards the market of final goods can be obtained through the maximisation of (1) under constraint (15) with respect to consumption per capita and capital. The solution to this problem is defined by an equation of the growth of consumption described as follows[6]:

$$\gamma = \frac{\dot{C}}{C} = \frac{1}{\sigma}\left[r - n - \rho\right] + n \quad \textbf{(16)}$$

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[5] For a detailed examination of the implications in terms of welfare, see Steger (2005), Eicher and Turnovsky (1999) and Jones (1995).

[6] It should be noted that using the version of the budget constraint in terms of prices of factors makes it possible to rewrite the equation as $\gamma = \frac{1}{\sigma}\left[r - \frac{\dot{L}}{L} - \rho\right] + \frac{\dot{L}}{L}$.

where r is the return on capital, as described in equation (10), and n the growth rate of the workforce.

In order to obtain a system with stationary variables, we can follow Steger (2005) and rewrite equations (11), (14), (15) and (16) in terms of scaled variables defined as $y = Y / L^{\beta_K}$, n $k = K / L^{\beta_K}$, $c = C / L^{\beta_K}$, $a = A / L^{\beta_A}$, $\dot{a} = \dot{A} / L^{\beta_A}$, $p_A = P_A / L^{\beta_K}$, $\zeta = L_Y / L^{\beta_A}$ and $(1-\zeta) = L_A / L^{\beta_A}$, where $\beta_k = \frac{1-\phi+e_\phi+\lambda}{1-\phi+e_\phi}$ and $\beta_A = \frac{\phi+e_\phi}{1-\lambda}$. The analytical derivation of the parameters used to construct the system with scaled variables employs the social planner's solution to the problem of the intertemporal optimisation of the representative consumer (Steger 2005).

The system of equations characterising the optimality conditions and the social planner's problem at the same time can therefore be rewritten as:

$$\gamma = \dot{c} = \frac{c}{\sigma}\left[r-(1-\sigma)n-\rho\right]-\beta_K nc \quad \textbf{(17)}$$

$$\dot{k} = y - c - \beta_K nc \quad \textbf{(18)}$$

$$\dot{a} = \delta a^{\phi}\left[\left(1-\varsigma\right)\right]^{\lambda} - \beta_A na \quad \textbf{(19)}$$

$$\dot{p}_A = p_A\left(r-n\right)-\pi \quad \textbf{(20)}$$

$$\frac{\alpha y}{\zeta} = \frac{\alpha j}{(1-\zeta)} \quad \textbf{(21)}$$

where $Y = (a\zeta)^{\alpha} k^{1-\alpha}$, $j = \delta(1-\zeta)^{\lambda} a^{\phi}$, $r = (1-\alpha)^2 \frac{y}{k}$ and $\pi = \alpha(1-\alpha)\frac{y}{a}$.

In particular, (17), (18) and (19) are respectively the Keynes-Ramsey rule of optimal private consumption and the equations of motion for private capital and technology, (20) is the price of the projects produced by the SR&D, and (21) describes the optimal allocation of labour between the SFG and the SR&D.

2.3 Simulations and empirical specification

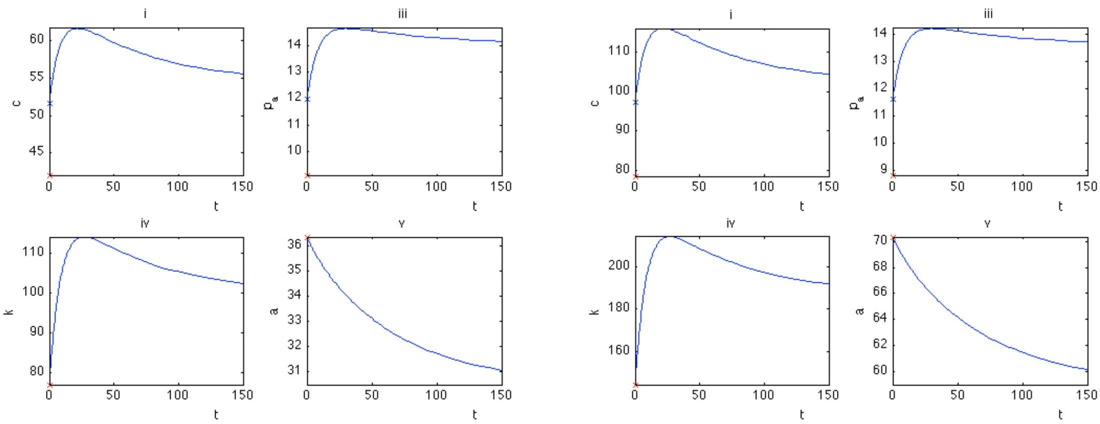
To complete the theoretical analysis, we now present the results of the simulations of the system of equations (17)–(21) under the initial conditions $k(0) = k_0$ and $a(0) = a_0$. Given our interest in examining the role of technological progress and the accumulation of knowledge in the economic system, particular attention will be focused on the parameters characterising equation (19), namely φ and λ.

Moreover, the fishing-out hypothesis inserted into the model by Steger (2005) will again be used in order to distinguish the direct effect of the elasticities linked to R&D and the accumulation of human capital. This hypothesis makes it possible to analyse the presence of negative externalities within the process of technology accumulation and at the same time to insert the negative externalities linked to the socio-economic context in which the knowledge is absorbed and disseminated (referred to here as the social externality).

