Inclusive Institutions, Innovation and Economic Growth: Estimates for European Countries

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Abstract

This paper investigates the theoretical and empirical foundations of the links between inclusive institutions, innovation and economic growth. Its first contribution to the literature is to provide a non-scale R&D-based growth model incorporating negative externalities linked to low institutional quality that not only affect the productivity of private and human capital, but also constrain the diffusion of existing technological knowledge. In turn, these negative externalities reduce economic growth. The second contribution of this paper is to run estimates for a sample of European Union countries. Empirical analysis based on pooled long- and short-run estimates confirms the importance of private capital and technology as instruments to increase economic growth in European countries and suggests the existence of a positive relationship between inclusive institutions, innovation and economic growth. The estimates also show that market failures linked to the degree of market competition and to the level of network interaction in the economic system significantly condition the influence of formal institutions on private capital, technology and GDP growth.

JEL classification: O30, O41, O43

Keywords: Innovation, economic growth models, institutions and growth

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1 Introduction

Innovation is a persistent source of economic growth (Aghion, 1992; Grossman and Helpman, 1991). However, in the new knowledge-based economy some of the intrinsic features of each society influence the ability of its economic system to translate innovative efforts and external knowledge flows into economic growth. The innovation systems literature focuses on the role of institutions in determining technological change, and stresses the importance of institutions such as universities and research institutes being linked to the production or diffusion of innovations (Barbosa and Faria, 2011; Lundvall, 1992). Furthermore, empirical analysis shows that institutional differences affect the extent of R&D spillovers; for example, countries where the ease of doing business, the quality of the tertiary education system and the level of patent protection are relatively high benefit more from R&D efforts and international R&D spillovers (Coe, Helpman and Hoffmaister, 2009; Tebaldi and Elmslie, 2013). A related field of research underlines the influence of intangible assets and specific institutional characteristics on innovation capacity at the regional level (Crescenzi and Rodríguez -Pose, 2011; d'Agostino and Scarlato, 2011; Dettori, Marrocu and Paci, 2011; Rodríguez -Pose, 1999; Rodríguez-Pose and Crescenzi, 2008; Sterlacchini, 2008).

More broadly, recent studies argue that differences in per capita income can be explained by features of societal organisation that may prevent a country from adopting the best technologies (Acemoglu et al., 2005; Barbosa and Faria, 2011; Tabellini, 2008). For example, institutional failure may emerge when technological advancement represents a threat to the ruling groups and such groups consequently decide to block innovations to preserve their political power (Acemoglu and Robinson, 2000; Acemoglu, 2006). According to Acemoglu (2012), civil and political rights are strictly intertwined with technological development and the various dynamics of economic growth. Similarly, other studies highlight that interest groups engaging in rent-protecting activities may constitute structural barriers to innovation and growth (Dias and McDermott, 2006; Dynopoulos and Syropoulos, 2007; Parente and Zhao, 2006; Van Long and Sorger, 2006).

What emerges from these different fields of research is that inclusive institutions, i.e. institutions that provide incentives and opportunities for a broad cross-section of society, are favourable to both technological progress and economic growth (Acemoglu, 2012). Our paper integrates these areas of the literature and investigates the theoretical foundations of the linkage between inclusive institutions and economic growth, emphasising innovation as the intermediate variable that drives this interplay. This paper incorporates, within the general definition of institutional quality, social and institutional factors that promote inclusiveness and social cohesion. It shows that these factors serve as preconditions for the successful exploitation of knowledge, and analyses how their combination persistently hampers or enhances the ability of a country to foster economic growth.

At a more detailed level, this paper focuses on the influence of social and institutional quality on innovation. The link between these variables may be attributable to a number of factors. For example, a growing body of literature investigates the links through which inclusive institutions influence technological change and factor accumulation by examining the relationship between institutions, human capital and knowledge creation (Dias and McDermott, 2006; Dias and Tebaldi, 2012; Tebaldi and Elmslie, 2008). In particular, Dias and Tebaldi (2012) propose a model in which institutions that ensure the human capital market functions effectively increase the return to education, thus stimulating human capital accumulation. As a consequence, such institutions indirectly increase the productivity of the economy, boosting knowledge creation and the rate of economic growth. Similarly, Dias and McDermott (2006) present a model based on the assumption that good institutions stimulate entrepreneurship in the modern goods sector, encouraging workers to invest in education. The accumulation of human capital then leads to more rapid structural transformation and economic growth. The link between inclusive institutions and innovation can also be direct. For example, institutional reforms have a direct influence on knowledge creation through incentives to undertake R&D activities generated by market-friendly policies such as improvements in the patent system and property rights enforcement (Tebaldi and Elmslie, 2008; 2013).

This paper reveals several new insights to the literature. First, it suggests that inclusive institutions affect the productivity of economy-wide inputs and the diffusion of knowledge. In particular, inclusive institutions speed up the dissemination of ideas, promote cooperation among researchers, and strengthen the flow of knowledge from educated to non-educated workers (Dias and Tebaldi, 2012; Hauser, Tappeiner and Walde, 2007; Miguélez, Moreno and Artís, 2011; Tebaldi and Elmslie, 2008). Second, this paper demonstrates that investments in innovative activities are fully exploited in an enviroment in which people trust each other and are connected by dense network relationships, repeated interaction and shared values. This is made possible through different channels: social networks provide for better enforcement of informal norms, thus reducing monitoring costs (Knack and Keefer, 1997; Sabatini, 2099a; Sabatini, 2009b). Moreover, social networks improve information about quality firms and projects (Bjørnskov, 2010; Dearmon and Grier, 2011; Hug and Spörri, 2011; Zak and Knack, 2001) and increase the probability of good ideas receiving finance (Akçomak and ter Weel, 2009; Rost, 2011). In both cases, the effect is to provide an incentive for the adoption of new ideas and technologies. In contrast, low levels of social interaction and trust disincentivise cooperative behaviour, hinder creativity, increase uncertainty and hamper risky innovative activities.

In brief, we argue that low-quality social and institutional conditions impose negative externalities on the absorption and diffusion of innovation. In turn, these negative social and institutional externalities reduce economic growth. The key contributions of this paper are twofold. First, we encapsulate the aforementioned hypotheses in a non-scale R&D-based growth model incorporating negative social and institutional externalities that not only affect the productivity of private and human capital, but also constrain the diffusion of existing technological knowledge. The second main contribution of the paper is to provide new empirical results for a sample of European Union (EU) countries.

The focus on the EU is motivated by the current discussion on policies to enhance economic growth after the failure of the Lisbon Strategy, for which the underlying belief is that more competition and less regulation bolster innovation and thus growth (Barbosa and Faria, 2011). More recently, improving social and institutional quality has been included as one of the principle objectives of the EU under the general framework of sustainable development and in the regional policy framework (Biagi and Lambir, 2007; Farole, Rodríguez -Pose and Storper, 2011). In particular, five objectives have been set as part of the so-called Europe 2020 growth strategy - employment, innovation, education, social inclusion and climate/energy - which are to be achieved by 2020 (European Commission, 2010). From this perspective, environmental and social sustainability targets are regarded as complementary to a process of economic growth driven by innovation, recognising the unequal distribution of environmental burdens and health risks across social groups (Nunes et al., 2011; EEC, 2008; Serrel and Johnstone, 2006) and the influence of the environment on well-being (Welsch, 2006; Silva, de Keulenaer and Johnstone, 2012). This strategy also recognises that countries with a better quality of government (government that is impartial, efficient and non-corrupt) also score higher in dimensions related to the welfare of citizens, environmental sustainability and income inequality, and that higher institutional quality leads to better economic performance (Besley and Persson, 2009; Besley, Persson and Reynals-Querol, 2012; Charron, Dykstra and Lapuente, 2012).

Our empirical analysis based on pooled long- and short-run estimates confirms the importance of private capital and technology as instruments to increase economic growth in European countries, and suggests the existence of a positive relationship between inclusive institutions, innovation and economic growth. Elasticity measures show that reforming institutions with the aim of enhancing governance, social inclusion and environmental sustainability may generate strong incentives for private investment, knowledge diffusion and the adoption of technological innovation, thus promoting economic growth. The estimates also show that market failures linked to the degree of market competition and to the level of network interaction in the economic system significantly condition the influence of formal institutions on private capital, technology and GDP growth.

The remainder of this paper is organised as follows. In Section 2 we present the theoretical framework of our analysis. In Section 3, we run estimates for a sample of European countries to test our arguments and discuss the empirical results. In the final section we conclude the paper by summarising the main findings and highlighting relevant policy implications of our work.

2 Theoretical framework

This section provides a detailed discussion of the non-scale R&D-based growth model we employ to analyse patterns of economic growth conditioned on the technological knowledge accumulation process. In line with Steger (2005a), our theoretical framework introduces two negative externalities into the technological knowledge accumulation function that generate non-explosive economic growth. These externalities not only affect the productivity of private and human capital, but also constrain the diffusion of existing technological knowledge. Unlike previous contributors to this field (Eicher, 2000; Eicher, 2001; Jones, 1995; Peretto, 2002), we propose a model in which these externalities are identified on the basis of institutional quality and network relationships in a given country. Although institutional quality is uniquely used to identify the first negative externality, both institutional quality and network relationships affect the diffusion of technological knowledge already accumulated. Our comprehensive model is composed of three different sectors dealing respectively with the production of an homogenous final output (the final output sector, FO), several varieties of intermediate goods (the capital goods sector, CG) and blueprints (the research and development sector, R&D).

2.1 The final output sector

Consider a sector comprising of a large number of firms, n_{FO}, ordered on the interval $[0, 1]$. The firms produce a single homogeneous good that is sold in a competitive market and can be consumed or invested. The production function faced by the firms in the final output sector is:

$$Y = (\theta L)^{\sigma_L} \int_0^A [\phi x(i)]^{\sigma_K} \, di \quad with\, \sigma_L, \sigma_k < 1 \, and \, \sigma_L + \sigma_k = 1, \tag{1}$$

where Y is the final output and L is the stock of labour in the entire economic system, which grows at a constant rate $\dot{L} = nL$ (where n is the sum of labour employed in the final output sector and labour employed in the R&D sector). The variable $x(i)$ is the number of intermediate capital goods of type i produced in the capital goods sector that are ordered in the interval $[0, A]$, where A describes the availability of intermediate capital goods at every point in time. In addition, θ and ϕ are the shares of intermediate goods and labour employed in the final output sector $[0 \leq \theta, \phi \leq 1]$, where $[1 - \theta, 1 - \phi]$ are the shares of the same variables in the R&D sector.

Because the elasticity of substitution between different capital goods is constant and equal to $\epsilon = (1/1-\sigma_K)^1$, and given the symmetry of $x(i)$ [2], the technology behind the production of final output (1) can be rewritten as:

$$Y = A^{1-\sigma_K} (\theta L)^{\sigma_L} (\phi K)^{\sigma_K}, \tag{2}$$

which states that total factor productivity A may change according to the number of intermediate capital goods. As a consequence, given that FO is a perfect competition sector[3], the optimal demand price for capital goods is given by $P_D^{FO} = \left[\frac{(\epsilon-1)}{\epsilon}\frac{Y}{\phi K}\right]$[4]. Given Equation (2), the dynamics of the aggregate capital stock are given by:

$$\dot{K} = Y - C = A^{1-\sigma_K} (\theta L)^{\sigma_L} (\phi K)^{\sigma_K} - C, \tag{3}$$

where C is total consumption.

2.2 The capital goods sector

As introduced above, the different varieties of capital goods $x(i)$ are produced in a separate sector comprising a large number of firms ordered in an interval $[0, A]$. To start producing a capital good x, each firm needs to buy a blueprint from the R&D sector, to become the only producer of that variety of good in a monopolistic regime. As a consequence, each firm determines the optimal quantity of capital goods to sell to the FO and R&D sectors that maximises its operating profit given by $\pi = [p(x) - r]\, x$, where $p(x)$ is the price of the good and r is the gross interest rate. The standard solution for maximising profit defines the optimal quantity x and price $p(x)$ in the capital goods sector. Moreover, because the other two sectors include a large number of firms, the elasticity of substitution among CG is equal to the respective price elasticities of demand in FO (denoted by ϵ_1) and R&D (denoted by ϵ_2). This means that we can simplify the model by assuming that $\epsilon = \epsilon_1 = \epsilon_2$[5], and leads to $P_D = P_D^{R\&D} = P_D^{FO} = \left[\frac{(\epsilon-1)}{\epsilon}\frac{Y}{\phi x}\right]$ [6], where $P_D^{R\&D}$ is the demand price in the R&D sector. Given that demand and supply prices are the same ($P_D = P_S$) in equilibrium, we can rearrange the operating profit function as $\pi = \left[\frac{(\epsilon-1)}{\epsilon}\frac{Y}{\phi x}\right] x - rx$, which yields the optimal CG supply price $P_S = \left[\frac{\epsilon}{\epsilon-1} r\right]$ and the gross interest rate $r = \left[\frac{(\epsilon-1)}{\epsilon}\right]^2 \frac{Y}{\phi K}$. Following Steger (2005b), each firm becomes the only producer of a single variety i of a capital good. As a consequence, the CG sector is characterised by monopolistic competition, and this leads to positive mark-ups of prices over marginal cost, which causes underinvestment in the R&D sector. This market failure justifies policy intervention to restore competition in the capital goods sector (Aghion et al. 2004; Griffith, Harrison and Macartney, 2007). In practice, because the monopolistic power of the firm in the CG sector changes the equilibrium between demand and supply across the entire economic system, we must control for such power to account for the influence of technology

[1] The last equation leads to the definition $\sigma_k = \frac{\epsilon-1}{\epsilon}$.

[2] Following d'Agostino and Scarlato (2011), the solution for the profit maximisation process in the CG sector states that every firm sets the same price and sells the same quantity of the durable good it produces. Because intermediate goods and capital are linked by the relation $K = \int_0^A x di = Ax$, where x is the optimal quantity of intermediate goods sold, this leads to the symmetry of $x(i)$. See subsection 2.2 for more details.

[3] The production function in (2) is required to exhibit constant returns to scale in private inputs to guarantee competitive equilibrium in the FO sector.

[4] From an algebraic point of view, the last equation is obtained by the first derivative of (2) with respect to K, where we substitute $\epsilon = 1/1 - \sigma_K$.

[5] This assumption guarantees that the CG producer has no incentive to differentiate prices across the FO and R&D sectors.

[6] Remembering that $K = Ax$, this expression is equivalent to $P_D = \left[\frac{(\epsilon-1)}{\epsilon}\frac{Y}{\phi K}\right]$.

and private investment on consumption growth rate. Thus, throughout our analysis, we include the market power control defined as u_{comp}.

2.3 The research and development sector

The last sector, the research and development sector (R&D), is characterised by a large number of firms ordered on the interval $[0, 1]$ that operate in a perfect competition regime. In accordance with Steger (2005b), the growth rate of the stock of knowledge (or technology) in the economy is linked to the level of technological knowledge and the shares of labour and private capital employed in the sector[7]. The function can be expressed as follow:

$$\dot{A} = J = A^{\eta_A} \left[(1-\theta)\, L\right]^{\eta_L} \left[(1-\phi)\, K\right]^{\eta_K}, \tag{4}$$

with $\eta_L = \eta_L^P + \eta_L^e$, $\eta_K = \eta_K^P + \eta_K^e$, η_A^{so}, $\eta_K^P\, \eta_L^P > 0$, where $\eta_K^e\, \eta_L^e < 0$ and $\eta_A = \eta_A^{SO} + (1-\eta_K)$. This model formulation allows for constant returns to scale in private inputs ($\eta_k^p + \eta_L^p = 1$), but decreasing returns to scale across the entire system, which is guaranteed by the negative externalities associated with economy-wide averages of private resources (η_k^e, $\eta_L^e < 0$). In addition, η_A^{SO} describes the degree of diffusion of technological knowledge already accumulated in the R&D sector (Steger, 2005a; Jones, 1995). Increasing values of η_k^e and η_L^e reduce the overall productivity of private capital $1-\phi$ and human capital $1-\theta$, and they constrain the diffusion of technological knowledge already accumulated A. However, because the growth rate of the stock of knowledge exhibits constant returns to scale, these negative externalities also reduce the elasticities of private capital, human capital and existing knowledge with respect to the growth rate of the stock of knowledge.