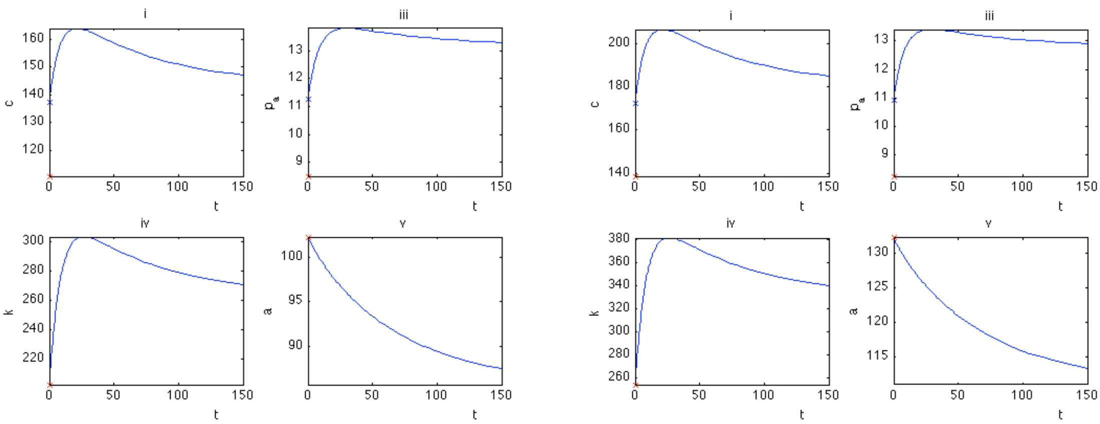
As outlined in the introduction, it is in fact reasonable to suggest that the institutional and social context influences the ability of firms to take advantage of the knowledge available. The (negative) externalities deriving from socio-institutional frictions thus reduce the impact of technology on the economic system. In order to keep the model simple, it is assumed that the overall negative externality comprises both the component linked to fishing out and the one due to the socio-institutional friction hindering the spread of knowledge in the economic system. For simplicity and with no loss of generality, however, it is assumed for the rest of the model that the externality deriving from the hypothesis of fishing out is both constant and negligible in scale. The externality e_φ, for which the term "social filter" will be used from now on, can thus be identified on the hypothesis of social externality alone.

Figure 1 presents the results of simulations for different values of e_φ. The variables considered are private consumption, private investment, technology and the price of the goods of the SR&D. As the first panel of the figure shows, a high value of the externality e_φ tends to reduce the intensity of the innovative activity, thus leading to a drop in private consumption, private investment and technology, and is associated with a higher level of prices in the SR&D. Conversely, as panel d shows, a value of 0.2 rather than 0.8 for the externality means higher levels of private consumption, private investment and technology together with lower prices for the patents produced in the SR&D. This result bears out the hypothesis that negative externalities linked to obstructions in the spread of knowledge have a major impact on the growth of the economic system.

Figure 1 – Trends for the primary variables of the model



a) $\lambda = 0.6,\ \varphi = 0.4,\ e_{\varphi} = 0.8$ b) $\lambda = 0.6,\ \varphi = 0.4,\ e_{\varphi} = 0.6$



c) $\lambda = 0.6,\ \varphi = 0.4,\ e_{\varphi} = 0.4$ d) $\lambda = 0.6,\ \varphi = 0.4,\ e_{\varphi} = 0.2$

Note. The parameters ρ=0.02 , δ=0.1 and n_{pop} = 0.015 are used in the simulations presented as well as the relax algorithm (Trimborn 2008).

3. An estimate of the social filter for the Italian regions

The hypotheses arising from the theoretical model can be tested for the Italian regions by estimating a composite indicator that includes yardsticks of competitiveness and environmental and social sustainability. This indicator should serve to measure the level of the social externalities present in the process of technology accumulation, which have effects on the economic system and on territorial growth prospects, as discussed in the previous section. The identification process draws on the work of Crescenzi and Rodríguez-Pose (2009), which calculates a measurement of the social filter for the European regions based exclusively on variables regarding human resources and demographic structure.

We shall instead broaden the analysis to consider also variables reflecting other social and institutional dimensions that may affect the competitiveness of the regions. In particular, the variables that define the social filter for each Italian region can be identified primarily in the three spheres of social exclusion (Riggi and Maggioni 2009), the educational level of the population (Lundvall 1992, Bramanti and Riggi 2009, Crescenzi and Rodríguez-Pose 2009, Castellacci and Archibugi 2008) and the quality of the territory (Camagni 2009, Capello et al. 2009).

The indicator is constructed on the basis of the targets set by the Dipartimento delle Politiche di Sviluppo (DPS: Department of Development Policies) in the last cycle of regional policies (2007–13) with reference to some essential services. As regards the first sphere of interest, namely social exclusion, three variables are considered: 1) long-term unemployment (ld); 2) the rate of juvenile unemployment (dg); 3) the index of regional poverty of families (pf). The first is constructed as the percentage of people seeking employment for over 12 months with respect to the total workforce, the second as the percentage of people aged 15–24 seeking employment with respect to the same age group in the total workforce, and the third as the percentage of families living beneath the poverty threshold.

The variables regarding the second sphere, which describes the quality of human resources, are as follows: 1) the drop-out rate at the end of the first year of high school (ass), characterised as the number of drop-outs among pupils enrolled in the first year of high school with respect to the total; 2) the rate of secondary education (es), defined as the total number of high school pupils with respect to the 14–18 age group of the resident population; 3) the percentage of employed people taking part in courses of training and education (let), defined as the percentage of employed adults aged 25–64 involved in training and education schemes with respect to the corresponding age group of the employed population as a whole.

Finally, two variables are used to pinpoint territorial quality: 1) the presence of municipal waste-sorting services (rd); 2) the families' perception of the risk of crime in the area where they live (rc).

Table 1 presents the primary results of principal component analysis (PCA) regarding the eight variables selected within the three dimensions identified. The estimate refers to the year 2008. As the table shows, the first component accounts for a large proportion of the information contained in the set of variables, with a cumulative frequency equal to 44% of the information as a whole. When the second component is also taken into consideration, the cumulative frequency rises to approximately 80% of the total information. This result appears to confirm that the correct variables have been chosen to measure the competitiveness and socio-institutional conditions of the regions.