We propose two distinct hypotheses to identify the negative externalities associated with economy-wide averages of private resources ($\eta_K^e\, \eta_L^e$) and the degree of diffusion of technological knowledge already accumulated in the R&D sector (η_A^{SO}):

H1: Institutions that are not inclusive, as indicated by a low level of institutional quality, affect the generation of new technology by constraining the productivity of economy-wide inputs and the overall elasticities of private capital, human capital and existing knowledge with respect to the growth rate of the stock of knowledge.

We define η_K^e and η_L^e as the negative externalities of low institutional quality on private capital and human capital, respectively. However, $A^{\eta_A^{SO}+(1-\eta_K)}$, the negative externality linked to private capital, η_K^e, also affects the degree of diffusion of technological knowledge already accumulated in the R&D sector, in line with d'Agostino and Scarlato (2011).

Unlike previous contributions to this field (Eicher et al., 2000; Eicher, 2001; Jones, 1995; Peretto and Smulders, 2002), H1 proposes that the adoption of new ideas or blueprints is constrained by the background social and institutional context in which new discoveries take place. Indeed, the dynamics of innovation depend on the ability of the economic system to translate innovative efforts and external knowledge flows into economic growth (Acemoglu, 2012; Tebaldi and Elmslie, 2008). To define η_A^{SO} in more detail, we propose a second hypothesis:

H2: The presence of network relationships increases the degree of diffusion of existing knowledge.

[7] Symmetrically to (1), the R&D technology is defined by $\dot{A} = A^{\eta^{SO}} \left[(1-\theta)\, L\right]^{\eta_L} \int_0^A \left[(1-\phi)\, x(i)\right]^{\eta_K} di$.

We measure the positive spillovers generated by network relationships by the degree of diffusion of technological knowledge already accumulated in the R&D sector η_A^{SO}. Akçomak and ter Weel (2009) show that network interactions emerge when researchers and capital providers trust each other, thus facilitating the diffusion of ideas within the R&D sector and the adoption of innovations in the economic system. Furthermore, network interactions are crucial in facilitating the horizontal integration of small and medium firms, which generates positive spillovers to innovation.

According to Hypotheses 1 and 2, we have two opposite effects linked to the degree of diffusion of technological knowledge already accumulated in the R&D sector: one depending on the negative externality generated by low institutional quality on private capital η_K^e and human capital η_L^e, and the other depending on the positive spillovers produced by network relationships η_A^{SO}. This means that to identify the first effect, we have to control for the second. Because we are interested in identifying the first effect, we treat network interaction spillovers as a second source of control in the cross-country comparison. We define this control as u_{netint}.

Returning to the model, the price of one design or blueprint in the R&D sector is given by $v(t) = \int_t^\infty \pi(\tau) e^{-\int_t^\tau r(u)du} d\tau$, which becomes $\dot{v} = rv - \pi$ by differencing the last equation with respect to time. Substituting r and π into the latter then gives the rate at which the price of one design or blueprint grows:

$$\dot{v} = \left[\frac{(\epsilon - 1)}{\epsilon}\right]^2 \frac{Y}{\phi K} - \frac{(\epsilon - 1)}{\epsilon^2} \frac{Y}{\phi A}, \tag{5}$$

which shows that including only private returns in the price of one design or blueprint and the growth thereof leads to the emergence of a second market distortion. Furthermore, given the market structure of the R&D and FO sectors in equilibrium, factor prices are equalised across these sectors such that $w_{FO} = w_{R\&D}$ and $P_{FO}^D = P_{R\&D}^D$, thus allowing us to define the optimal allocation of labour and private capital across the two sectors as follows:

$$\frac{(\epsilon - 1)}{\epsilon} \frac{Y}{\theta L} = v \frac{J}{(1-\theta)L} \tag{6}$$

and

$$\frac{(\epsilon - 1)}{\epsilon} \frac{Y}{\phi K} = v \frac{J}{(1-\phi)K}. \tag{7}$$

2.4 Representative household behaviour and optimality conditions

To complete the model, we introduce representative household behaviour and assume that at any point in time, the representative household will supply one unit of labour and maximise its intertemporal utility by controlling for private consumption per capita. Given a CRRA instantaneous utility function, the overall utility maximised by the representative household is:

$$U(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma} e^{-\rho t}, \tag{8}$$

where $c = C/L$ is per capita consumption, ρ is the intertemporal discount rate, and σ is the inverse of the intertemporal elasticity of substitution, such that high values of σ imply more uniform intertemporal consumer behaviour. Moreover, given the identified structure of the three different sectors composing the economy, we can rewrite the private capital accumulation function, constraining the decisions of the representative household as:

$$\dot{K} = rK + wL + A\pi - v\dot{A} - C. \tag{9}$$

Given the structure of the utility of the representative household and the private capital accumulation function, we can derive the market solution for the model, which differs from the social planner solution (see Eicher and Turnovsky, 1999) in terms of the balanced growth rate (Steger, 2005a; Steger, 2005b), but not in terms of the long-run growth rate. This means that the centralised (social planner) solution is superior to the decentralised (market) solution in terms of welfare. The gap between the two solutions depends on the monopolistic competition structure of the CG sector, on the negative externalities linked to institutional quality, and on the positive spillovers due to network relationships. Public policies that reduce these distortions may raise the level of the balanced growth path, even if they cannot modify the long-run growth rate.

Hence, by solving the household intertemporal optimisation process using Equations (8) and (9) with $K(0) > 0$ and $A(0) > 0$) and applying the Ramsey-Keynes rule of optimal consumption[8], we obtain:

$$\gamma = \frac{\dot{C}}{C} = \frac{1}{\sigma}\left[r - \rho - (1-\sigma)n\right], \tag{10}$$

which states that when the real interest rate is equal to the intertemporal discount rate, it is optimal to maintain consumption at a constant level. Further, the solution to the household optimisation problem leads to identification of the dynamic system that drives all sectors of the economy, defined by Equations (3), (4) and (5), and the allocations of inputs (6) and (7). The dynamic system thus derived serves as the basis for the analysis of transitional dynamics. The general stability properties can be analysed and the speed of convergence determined. For this purpose, we need to derive the balanced growth path[9]. As is standard in the literature, we simplify the model by employing an auxiliary assumption whereby $\dot{Y}/Y = \dot{K}/K$, which states that by dividing Equation (3) by K, we have $\dot{Y}/Y = \dot{K}/K = \dot{C}/C$ on the balanced growth path. Hence, we can unequivocally determine $\dot{K}/K$ and $\dot{A}/A$, which are given by[10]:

$$\frac{\dot{K}}{K} = \beta_K n, \;\; where\ \beta_K = \frac{\sigma_L(1-\eta_A) + \eta_L\sigma_A}{(1-\sigma_K)(1-\eta_A) - \eta_K\sigma_A} \tag{11}$$

$$\frac{\dot{A}}{A} = \beta_A n, \;\; where\ \beta_A = \frac{\eta_L(1-\sigma_K) + \eta_K\sigma_L}{(1-\sigma_K)(1-\eta_A) - \eta_K\sigma_A}. \tag{12}$$

Following Eicher and Turnovsky (1999), using Equations (11) and (12) enables us to determine the conditions for positive and balanced growth by applying the social planner solution to a general R&D-based growth model. The result is equally applicable here, because the underlying production function and the resulting balanced growth rates are structurally identical for the decentralised and centralised solutions (Steger, 2005b). Accordingly, $(1-\sigma_K)(1-\eta_A)-\eta_K\sigma_A > 0$ and $\sigma_K < 1$ are necessary and sufficient conditions for positive growth. In addition, there are three conditions related to the production function: (i) constant returns to scale; (ii) a condition of the Cobb-Douglas type; (iii) homogeneous separability in exogenously