Table 1 – Estimate of the principal components for the Italian regions, 2008

	Comp I	Comp II	Comp III	Comp IV	Comp V	Comp VI	Comp VII	Comp VII
Eigenvalue	3.867	2.734	0.728	0.297	0.205	0.073	0.062	0.036
Frequency	0.483	0.342	0.091	0.037	0.026	0.009	0.008	0.005
Cumulative frequency	0.483	0.825	0.916	0.953	0.979	0.988	0.996	1.000

	Comp I	Comp II	Comp III	Comp IV	Comp V	Comp VI	Comp VII	Comp VII
es	0.165	0.553	-0.032	0.136	-0.330	0.225	0.601	-0.356
ld	0.487	-0.049	-0.180	0.143	0.341	-0.145	-0.300	-0.694
dg	0.486	-0.108	0.014	0.143	0.084	-0.637	0.433	0.363
let	0.028	0.568	-0.012	0.552	-0.128	-0.150	-0.504	0.282
rd	-0.435	0.128	0.349	0.346	0.681	-0.053	0.274	-0.106
rc	0.5090	0.137	-0.333	-0.542	0.491	0.095	-0.011	0.262
pf	0.450	-0.222	0.066	0.330	0.210	0.699	0.051	0.317
ass	0.297	0.183	0.854	-0.338	-0.047	-0.009	-0.175	-0.041

The lower section of the table shows the contributions of each variable to the identification of all the principal components. Since the first two components prove predominant, the other six emerging from PCA are discarded. The first component is characterised by high positive coefficients with respect to long-term unemployment (ld), juvenile unemployment (dg), household poverty (pf) and the risk of crime (rc). It should be noted that the variables connected with level of education and human capital all have negative coefficients apart from the one regarding the school drop-out rate. Particularly, the negative sign of the school drop-out rate variable is in line with the expectations, since it is connected to the attractivity of the school system. These results appear to bear out the identification of the first component as a social filter. It is also important to note that, as shown in Appendix A, where we report PCA estimations for 1998, the results of PCA remain constant over time.

The data presented in the table make it possible to put forward an identification also for the second principal component, which is characterised by a strongly positive incidence of the variables connected with education and human capital in general and could therefore be identified as an index of competitiveness of the economic system referring primarily to the endowment of human capital. This second identification proves less immediate, however, in view of the positive coefficients of certain variables, such as the risk of crime and juvenile unemployment.

Figure 2 – Relations between the first two principal components for each region, 2008

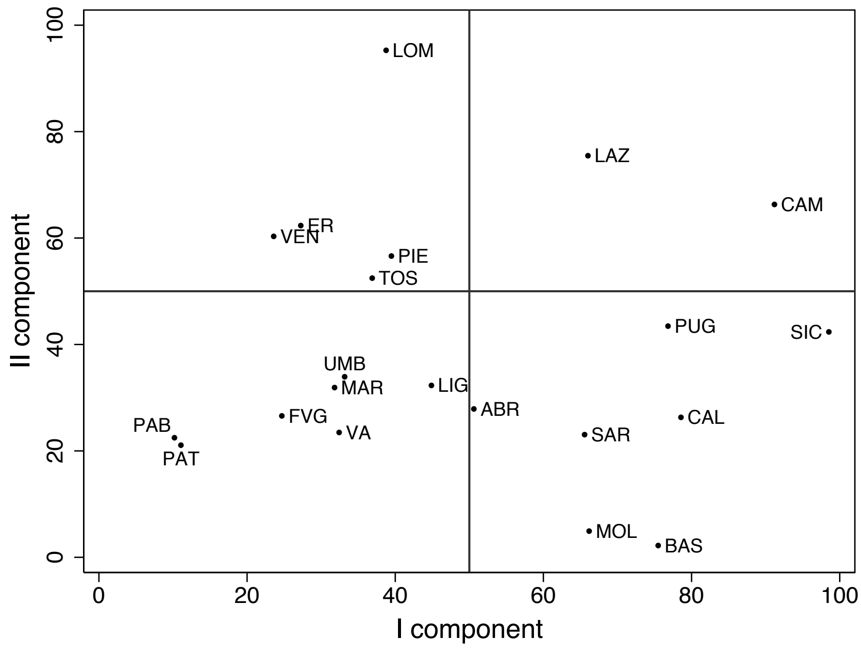
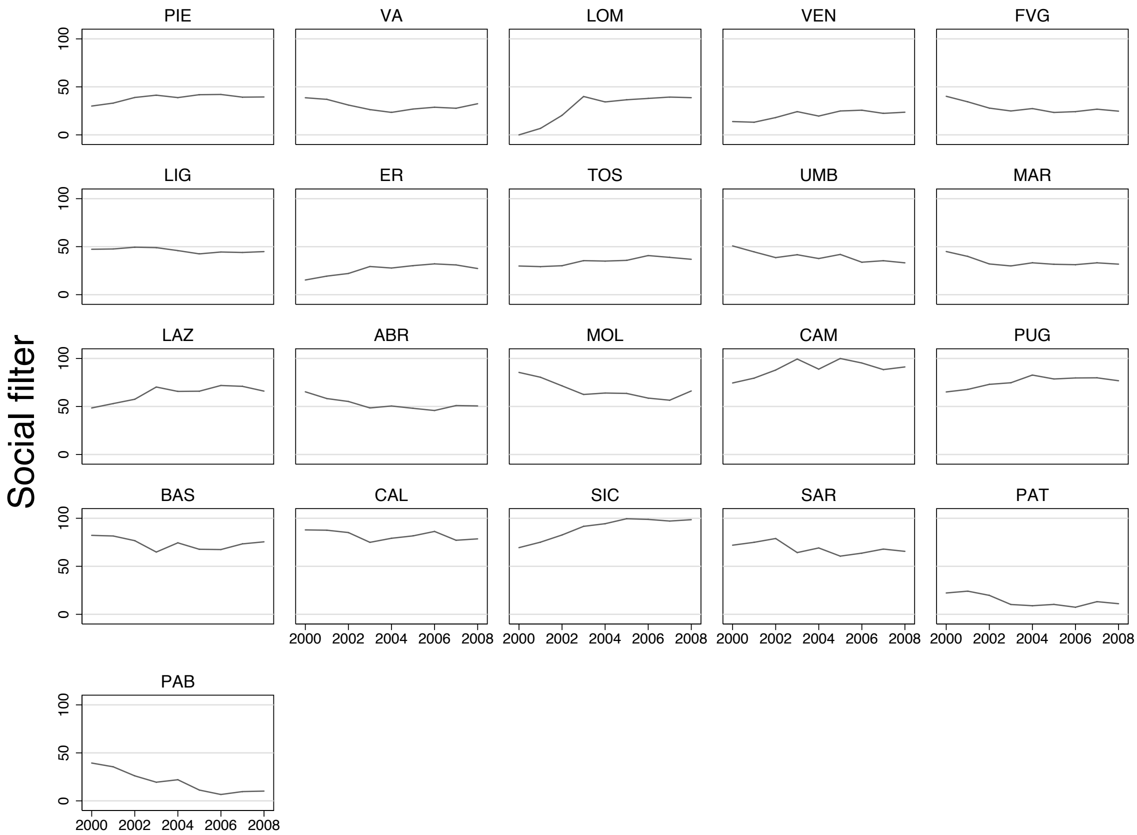


Figure 2 presents the ranking of the Italian regions in terms of the two principal components identified above. Some clarification is needed, however, before proceeding. First, Component I can be reasonably identified as social filter and it is measured on a scale from 0 to 100, where the lower values represent the absence of socio-institutional problems. This means that the social filter has greater importance in the Italian regions on the positive side of the axis.

Second, Component II is measured on a scale from 0 to 100, where the positive values correspond to a great competitive attractiveness of the economic system.

Two primary results can be seen in the figure. First, the regions of the South are concentrated in the right half of the diagram and therefore characterised by high incidence of the social filter. Second, among the regions of the Centre and North, which are concentrated in the left half (scarce presence of negative externalities of environmental and social character), the regions of the Northwest are distinguished by a high degree of competitiveness of the economic system (Component II). Furthermore, except for Campania, characterized by high values of both the principal components, all the regions located in South Italy area characterized by high values for the social filter (Component I) and low degree of competitiveness of the economic system (Component II).

Figure 3 – Estimate of the social del filter for the Italian regions, 1998–2008



Finally, Figure 3 shows the trends of the social filter over time for each of the regions considered, the results being obtained by extending the PCA to cover the period 1998–2008. The figure shows evolution of the social filter present in the regional systems over time, increasing for example in Lombardy, Emilia Romagna, Campania, Puglia and Sicily but decreasing for Sardinia and Abruzzo.

4. Results of the empirical analysis

4.1. Econometric method

Equations (17)–(21) characterise the path of growth depending on the accumulation of physical and human capital, investment in R&D and the impact of the social filter.[7] For the purposes of empirical analysis, the results outlined in section 2 will be used to characterise the trends of the variables and the signs expected in the relations. Let us therefore specify the following growth function:

$$\gamma_{it} = \varphi_1 \gamma_{it-1} + \phi_2 p\_inv_{it-1} + \phi_3 tec_{it-1} + \phi_4 X_{it} + v_i + \eta_t + \varepsilon_{it} \qquad \textbf{(22)}$$

where i and t characterise every region and temporal period (with $t = 1, \ldots\ldots T$), and $X_{it} = \left[Chum_{it}, Sfilter_{it} \right]$ γ_{it-1} is the growth rate of per capita GDP at time $t-1$, p_inv_{it-1} private investment at $t-1$, $Chum_{it}$ human capital, tec_{it-1} the level of technological knowledge, and $Sfilter_{it}$ the social filter identified and estimated in section 3.

Equation (22) highlights some problems regarding the econometric estimate. First, the two specific non-observable terms of the individual region v_i and the time period η_t must be handled in different ways due to the dynamic nature of the equation. To be more specific, the first effect is addressed through the use of dummy variables and the second requires the use of first difference estimator.

Second, in order to avoid loss of efficiency, it is necessary for the estimator to take into account the presence of endogeneity in at least two explanatory variables, namely private investment and the level of technological knowledge. The hypothesis of endogeneity in these regressors depends directly on the accumulation functions described by equations (18) and (19) respectively. Furthermore, It should be noted that since the share of the workforce in the SR&D

[7] In order to keep the econometric model as simple as possible, the price of projects/patents for the production of new kinds of intermediate goods is taken as equal to 1.

depends on the wages received by the workers there in comparison with wages in the sector of final goods, a certain degree of endogeneity can be assumed also in the case of human capital.

The Generalized Method of Moments (GMM) for panel data, originally presented by Arellano and Bond (1991) and Arellano and Bover (1995), is used to estimate equation (22). These estimators are based first on the first difference of the regressors, in order to control the non-observable effects, and second on the use of the past values of the dependent variable and the regressors as instruments to eliminate the problems due to endogeneity. Equation (22) can therefore be rewritten as:

$$\Delta\gamma_{it} = \varphi_1 \Delta\gamma_{it-1} + \phi_2 \Delta p\_inv_{it-1} + \Delta\phi_3 tec_{it-1} + \phi_4 \Delta X_{it} + \Delta\varepsilon_{it} \quad \textbf{(23)}$$

where all the variables are now expressed in terms of deviation from the mean. Thus specified, equation (23) violates the assumption of non-correlation between the term of error $\Delta\varepsilon_{it}$ and the dependent variable $\Delta\gamma_{it-1}$ expressed at time $t-1$. Use of the instruments thus becomes necessary in order to restore both the assumption of non-correlation and the assumption of exogeneity in the regressors at the same time. Moreover, it is important to note that there is a trade-off between efficiency and bias in the estimator, which derives from the excessive use of instruments, in terms of lags of the variables included in the econometric specification. As discussed by Roodman (2009), the over-use of instruments, especially when the cross-sectional component is small, can lead to a non-robust estimate of the parameters. In order to limit the presence of bias in the estimates, it is advisable to use only one lag for each explanatory variable.