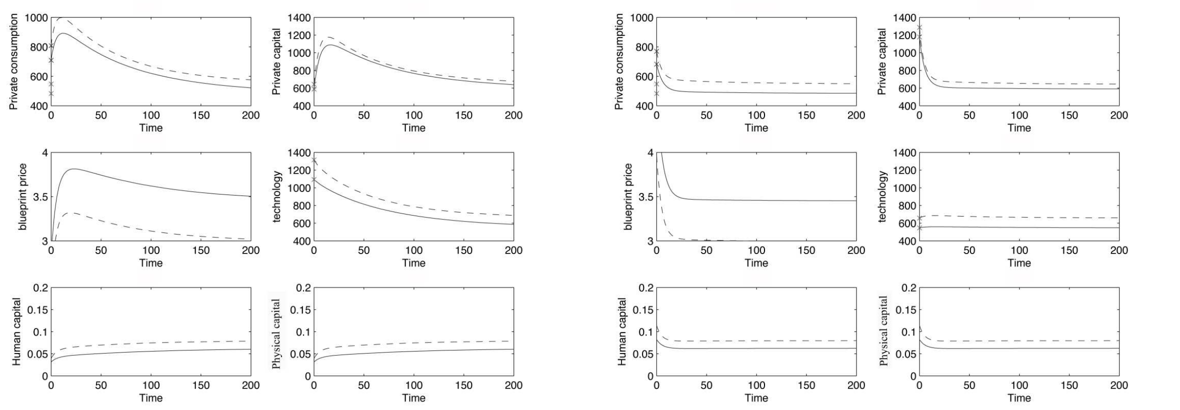
[8] Because we need to obtain the growth rate of private consumption in terms other than per-capita, we calculate the first difference of c over time and obtain $c = \frac{(\dot{C}L - C\dot{L})}{LC} = \gamma - n$, where γ is the growth rate of private consumption.

[9] As is normal, the balanced growth path is defined by the constant (possibly different) growth rates of the endogenous variables. This definition implies that the allocation variables (θ and ϕ) must be constant along the balanced growth path.

[10] The balanced growth rates of K and A can be derived from $d[Y/K]/dt = 0$ and $d[J/A]/dt = 0$ by noting that, on the balanced growth path, the allocation variables (θ and ϕ) are constant, and that $\dot{L}/L = n$.

Figure 1: Basic model simulation results

(a) Technology shock, different institutional quality levels (b) Private capital shock, different institutional quality levels



Notes: Figures 1a and 1b use parameters extracted from studies by Steger (2005a; 2005b). We have $\sigma_A = 0.3$, $\sigma_L = 0.64$, $\sigma_K = 0.36$, $\eta_A^{SO} = 0.06$, $\eta_L^P = 0.64$, $\eta_K^P = 0.36$, $\eta_L^e = 0.2$, $\eta_K^e = 0.2$, $\rho = 0.05$, $\Sigma = 1$, $n = 0.15$, $u_{netint} = 0$, $u_{comp} = 0$.The broken line maintains all of the parameters at fixed levels except for $\eta_L^e = 0.15$, $\eta_K^e = 0.15$. The figures are obtained by setting steady-state values of 600 for private consumption and private capital, a steady-state value of 900 for technology, the price of blueprints to 3, and the share of labour and capital goods in the research and development sector to 0.09.

and endogenously growing factors. The model shows even growth ($\dot{K}/K = \dot{A}/A$) in the first and third cases and uneven growth ($\dot{K}/K \neq \dot{A}/A$) in the second case. Provided one of the preceding conditions for balanced growth applies, the balanced growth rates can be written as $\dot{Y}/Y = \dot{K}/K = \dot{C}/C = \beta_K n$ and $\frac{\dot{A}}{A} = \beta_A n$.

Moreover, as is clear from the equations, the balanced growth rates are crucially determined by the structural characteristics of the technology side of the model given by the elasticities of the factors of production in FO and R&D. Given that $\eta_A = \eta_A^{SO} + (1 - \eta_K)$ and $\eta_L = \eta_L^P + \eta_L^e, \eta_K = \eta_K^P + \eta_K^e$, this implies that the negative externalities produced by low institutional quality and associated with private capital and labour, and the influence of network relationships on the accumulation of technology, structurally affect the balanced growth path. Furthermore, growth is characterised by the absence of a scale effect, i.e. growth is independent of the size of the economy, and the balanced growth rates are proportional to the growth rate of the exogenously growing factor (labour).

2.5 Simulations of the basic model

Given the dynamic system described by Equations (3), (4), (5) and(10), the two static allocations constraints (6) and (7), and rescaling the main variables using Equations (11) and (12), we obtain a comprehensive framework that can be used in simulation analysis (Trimborn et al., 2008). The aim of the analysis described here is to show that shocks to the technology and private capital affect the growth rates of private consumption, private capital and technology through the allocation of human and physical capital between the R&D and final output sectors and variations in blueprint prices, and that differences in institutional quality (as defined in subsection 2.3) influence the effects of these shocks.

Figure 1 reports the main outcomes from a simulation analysis of the effects of a symmetric shock to the technology growth rate (Panel a) and private capital (Panel b). All of the figures are obtained by setting steady-state values of 600 for private consumption and private capital, a steady-state value of 900 for technology, the price of blueprints to 3, and the shares of labour and capital goods in the research and development sector to 0.09. The parameters are in line with those adopted by Steger (2005a; 2005b). The solid line in each figure describes a value of 0.02 for η^e_K and η^e_L, and the broken line sets these parameters to 0.015. All of the figures report the effect of the shock on blueprint prices and on human and physical capital, which represent the main channels through which the shock spreads within the three different sectors of the economy described.

Given these parameters, Figure 1a shows that a 1% shock to technology A increases private capital and consumption, and that this shock influences these variables through the allocation constraints (6) and (7) and the variability of blueprint prices. The shock is not permanent, but is strongly persistent over time, because an increase in A has a positive influence on the number of intermediate goods varieties, which also influences private capital. When there is a symmetrical decrease in η^e_K and η^e_L (represented by a shift from continuous to dotted lines), all of the impulse responses are persistently differently shaped from their previous states. This result depends on variations in η^e_K and η^e_L jointly influencing the behaviour of private and human capital and technology ($\eta_A = \eta^{SO}_A + (1 - \eta_K)$. In line with the identification of the negative externalities η^e_K and η^e_L with constraints related to low institutional quality in the country, this outcome predicts that a shock has different short-run effects on A depending on the institutional framework of the economy in question. Moreover, Figure 1a shows that a symmetrical decrease in η^e_K and η^e_L alters the effect of the shock on blueprint prices, which generates a permanent change in returns gained from the realisation of a new idea. Although they are less pronounced, the results reported in Figure 1a are still valid where a symmetrical 1% shock to private capital is considered, as described by Figure 1b. Unlike in the previous case, examining private capital we find that the effect of the shock dissipates more rapidly and that variations in technology and private capital are less consistent. Where there is a symmetrical decrease in η^e_K and η^e_L (represented by a shift from continuous to dotted lines), there is a permanent change in the temporal behaviour of the impulse responses, but this change is less evident than in the previous case.

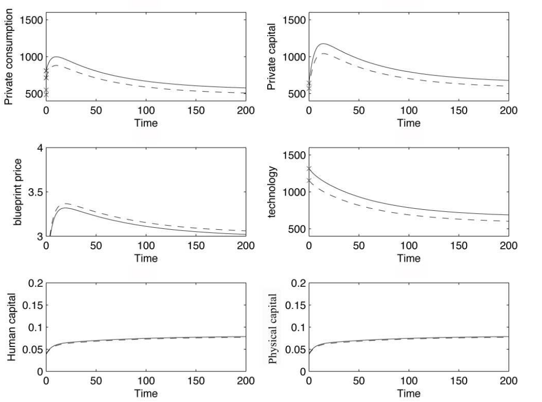
In sum, these results show that i) impulses affecting technology have an effect on all of the variables considered; ii) changes in institutional quality condition the transitional dynamics of the economic system and the balanced growth path; and iii) the effects of institutional quality permanently alter the level of impulse responses.