In order to avoid this potential problem, use is made here of the set of instruments described above as regards the regression of the first differences. These are appropriate instruments when it is assumed that the correlation between the explanatory variables and the specific non-observable term of the individual region remains constant for the entire period. The moment conditions for the system of equations (22) and (23) can therefore be written as:

$$E[\gamma_{it-2}(\epsilon_{it} - \epsilon_{it-1})] = 0$$

$$E[\bar{X}_{it-2}(\epsilon_{it} - \epsilon_{it-1})] = 0$$

where $\bar{X}_{it+p}$ is the vector of explanatory variables that also includes the endogenous variables. Particularly, if we define $\Delta\varepsilon_i$ as the vector of transformed error terms and Z_{it} as a composite matrix of instruments, where each row contains instruments that are valid for a given period, the set of moment conditions can be written concisely as:

$$E[Z_i'\Delta\varepsilon_i] = 0$$

The use of these moment conditions makes it possible to obtain efficient and robust estimates through utilisation of the GMM estimator.

A crucial assumption for the validity of GMM is that the instruments are exogenous. If the model is exactly identified, detection of invalid instruments is impossible because even when $E[Z_i'\Delta\varepsilon_i] \neq 0$ the estimator will choose $\hat{\beta}$ so that $Z'\hat{E} = 0$ exactly. But if the model is overidentified, a test statistic for the joint validity of the moment conditions (identifying restrictions) falls naturally out of the GMM framework. The Hansen (1982) J test statistic for overidentifying restrictions impose that, under the null of joint validity, the vector of empirical moments $\frac{1}{N}Z'\hat{E}$ is randomly distributed around 0. A Wald test can check this hypothesis and has a χ^2 distribution with degrees of freedom equal to the degree of overidentication, $j-k$. When the sample size N goes to infinity, the Hansen test coincides with the Sargan (1958) statistic.

Sargan Hansen statistics can also be used to test **cc** the validity of subsets of instruments, via a "difference in Sargan" test, also known as a C statistic. If one performs an estimation with and without a subset of suspect instruments, under the null of joint validity of the full instrument set, the difference in the two reported Sargan Hansen test statistics is itself asymptotically χ^2 distribution, with degrees of freedom equal to the number of suspect instruments. The regression without the suspect instruments is called the unrestricted regression since it imposes fewer moment conditions. The difference-in-Sargan test is of course only feasible if this unrestricted regression has enough instruments to be identified.

Finally, since the estimations and the test of overidentified restrictions are valid only when there is no residual autocorrelation in the error term, we use an Arellano-Bond statistic to test for absence of second order autocorrelation.

4.2 Results

The data used to estimate the growth equation (23) for the Italian regions over the period 2000–2008 are extrapolated from the DPS-ISTAT (Department for Development Policies-National Institute of Statistics) territorial database on development policies. The choice of period depends largely on the availability of data. The dependent variable γ_t is the yearly growth rate of Gross Domestic Product per capita and p_inv_{it-1} is the ratio of gross private investment to GDP. The number of patents registered at the European Office Patent per million inhabitants indicates the level of technological knowledge in the economic system, tec_{it-1}, and $Chum_{it}$ represents the share of human capital described as the percentage of the population in the 25–64 age group attending years course of study or professional training. Finally, $Sfilter_{it}$ is the score for each region with regard to the first principal component, identified here as the social filter. As showed in section 3, this measurement is scaled so as to obtain an index from 0 to 100, where 100 indicates the worst performance in terms of the impact of the social filter on the economic system. Appendix 2 reports descriptive statistics for all the variables used in the panel data analysis.

Table 2 presents the estimates for the growth equation. While those in the first column are calculated by means of the basic model, taking into account only the variables of private investment and human capital, those in the second also reflect the level of technological knowledge. The social filter is then added in the third, interaction between the filter and the level of technological knowledge in the fourth. It should be noted that investment p_inv_{it-1} and the level of technological knowledge tec_{it-1} are included in the estimate as endogenous variables with lags to take into account their respective functions of accumulation, as described in (18) and (19).

Generally speaking , the estimates presented are significant and all the variables show the expected signs, with all the introduced controll variables (such as the time dummy and the time trend for island areas $d.islands$) are strogly significan. This result demonstrates the model's ability to describe the relationship between the accumulation of technological knowledge, human capital, socio-institutional conditions and growth in the Italian regions.