2.6 Simulations of the model introducing market failure

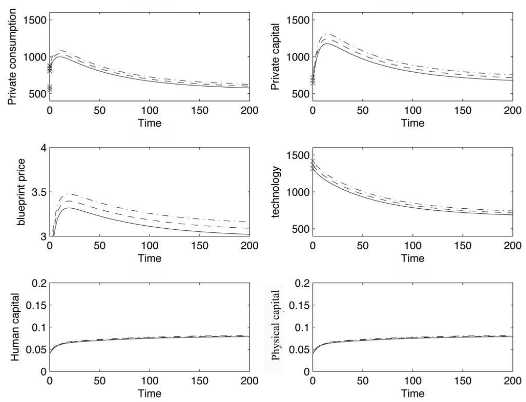
To complete the simulation analysis, we follow Steger (2005a; 2005b) by introducing into the dynamic system Equations (3), (4), (5) and (10) two market imperfections concerning the presence of monopolistic competition regime in the CG sector (u_{comp}) and the positive external effect associated with technological knowledge defined as network interaction spillovers u_{netint}. Because these market imperfections act on the allocation constraints (6) and (7) by controlling for them, we can identify the effects of η^e_K and η^e_L more precisely. To address this task, we use the same simulation structure as that employed in the previous subsection, and first impose a shift of 0.001 in u_{comp}, followed by a shift in u_{netint} from 0 to 0.001, 0.002 and 0.003. The solid lines indicates the absence of market failure, whereas the dotted lines indicate increasing market failures.

Figure 2: Results of simulations of the basic model with market failure

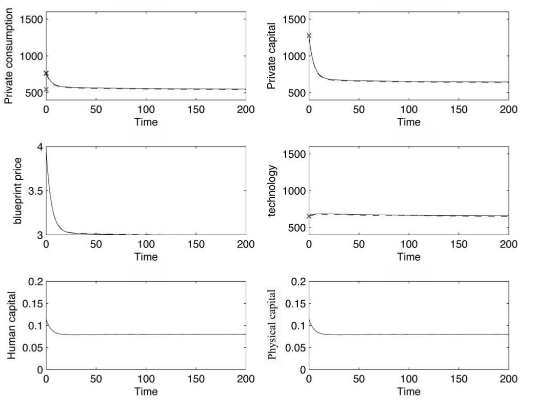
(a) Technology shock, differences in market power



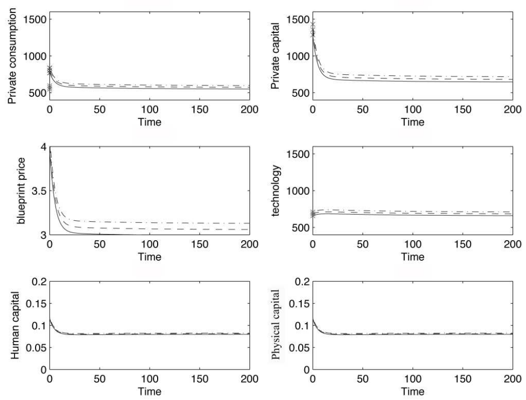
(b) Technology shock, differences in network interactions



(c) Private capital shock, differences in market power



(d) Private capital shock, differences in network interactions



Notes: Figures 2a, 2b, 2c and 2d use parameters extracted from studies by Steger (2005a; 2005b). We have $\sigma_A = 0.3$, $\sigma_L = 0.64$, $\sigma_K = 0.36$, $\eta_A^{SO} = 0.06$, $\eta_L^P = 0.64$, $\eta_K^P = 0.36$, $\eta_L^e = 0.2$, $\eta_K^e = 0.2$, $\rho = 0.05$, $\Sigma = 1$, $n = 0.15$, $u_{netint} = 0$, $u_{comp} = 0$.The broken lines in Figures 2a and 2c maintain all of the parameters at fixed levels, except $0 \geq u_{netint} \geq 0.03$. The broken lines in Figures 2b and 2d maintain all of the parameters at fixed levels, except $u_{comp} = 0.01$. The figures are obtained by setting steady-state values of 600 for private consumption and private capital, a steady-state value of 900 for technology, the price of blueprints to 3, and the shares of labour and capital goods in the research and development sector to 0.09.

Figure 2 reports the outcomes of a shock to technology (Panels a and b) and a shock to private capital (Panels c and d), respectively, taking account of the influences of the monopolistic competition regime in the CG sector and network interaction spillovers. The figure shows that differences in u_{comp} and u_{netint} mask the effects of η_K^e and η_L^e. In particular, we note that an increase in market power in the CG sector reduces the magnitude of the shift due to an exogenous shock to technology (Panel a), whereas there is no significant effect when private capital is considered (Panel c). The effect involves blueprint prices, which rise after a shock to technology. The effect increases with the values of market power in the CG sector.

The opposite effect on market power in the CG sector is shown by Panels b and d of Figure 2, where network interaction spillovers are considered. As expected, higher levels of u_{netint} increase the effects of exogenous shocks on A and K. Moreover, the effects of network interaction spillovers are similar to a decrease in η^e_K and η^e_L (Figure 1), as they increase private consumption and private and human capital, and unlike in the previous case, increase blueprint prices instead of reducing them. The influence of such market imperfections on the allocation variables do not appear to be significant. These results support our intuitions: first, increased competition and new firms entering the market spur innovation (Aghion et al. 2004; Griffith, Harrison and Macartney, 2007); second, network relationships stimulate the diffusion of knowledge (Akçomak and ter Weel, 2009; Rost, 2011; Sabatini, 2099a; Sabatini, 2009b).

2.7 Empirical model specification

Estimating the dynamic system (Equations (2), (3), (4) and (5) under static allocation constraints (6) and (7) given the steady-state values defined by conditions (11) and (12) is not a simple task. Because institutional quality constrains the accumulation of new technology and impedes the growth of returns to scale, our model belongs to the AK family and the estimation strategy has to account for recent contributions to the estimation of AK models summarised by Bond et al. (2010). Following the outline proposed by Bond et al. (2010), the simplest way to represent an AK model is as follows:

$$\gamma^c_{it} = \alpha_1 \gamma^c_{t-1} + \beta \Delta x_{it} + \zeta x_{it-1} + e_t + f_i + \Delta\epsilon_{it} \tag{13}$$

where γ_{it} is the growth rate of per-capita GDP (as a proxy for the per-capita private consumption growth rate) and x_{it} is a vector that follows conditions (11) and (12) in determining the country-specific steady-state growth rate. The first difference expression of this model formulation is obtained by assuming that the level formulation of Equation (13) contains a non-stationary process c_{it} that in the first difference is equal to $\Delta c_{it} = \theta_0 + \theta_1 x_{it-1} + u_{it}$. Moreover, unlike the model of Bond et al. (2010) described in subsection 2.4, private capital and consumption along the balanced growth path grow at a constant rate equal to $\beta_K n$ in the proposed model, whereas the long-run growth rate of technology along the balanced growth path is $\beta_A n$. This means that in this case, the vector x_{it} and its lagged value x_{it-1} account for both these conditions, such that $x_{i,t}, x_{i,t-1} = [K, A]$. Further, in line with steady-state conditions (11) and (12), the inclusion of x_{it-1} takes into account that past values of private capital and technology predict a more rapid long-run growth and that positive and significant parameters ζ associated with x_{it-1} allow for the presence of endogenous growth (Bond et al., 2010). In addition, e_t is the time fixed effect and ϵ_{it} is the error term. Because (13) is expressed in the first difference, the country-specific fixed effect drops out of the model.