Table 2- Results of the estimates of the growth equation, full sample analysis

	I		II		III		IV	
γ_{t-1}	0.273	***	0.245	***	0.238	***	0.153	**
	(0.086)		(0.072)		(0.084)		(0.060)	
$Chum_{it}$	0.203	**	0.172	**	0.160	**	0.095	*
	(0.868)		(0.822)		(0.771)		(0.593)	
p_inv_{it-1}	0.237	**	0.301	***	0.242	**	0.219	***
	(0.108)		(0.099)		(0.100)		(0.085)	
tec_{it-1}			0.040	***				
			(0.008)					
$Sfilter_{it}$					-0.049	**		
					(0.020)			
$Sfilter_{it}xtec_{it}$							-0.009	***
							(0.003)	
$d.islands$	-0.289	**	-0.322	***	-0.221	*	-0.282	*
	(0.132)		(0.110)		(0.117)		(0.146)	
$d.2001$	-2.154		-1.675		-1.229		-0.932	
	(1.558)		(1.588)		(1.306)		(1.083)	
$d.2002$	-3.884	**	-3.284	*	-2.995	**	-2.779	**
	(1.726)		(1.709)		(1.456)		(1.270)	
$d.2003$	-3.835	**	-3.546	**	-3.065	**	-2.902	***
	(1.572)		(1.534)		(1.258)		(1.103)	
$d.2004$	1.169	**	0.782		1.155	**	0.026	
	(0.494)		(0.537)		(0.452)		(0.439)	
$d.2005$	-0.799		-0.875	*	-0.571		-1.190	***
	(0.569)		(0.551)		(0.470)		(0.452)	
$d.2006$	2.021	***	1.691	***	2.089	***	1.103	***
	(0.437)		(0.469)		(0.372)		(0.374)	
N	147		147		147		147	
N instruments	26		27		27		27	
Arellano Bond test	-0.127		0 .386		0.985		-0.658	
	(0.898)		(0.699)		(0.324)		(0.510)	
Hansen test	25.10		16.66		19.35		19.32	
	(0.068)		(0.118)		(0.055)		(0.023)	
Difference in Hansen test	7.41		11.89		8.50		16.88	
	(0.388)		(0.156)		(0.386)		0.018	
Sargan Test	30.245		29.423		31.074		23.904	
	(0.035)		(0.043)		(0.028)		(0.066)	

Note: The dependent variable is the growth rate of GDP per-capita. The asterisks indicate the levels of significance of the parameters: * 0.10, ** 0.05 and *** 0.01.

In more specific terms, the first two columns of the Table show the importance of human capital and technological knowledge in fostering Italy's economic growth, with coefficients from 0.56 to 0.095 ($c_{hum_{it}}$) and 0.040 (tec_{it-1}) respectively. As expected (see Lodde 2008, Hirsch e Sulis 2009, Marrocu e Paci 2010, Quatraro 2009), the more innovative regions, which are characterised by higher levels of patents and human capital, register better performance in terms of economic growth.

This situation changes considerably when the impact of the social filter on the economic system is taken into consideration. In line with our hypotheses, poor performance as regards the factors of a social and institutional character affects the propagation of technological knowledge, with a direct impact on regional growth equal to -0.049 ($Sfilter_{it}$). The scale of this parameter proves larger than the estimate of Crescenzi and Rodríguez-Pose (2009) for the European regions, where the value registered for the social filter was about 0.010. As noted above, our findings differ substantially from those of Crescenzi and Rodríguez-Pose, who include only aspects connected with human capital in the social filter.

Moreover, when the indirect channel ($Sfilter_{it} x tec_{it}$), which indicates the effects of the social filter on the region's innovative capacity, is also taken into consideration, the impact of the social filter on the growth proves stronger still, with a coefficient of -0.009. This interaction term is interpreted as a joint variation of the technological knowledge and of the social filter, which produces an adjointed negative impact of the growth rate of GDP per-capita through the investment channel as showed in Figure 1.

As a first result, estimations presented in Table 2 suggest the good ability of the proposed endogenous growth model to explain growth patterns of the Italian regions, whereas the proposed test statistics confirm the robustness of the results. Particularly, Arellano-Bond second order autocorrelation test excludes the presence of residual autocorrelation in the error term of equation (22) whereas Hansen, Sargan and difference in Sargan tests show that the model is correctly identified and that the chosen instruments are exogenous.

Table 3- Results of the estimates of the growth equation, North sub-sample

	I		II		III		IV	
y_{t-1}	0.304	**	0.287	**	0.297	**	0.285	**
	(0.124)		(0.117)		(0.126)		(0.142)	
$Chum_{it}$	1.102	***	0.949	***	1.077	***	1.124	***
	(0.291)		(0.241)		(0.328)		(0.347)	
p_inv_{it-1}	-0.028		0.012		-0.043		-0.045	
	(0.179)		(0.152)		(0.181)		(0.223)	
tec_{it-1}			0.040	***				
			(0.006)					
$Sfilter_{it}$					-0.036			
					(0.031)			
$Sfilter_{it} x tec_{it}$							-0.011	*
							(0.007)	
$d.2002$	-0.361		-0.593		-0.344		-0.314	
	(0.562)		(0.542)		(0.573)		(0.581)	
$d.2003$	-1.468	***	-1.338	***	-1.467	***	-1.537	***
	(0.379)		(0.358)		(0.377)		(0.408)	
$d.2004$	-1.386	***	-1.342	***	-1.391	***	-1.396	***
	(0.408)		(0.372)		(0.405)		(0.405)	
$d.2005$	-1.502	***	-1.522	***	-1.481	***	-1.610	***
	(0.428)		(0.430)		(0.440)		(0.438)	
$d.2006$	-3.769	***	-3.148	***	-3.773	***		
	(0.461)		(0.496)		(0.480)			
N	87		87		87		87	
N instruments	27		28		28		28	
Arellano Bond test	0.662		0.397		0.540		-0.331	
	(0.507)		(0.691)		(0.588)		(0.740)	
Hansen test	34.94		21.82		36.67		12.90	
	(0.000)		(0.026)		(0.000)		(0.115)	
Difference in Hansen test	6.15		15.17		11.51		9.12	
	(0.407)		(0.034)		(11.51)		(0.167)	
Sargan Test	31.904		25.993		32.158		15.318	
	(0.022)		(0.099)		(0.021)		(0.428)	

Note: The dependent variable is the growth rate of GDP per-capita. The asterisks indicate the levels of significance of the parameters: * 0.10, ** 0.05 and *** 0.01.

Table 4- Results of the estimates of the growth equation, South sub-sample

	I		II		III		IV	
γ_{t-1}	0.174		0.257	*	0.143		0.016	
	(0.142)		(0.149)		(0.144)		(0.137)	
$Chum_{it}$	0.090		0.380		-0.144		0.487	
	(0.552)		(0.528)		(0.632)		(0.411)	
p_inv_{it-1}	0.426	***	0.542	***	0.367	**	0.263	*
	(0.165)		(0.164)		(0.185)		(0.155)	
tec_{it-1}			0.037	**				
			(0.015)					
$Sfilter_{it}$					-0.054	*		
					(0.030)			
$Sfilter_{it} x tec_{it}$							-0.009	***
							(0.003)	
$d.2001$	2.866	**	3.259	**	2.353	*	2.694	**
	(1.353)		(1.337)		(1.453)		(1.052)	
$d.2002$	1.087		1.531		0.625		0.784	
	(1.322)		(1.311)		(1.385)		(1.024)	
$d.2003$	0.778		1.457		0.158		0.390	
	(1.197)		(1.148)		(1.503)		(0.952)	
$d.2004$	1.995	***	1.727	***	1.891	***	0.704	
	(0.510)		(0.563)		(0.502)		(0.555)	
$d.2005$	0.331		0.401		0.179		-0.259	
	(0.442)		(0.430)		(0.483)		(0.425)	
$d.2006$	2.593	***	2.655	***	2.481	***	1.360	***
	(0.479)		(0.554)		(0.452)		(0.473)	
N	60		60		60		60	
N instruments	26		27		27		27	
Arellano Bond test	-1.204		-0.843		1.320		0.3122	
	(0.228)		(0.398)		(0.186)		(0.754)	
Hansen test	19.11		19.21		16.44		4.55	
	(0.059)		(0.057)		(0.126)		(0.805)	
Difference in Hansen test	13.93		17.34		14.93		3.77	
	(0.052)		(0.027)		0.061		(0.806)	
Sargan Test	21.692		20.674		21.692		16.740	
	(0.245)		(0.296)		(0.245)		(0.334)	

Note: The dependent variable is the growth rate of GDP per-capita. The asterisks indicate the levels of significance of the parameters: * 0.10, ** 0.05 and *** 0.01.

Tables 3 and 4 replicate the estimations in two sub-samples of regions defined as North and South respectively. The first sample includes all the regions located in the North and Center of Italy excluding Lazio, whereas the second sub-sample includes Lazio and all the remained Italian regions. The choice of these sub-samples[8] seems reasonable since all the regions in the South sub-sample (and in Lazio) show the highest values of social filter for the entire period of time (see Figure 3).

In particular, Table 4 (South sub-sample) shows that the estimation parameter of tec_{it-1} is in line with the full-sample estimation, whereas the parameter associated with the social filter is much higher than in full sample. These results are not confirmed for the first sub-sample of regions as presented in Table 3. In this case only tec_{it-1} and $Sfilter_{it}xtec_{it}$ are significant, but the impact of technological knowledge and of the $Sfilter_{it}xtec_{it}$ on growth are lightly higher than in full sample estimations. This result, in line with expectations, suggests that the majority of innovative activities are concentrated in North of Italy. For both sub-samples the proposed test statistics confirm the robustness of the estimation results.

Table 3 – Estimated elasticities for Italy

	Technological knowledge				Social filter
	total elasticity	direct elasticity	indirect elasticity	indirect/direct percentage	direct elasticity
Full sample analysis	0.182	0.238	-0.055		-0.040
	18%	23%	-5.5%	22%	-4%
South sub-sample	0.078	0.104	-0.025		-0.049
	8%	10%	-2.5%	25%	-5%
North sub-sample	0.319	0.373	-0.053		-
	32%	37%	5.3%	14%	-

Note: The measurements of direct and indirect elasticity use the parameters estimated in Table 2, specifications III and IV. For example, the direct elasticity of the number of patents is calculated by means of the formula $d\, e_{tec_{it-1}} = \beta_{tec_{it-1}} (Mtec_{it-1} / M\gamma_{it})$, where $Mtec_{it-1}$ and $M\gamma_{it}$ represent the mean values of the number of patents and the growth rate of GDP per capita respectively, and $\beta_{tec_{it-1}}$ is the parameter estimated in Table 2. Indirect elasticity is calculated by means of the formula $ind\, e_{tec_{it-1}} = \beta_{sfilter_{it}xtec_{it-1}} (Mtec_{it-1} / M\gamma_{it})$.

[8] Different sub-sample selections have been tested: i.e. excluding Lazio from the South sub-sample or including Lazio in the North sub-sample.

To complete the analysis, we present three measurements of elasticity obtained by means of the parameters of columns II, III and IV of Tables 2, 3 and 4, namely the direct and indirect elasticity of the technological knowledge and the direct elasticity of the social filter. In accordance with the methodology proposed by works such as d'Agostino et al. (2011), these measurements give an immediate picture of the impact of the variables examined on economic growth.

The estimates of elasticity calculated for Italy and for the two proposed sub-samples as regards the technological knowledge and the social filter are presented in table Table 5. Analysis of these values yields at least three important results. First, the impact of technological innovation on GDP per-capita growth is very high at the national level, with a direct percentage elasticity of about 23% (in the North sub-sample the direct percentage elasticity is about 37%). Secondly, the impact of innovation tends to decrease substantially when the indirect elasticity influenced by the social filter is taken into consideration: the ratio indirect/direct elasticity accounts for about 22% at the national level and for 25% and 14% in South and North sub-samples respectively. Thirdly, the impact of the direct elasticity of the social filter on Italy's economic growth is very marked, with an impact of about 4% of GDP growth rate, which becomes 5% looking only to the regions in South sub-sample. This suggests that policies affecting social and institutional conditions can have substantial repercussions on economic growth for all the Italian regions and specially in South Italy regions.