Proceeding with the model outline, if we consider the steady-state in which $x_{it} = x_i$ and remember that output per worker grows at the country-specific rate g_i, we obtain

$$g_i = \frac{e_t}{1-\alpha} + \left(\frac{\zeta}{1-\alpha}\right) x_i, \tag{14}$$

where the formulation accounts for heterogeneous steady-state growth rates that increase with the share of private capital and the level of technology with respect to total output. When the parameter vector $\zeta > 0$, this hypothesis is validated. The inclusion of the steady-state path in Equation (13) allows us to identify the estimated parameters without omitted variable bias. Bond et al. (2010) estimate a simple formulation of Equation (13) by using instrumental variables to reduce the presence of serial correlation between lagged values of the dependent variable and the error term. We adopt a similar approach by using an IV estimator with an instrument matrix dated $t-2$ and earlier to allow for the expected MA(1) error structure in these first-differenced model specifications. Specifically, we use lagged observations from $t-2$ to $t-6$ on the per-capita GDP growth rate, on the growth rates of private capital and technology and on the lagged values of the last two variables by level and lagged observations dated $t-2$ and $t-3$ on a set of additional instruments (trade as a share of GDP and government spending as a share of GDP). Following this outline, Equation (13) is estimated by an ADL(p,q) model specified as:

$$\gamma_{it}^{c} = \alpha_1 \gamma_{t-1}^{c} + ... + \alpha_p \gamma_{t-p}^{c} + \beta_1 \Delta x_{it} + ... + \beta_q \Delta x_{it-q} + \zeta_1 x_{it-1} + ... + \zeta_q x_{it-q} + d_t + q_i + \delta_{it}, \tag{15}$$

where d_t is the time-specific idiosyncratic term, δ_{it} is the error term, and x_{it} is again a vector defined as $x_{it} = [K, A]$. The parameters estimated by Equation (15) are used to measure the long-run elasticities of private capital and technology with respect to per-capita GDP growth rate (called the long-run elasticity - level effect), which is given by $\bar{g}_i^L = \frac{\zeta_1 + ... + \zeta_p}{1-\alpha_1 - ... - \alpha_p} \frac{\bar{x}_i}{\bar{\gamma}_i^c}$, where $\bar{x}_i$ is a interquartile mean vector including investment in private capital and technology and $\bar{\gamma}_i^c$ is an interquartile mean vector of the per-capita GDP growth rate for each country i. This elasticity measure describes the initial steady-state level for each country, and where we use aggregated interquartile mean values for private capital, technology and the GDP growth rate, it describes the overall steady-state in the whole sample. In addition to this gauge of elasticity, we also calculate a long-run elasticity measure that accounts for the slope of the balanced growth path (called the long-run elasticity - growth effect). Similarly to the previous measure, this measure of elasticity is defined by $\bar{g}_i^G = \frac{\beta_1 + ... + \beta_p}{1-\alpha_1 - ... - \alpha_p} \frac{\bar{x}_i}{\bar{\gamma}_i^c}$.

To complete the empirical framework, after estimating the responses to private capital and technology shocks, we analyse how the of institutional variables (which identify the negative externalities η_K^e and η_L^e) disseminate these effects. We do so by estimating three auxiliary regressions that account for the direct influence of institutional variables on private capital, technology and per-capita GDP growth. It should be noted that because these equations account for short-run relationships only, we restrict the period of analysis. This means that we need in each specification to account for the long-run growth elasticities estimated in Equation (15). To accomplish this task, we include in each equation a set of specific time trends ($d\_\bar{g}_{it}$) with values that grow according to $\bar{g}_i^G$. For example, if we find that the balanced growth rate for a given country is 1.2, our specific country trend will be obtained by multiplying the specific linear trend by 1.2. Further, remembering that along the balanced growth path, private capital and consumption grow at a constant rate equal to $\beta_K n$, and that the long-run growth rate of technology along the balanced growth path is $\beta_A n$, we include country-specific time trends linked to private capital ($d\_\bar{g}_i^{Gk}$) in the first and third regressions and country dummy variables linked to technology ($d\_\bar{g}_i^{Ga}$) in the second. We specify the following auxiliary regressions:

$$\gamma_{it}^{a} = a_{21} \gamma_{t-1}^{a} + d_{21} \Delta z_{it} + d\_\bar{g}_i^{Ga} + \Delta \phi_{it} \tag{16}$$

$$\gamma_{it}^{k} = a_{11} \gamma_{1t-1}^{k} + d_{11} \Delta z_{it} + d\_\bar{g}_i^{Gk}{}_i + \Delta \mu_{it} \tag{17}$$

$$\gamma_{it}^{c} = a_{31} \gamma^{c} + d_{31} \Delta z_{it} + d\_\bar{g}_i^{Gk} + \Delta \psi_{it}. \tag{18}$$

where γ_{it}^k, γ_{it}^a and γ_{it}^c describe the growth rates of private capital, technology and per-capita GDP and z_{it} is a vector of institutional variables defined in section 3. It should be noted in particular, that the vector includes voice and accountability, government effectiveness, control of corruption, rule of law, the GINI index of income distribution, and the intensity of gas emissions. Furthermore, all of the specified equations include error terms ($\Delta\mu_{it}$, $\Delta\phi_{it}$ and $\Delta\psi_{it}$). In line with the model defined in Equation (15), the last three equations are estimated by an ADL(p,q) model under an IV estimator.

The parameters estimated from Equations (16), (17) and (18) are used to formulate short-run elasticity measures to compare the effects of institutional factors on the main variables of the model. As an example, the short-run elasticity of each institutional variable on private capital is given by:

$$e_{\gamma_{it}^k} = d_{11}\frac{\bar{\gamma}^k}{\bar{\gamma}^c}. \tag{19}$$

3 Data, variables and empirical issues

This section provides a detailed description of the variables and sources of data used to estimate Equations (15), (16), (17) and (18). The empirical analysis is based on two different period for a set of 15 European countries. The set of countries examined, along with descriptive statistics for each variable, are reported in Appendix A. Data covering the 1960-2010 period are used to estimate the steady-state country level (15), while data covering the 1996-2010 period are used to estimate Equations (16), (17) and (18) and to identify the negative externality linked to low institutional quality.

We use two different data sources to identify the main economic variables of Equation (15). The first is the Penn World Table dataset edited annually by the University of Pennsylvania. This dataset contains information on per-capita GDP growth rate at constant prices in chained series (and the corresponding per-capita growth rates) and on private capital. From this source, we extract the per-capita GDP growth rate used as a proxy for γ_{it}^c and the ratio of investment in physical capital to GDP used to measure both the growth rate of private capital γ_{it}^k and the share of private capital in GDP x_{it} in Equation (15). To account for the technology growth rate γ_{it}^a and the technology level a_{t-1}, we collect data from the AMECO database, which is redacted yearly by the Statistical Office of the European Commission. From this database, we extrapolate the annual contribution of technology to total factor productivity at constant 2000 prices.

As far as formal institutions are concerned, several indicators of institutional quality in the countries of interest are available from the literature (Carmignani, 2006). This analysis focuses on the quality of institutions in European countries to assess whether their political and economic institutions can be considered inclusive or extractive. As a guide for selection of the relevant indicators, we use a set of variables strictly related to the Europe 2020 growth strategy, which is aimed at strengthening inclusiveness and sustainable development. Thus, our empirical investigation contributes to the current debate on the growth strategy adopted by EU countries. We consider a set of variables related to the capacity of institutions to promote good governance, social inclusion and environmental sustainability, the main targets of the Europe 2020 growth strategy.