5. Conclusions and implications for policy

Our analysis shows the importance of endogenous factors of development linked to the local territory as regards the regions' ability to absorb technical progress and increase their rate of economic growth. These findings are useful in assessing the policies to be adopted for the underdeveloped regions of the South of Italy in view of the fact that recent trends have seen the weaker areas of the country being pushed increasingly to the sidelines as regards the international distribution of wealth.

The empirical evidence obtained in this work calls for a rethinking of the basic objectives informing the development policies for Southern Italy. First and foremost, public policies should not be confined to pumping resources into the disadvantaged regions. The general aim should rather be to promote the ability of economic agents to cooperate and create networks, and to introduce models of governance capable of facilitating relations and the dissemination of knowledge, thereby generating positive externalities and boosting the productivity of local activities.

Second, policies aimed at a marked improvement of institutions, quality of life and access to collective services in the southern regions appear to be indispensable prerequisites for intensification of the dissemination of knowledge and the acceleration of economic growth. The model developed here shows that failure to meet this requirement nullifies the effects of the traditional policies aimed at material infrastructures, firms and innovation. In our view, the negative externalities encompassed in the variable of the social filter reflect the paralysis of the institutions and its consequences, namely dissatisfaction, lack of confidence, shortage of public assets and, in the final analysis, uncertainty and high transaction costs, which keep the southern regions in a state of stagnation and underdevelopment.

The implications for policy-making appear vague and ambiguous. It is difficult to define the institutions (Rodríguez-Pose 2010) and their quality is closely connected with level of income. Institutions and development are therefore phenomena that strengthen one another reciprocally (Rodrik 2004) and the same formal institutional structures can give rise to different results in terms of the accumulation of social capital (De Blasio and Nuzzo 2006).

Despite our awareness of the considerable simplification involved, we would argue, however, that the only possible starting point for policies aimed at increasing the quality of the institutions in the southern regions is a reform of local government so as to boost the efficiency of the organisation of human resources and introduce a substantial effort to monitor and assess the results pursued.

The development policies should then focus primarily on the upgrading of collective services, starting with education, social services and the safeguarding of environmental resources. There are two reasons for this. First, as these objectives represent the output of government, monitoring them makes it possible to assess the quality of the institutions indirectly and take corrective measures if necessary. Second, and more importantly, an improvement in collective services is the minimum prerequisite for elimination of the environmental obstacles acting as a negative externality on the regions' ability to absorb innovations and to attract and retain entrepreneurial projects and skills. As we have tried to show by estimating the scale and effects of the social filter, policies that reduce its impact could have major repercussions on the economic growth of the southern regions as well as the development of the Italian economy in general.

Appendix A – Results of PCA for the Italian regions, 1998

Analysis of the eigenvalues in the correlation matrix

	Comp I	Comp II	Comp III	Comp IV	Comp V	Comp VI	Comp VII	Comp VII
Eigenvalue	3.530	2.824	0.727	0.394	0.320	0.140	0.039	0.025
Frequency	0.441	0.353	0.091	0.049	0.040	0.018	0.005	0.003
Cumulative frequency	0.441	0.794	0.885	0.934	0.974	0.992	0.997	1.000

Coefficients of the principal components

	Comp I	Comp II	Comp III	Comp IV	Comp V	Comp VI	Comp VII	Comp VIII
es	-0.160	0.503	-0.243	0.205	-0.581	-0.407	0.031	0.340
ld	0.428	0.257	-0.321	-0.224	-0.133	0.672	-0.163	0.320
dg	0.495	0.180	-0.031	0.201	-0.009	-0.013	0.777	-0.278
let	-0.210	0.522	-0.118	0.318	0.114	0.238	-0.298	-0.641
rd	-0.484	0.096	0.201	0.397	0.244	0.429	0.357	0.433
rc	0.527	0.427	-0.013	-0.430	0.637	-0.306	0.055	0.190
pf	0.468	-0.065	-0.018	0.649	0.336	-0.212	-0.356	0.266
ass	0.220	0.292	0.884	-0.059	-0.232	0.057	-0.151	0.024

Appendix B – Mean values of each variable used in the panel data analysis

Region-id	Region	γ	p_inv	tec	$Chum$	$Sfilter$
1	Piemonte	0.320	22.046	4.800	4.779	38.330
2	Valle D'Aosta	0.318	24.028	3.961	4.590	30.258
3	Lombardia	0.263	19.853	4.957	5.241	28.226
5	Veneto	0.532	22.603	4.727	6.038	20.615
6	Friuli Venezia Giulia	0.839	22.735	4.616	6.681	28.208
7	Liguria	0.890	18.169	4.033	5.265	46.125
8	Emilia Romagna	0.312	20.983	5.115	6.147	26.051
9	Toscana	0.583	18.593	4.241	6.071	34.670
10	Umbria	0.227	21.227	3.717	6.463	39.742
11	Marche	0.789	21.362	4.046	5.138	34.216
12	Lazio	0.648	18.187	3.589	6.587	63.326
13	Abruzzo	0.432	22.898	3.675	5.839	52.607
14	Molise	1.332	24.934	1.832	5.875	67.680
15	Campania	0.683	21.197	2.356	4.646	89.487
16	Puglia	0.441	21.134	2.303	4.865	75.399
17	Basilicata	0.638	27.194	1.765	5.769	73.761
18	Calabria	0.768	22.982	1.559	5.575	82.070
19	Sicilia	0.866	21.206	2.509	4.401	89.710
20	Sardegna	0.723	25.620	2.110	6.283	68.588
21	Bolzano	0.690	29.195	4.059	6.565	14.135
22	Trento	0.101	28.579	3.855	7.517	20.023

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