At a greater level of detail, we consider four different variables reflecting the characteristics of the political system (voice and accountability) and quality of governance (government effectiveness, control of corruption and the rule of law) (Charron, Dykstra and Lapuente, 2012; Fagerberg and Srholec, 2008). These variables are extracted from the Worldwide Governance Indicators provided by the World Bank. The WGIs bring together and summarise information from 30 existing data sources that report the views and experiences of citizens, entrepreneurs, and experts in the public, private and NGO sectors around the world on the quality of various aspects of governance. They draw on four different types of data source: surveys of households and firms (composed of data sources including the Afro-barometer survey, the Gallup World Poll, and the

Global Competitiveness Report Survey), commercial business information providers (comprising data sources including the Economist Intelligence Unit, Global Insight and Political Risk Services), non-governmental organisations (made up of data sources including Global Integrity, Freedom House and Reporters Without Borders), and public sector organisations (composed of data sources including CPIA assessments of the World Bank and regional development banks, the EBRD Transition Report and the French Ministry of Finance Institutional Profiles Database). From these data sources we first extract data on the voice and accountability variable, which captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, and of freedom of expression, freedom of association and a free media. Second, we draw observations on government effectiveness, a variable that captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressure, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The third type of data we extract comprises perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests, which is used as a proxy for the control of corruption. In contrast, the rule of law variable captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police and the courts, as well as the likelihood of crime and violence.

To these variables, we add two more indicators that reflect, with respect to other dimensions, whether the government is inclusive or extractive: the social and environmental sustainability of institutions. By taking account of social sustainability, we emphasise the literature that investigates the link between institutions and income distribution. Bad institutions increase income inequality because higher-income groups cope better with institutional inefficiencies than do lower-income groups (Carmignani, 2006). Moreover, high-quality institutions reduce income inequality by inducing non-educated workers to invest in education, thus fostering human capital accumulation (Dias and Tebaldi, 2012). We follow these analyses by adopting the GINI index of income distribution in purchasing power parity constant terms in year 2005 as a proxy of the social sustainability of institutions. Furthermore, according to the targets defined by the Europe 2020 strategy, we employ variations in energy intensity as a proxy capturing the degree of environmental sustainability assured by the institutional context. These observations are extracted from the Human Development Report redacted yearly by the United Nations.

In addition to these indicators, we collect observations for variables accounting for the market imperfection controls that emerge in the model. The first control, which is linked to the competitiveness of the domestic economy, is measured by the Economic Freedom of the World Index. This index published by the Economic Freedom of the World (EFW) is designed to measure a country's institutions and policies on a comparative basis. The key ingredients of this index are based on objective components (for example, government consumption as a share of total consumption, or transfers and subsidies as a share of GDP) collected from external sources including the International Monetary Fund, the World Bank and the World Economic Forum, as well as data based on surveys, expert panels and case studies. The scores for these variables are categorised into five main areas of economic freedom: i) size of government; ii) legal structure and security of property rights; iii) access to finance and sound money; iv) freedom to trade internationally; and v) regulation of credit, labour and business. The final score for the aggregate EFW index, which ranges from 1 to 10, where 10 represents the maximum degree of economic freedom, is obtained as the mean value of these components. This indicator is thus related to various aspects of the competitiveness and functioning of markets resulting from political decision-making.

Table 1: Levin-Lin-Chu and Im-Pesaran-Shin tests for unit-root in heterogeneous panels

	Levin-Lin-Chu with trend	Levin-Lin-Chu	Im-Pesaran-Shin with trend	Im-Pesaran-Shin
a_{t-1}	-3.644	-3.697	2.013	4.838
	(0.037)	(1.000)	(0.978)	(1.000)
hp_a_{t-1}	-8.521		-3.114	
	(0.999)		(0.000)	
k_{t-1}	-9.543	-11.287	-3.979	-2.922
	(0.012)	(0.057)	(0.000)	(0.002)
γ^c	-8.402	-9.412	-2.800	-1.792
	(1.000)	(1.000)	(0.0039)	(0.037)
γ^a	-8.182	-11.667	-3.175	-3.957
	(1.000)	(1.000)	(0.001)	0.000)
γ^k	-8.402	-9.412	-2.800	-1.792
	(1.000)	(1.000)	(0.003)	(0.037)

Notes:The first two columns report Levin-Lin-Chu test statistics (Levin et al., 2002) with and without a linear trend, whereas the last two columns report Im-Pesaran-Shin test statistic (Im et al., 2003) with the same specification. The number of lags used in the test statistics is three. The null hypothesis in the Levin-Lin-Chu test statistic is the absence of a unit-root in the series, whereas the null hypothesis in the Im-Pesaran-Shin test statistic allows for the presence of a unit-root in the series.

In addition, to incorporate the second market imperfection control into the model, we identify network interaction spillovers as a measure of overall trust. As is common in the literature (Dearmon and Grier, 2011; Knack and Keefer, 1997), we measure trust by responses to question from the World Values Survey dataset (European Values Study Group and World Values Association, 2006): "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?" In most of the literature (Tabellini, 2010; Zak and Knack, 2001; Charron and Lapuente, 2012), this variable is used to capture different cultural values (generalised trust) that affect the informal rules of the game, the functioning of formal institutions and differences in economic performance.

These last two measures accounting for market imperfection, are used to set two dummy variables with values equal to one when the level of economic freedom and the level of overall trust in a country, respectively, are higher that the interquartile mean of the full sample analysied over the 1996-2010 period. These two dummy variables are then used to divide the full-sample into four sub-samples defined as: i) high trust; ii) low trust; iii) high competition; and iv) low competition. Appendix A reports the countries in each sub-sample.

4 Results

This section provides an extensive overview of the results obtained by following the estimation strategy outlined in subsection 2.7. The analysis is based on a sample of EU-15 countries and uses two different data ranges: a longer period (from 1970 to 2010) is used to estimate the long-run relationship described in Equation (15), and a shorter period is used to estimate Equations (16), (17), (18).

As a preliminary analysis, Table 1 reports the Levin-Lin-Chu (Levin et al., 2002) and Im-Pesaran-Shin (Im et al., 2003) unit-root test statistics for all of the main variables included in the long-run regression, specified with and without a linear trend. The second test statistic may be more powerful for heterogeneous panels because it is based on an appropriately standardised average of the individual augmented Dickey-Fuller test, and has a standard normal limiting distribution. In more detail, the Levin-Lin-Chu test statistics has as its null hypothesis the absence of a unit-root in the series, whereas the presence of a unit-root in the series is the null hypothesis in the Im-Pesaran-Shin test statistic. In line with the Equation (15), we conduct the tests on both the level and the first difference of private capital and technology and on the growth

Table 2: Baseline specifications: pooled results in first differences

	Full-sample	Full-sample	High network interaction sub-sample	Low network interaction sub-sample	High competition sub-sample	Low competition sub-sample
γ^c_{it-1}	0.488***	0.593***	0.996***	0.439***	1.229***	0.322***
	(0.152)	(0.111)	(0.085)	(0.149)	(0.119)	(0.123)
γ^c_{it-2}	0.077*	0.052*	-0.049	-0.013	-0.317***	0.216***
	(0.054)	(0.039)	(0.067)	(0.047)	(0.062)	(0.057)
γ^c_{it-3}	0.085*		-0.064*	0.245***	0.031	0.133*
	(0.058)		(0.037)	(0.056)	(0.051)	(0.074)
γ^k_{it}	0.108***	0.102***	0.131***	0.048**	-0.033	0.100***
	(0.024)	(0.022)	(0.024)	(0.025)	(0.028)	(0.022)
γ^k_{it-1}	-0.019	-0.030*	-0.122***	-0.000	0.003	-0.027*
	(0.017)	(0.017)	(0.011)	(0.008)	(0.015)	(0.017)
γ^k_{it-2}	0.004	0.001	-0.003	-0.001	-0.004	-0.025**
	(0.008)	(0.008)	(0.012)	(0.007)	(0.007)	(0.013)
γ^k_{it-3}	-0.016***		-0.036***	-0.010*	-0.024***	-0.022***
	(0.006)		(0.007)	(0.006)	(0.007)	(0.009)
γ^a_{it}	0.846***	0.875***	0.500***	1.000***	1.290***	0.726***
	(0.087)	(0.090)	(0.075)	(0.119)	(0.103)	(0.095)
γ^a_{it-1}	-0.326***	-0.417***	-0.551***	-0.365***	-1.199***	-0.157*
	(0.122)	(0.087)	(0.073)	(0.161)	(0.129)	(0.089)
γ^a_{it-2}	-0.030	-0.009	0.096**	0.051	0.350***	-0.071*
	(0.058)	(0.054)	(0.044)	(0.045)	(0.076)	(0.048)
γ^a_{it-3}	-0.015		0.078*	-0.177***	-0.143***	-0.002
	(0.051)		(0.055)	(0.052)	(0.065)	(0.067)
k_{it-1}	0.025***	0.025***	0.021**	0.019*	0.003	0.002
	(0.010)	(0.009)	(0.010)	(0.013)	(0.011)	(0.021)
hp_a_{it-1}	0.079***	0.095***	-0.042	0.098***	0.118***	0.031
	(0.036)	(0.039)	(0.035)	(0.033)	(0.033)	(0.057)
Time fixed effect	yes	yes	yes	yes	yes	yes
Long-run elasticity growth effect private capital	0.025	0.025	0.004	0.020	0.007	0.021
Long-run elasticity level effect private capital	0.692	0.697	3.045	0.590	-	-
Long-run elasticity growth effect technology	0.726	0.679	1.00	0.752	1.868	0.730
Long-run elasticity level effect technology	0.117	0.141	-	0.160	0.740	-
Hansen J test	10.098	10.517	8.162	9.154	10.129	10.381
	0.607	0.651	0.772	0.690	0.605	0.583
Log-likelihood	-613.970	-630.682	-233.069	-351.247	-322.153	-284.234
Number of observations	450	450	180	270	240	210

Notes: The dependent variable is the growth rate of per-capita GDP. Standard errors are reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05 and 0.01 levels, respectively. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates. The set of instrumental variables common to all specifications are dated $t-2$ and earlier to allow for the MA(1) error structure in these first-differenced model specifications. In more detail, we use lagged observations dated to $t-2$ on $t-6$ of the log value of per-capita GDP and the share of private capital in GDP and technology, and employ lagged observations dated $t-2$ and $t-3$ on a set of additional instruments (trade as a share of GDP and government spending as a share of GDP). The instrumental variables are the first lag of the growth rate of per-capita GDP and the levels and first differences of the shares of private capital and technology. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.

rate of per-capita GDP. A comparison of these test statistics shows that the share of private capital in GDP rejects the null-hypothesis of stationarity when Levin-Lin-Chu test statistics without a linear trend are considered, whereas the unit-root hypothesis is rejected by the Im-Pesaran-Shin test statistics in both the specification with and the specification without a linear trend. In contrast, the unit-root hypothesis is not rejected by Im-Pesaran-Shin test statistics when technology is considered. However, to maintain coherence with specification (15), instead of first differencing this variable, we use a standard Hodrick–Prescott filter to extract the linear trend from the series, then use only the residual component in the long-run estimations: hp_a_{it-1}. As confirmed by the statistics reported in Table 1, this new variable is stationary.

Table 2 reports estimates of our baseline specification of the long-run growth rate of GDP based on Equation (15) in which time fixed effects are included. The set of instrumental variables common to all of the specifications are dated $t-2$ and earlier to allow for the MA(1) error structure in these first-differenced model specifications. In more detail, we use lagged observations dated $t-2$ to $t-6$ on the log value of per-capita GDP and the share of private capital in GDP and technology, and employ lagged observations dated $t-2$ and $t-3$ on a set of additional instruments (trade as a share of GDP and government spending as a share of GDP). The instrumental variables are the first lag of the growth rate of per-capita GDP γ^c_{it-1} and the levels and first differences of the shares of private capital (k_{it-1}, γ^k_{it}) and technology (hp_a_{it-1}, γ^a_{it-1}). The instruments chosen in line with Bond et al. (2010) are validated by the Sargan-Hansen test statistics. Standard errors robust to heteroskedasticity and autocorrelation are used across all of the reported estimates (see Cushing and McGarvey, 1999 for a discussion).

The first column of Table 2 reports the results for a general dynamic specification with up to three lags, and the second column excludes one lag from all of the variables. The next two columns report estimates for the high/low network interaction sub-samples, and the last two columns show estimates for the high/low market competition sub-samples. Long- and short run elasticity measures are reported for each specification at the bottom of the table. The IV estimates produced by our general dynamic model largely suggest that private capital and technology exert significantly positive long-run effects on both the slope and the level of the long-run growth path of GDP, although the effect of the share of private capital is not significant when we distinguish between the low and high competition sub-samples. The effect of technology remains insignificant in the high network interaction and low market competition sub-samples. The long-run parameters are quite stable along specifications ranging between 0.019 and 0.025 for k_{it-1} and between 0.079 and 0.118 for hp_a_{it-1}. As expected, the range of parameters for k_{it-1} is higher than that estimated by Bond et al. (2010), who find parameters ranging between 0.0075 and 0.0189 for the same variable. However, our analysis does not account for lower income countries, and it uses a different sample period to that examined by Bond et al. (2010). Unlike the analysis of Bond et al. (2010), the exclusion of one lag value for each variable (column II) does not change the main results.

These pooled estimates produced by our model suggest that increasing the share of private capital or technology has a quantitatively and statistically significant effect on the long-run growth rate of GDP. In particular, when measuring long-run elasticity a permanent 1% increases in technology predicts an upward shift of about 0.11% in the long-run growth path, whereas the same variation in the private capital share predicts a slope variation of about 0.69 %. The values of the elasticity measures vary, especially among the high network interaction sub-sample, in which a permanent 1% increase in the share of private capital predicts a 3% jump in the long run growth path, while an upward shift of only 0.59% is found among the low network interaction sub-sample. In results opposite to those for the share of private capital, we find that the primary effect of a change in technology is on the slope, rather than the level, of the long-run growth path. Indeed, a 1% increase in long-run elasticity associated with the growth effect of technology lifts the slope of the long-run growth path by about 0.7%, with the magnitude of the upward shift increasing among the high network interaction (1%) and high market competition (1.86%) sub-samples. In line with the simulation results presented in subsections 2.5 and 2.6, we find that variations in technology (long-run elasticity - growth effect of technology) produce higher variations in the GDP growth rate than do variation of the same magnitude in the share of private capital. Moreover, in line with our theoretical framework, policies that improve network interactions and market competition result in considerable changes in elasticity measures.

Proceeding with the outline described in subsection 2.7, Table 3 reports the estimation results for the dynamic equation of the technology growth rate described in (16). The reported specifications use the same set of instruments as those described before and standard errors robust to heteroskedasticity and autocorrelation (Cushing and McGarvey, 1999). Moreover, the use of one lag for the endogenous variable γ^a_{it-1} according with the Ackaike and Schwarz information criteria (not reported), and is avoided by employing the residual serial correlation LM test, which accepts the null hypothesis of no serial correlation in the residuals for all

Table 3: Pooled results for the regression of inclusive institutions on technology growth

	I		II		III		IV		V		VI	
γ^a_{t-1}	0.403	***	0.436	***	0.410	***	0.426	***	0.488	***	0.519	***
	(0.049)		(0.046)		(0.047)		(0.047)		(0.044)		(0.051)	
Voice and accountability	0.072	***										
	(0.013)											
Government effectiveness			0.046	***								
			(0.008)									
Control of corruption					0.046	***						
					(0.007)							
Rule of law							0.055	***				
							(0.010)					
GINI index									0.016	**		
									(0.007)			
Variance in energy intensity											-0.011	*
											(0.008)	
Technology fixed effect	yes		yes		yes		yes		yes		yes	
Short-run elasticity Full-sample	1.125		0.906		0.895		0.977		0.462		-0.025	
Short-run elasticity High network interaction	0.649		0.678		0.684		0.471		-0.014	-		
Short-run elasticity Low network interaction	1.292		1.047		1.014		1.020		1.064		-0.050	
Short-run elasticity High competition	1.084		0.875		0.903		0.931		0.718		-0.041	
Short-run elasticity Low competition	0.826		0.697		0.616		0.716		0.577		-	
Hansen J test	15.766		15.665		15.585		15.622		15.478		15.129	
	0.609		0.616		0.621		0.619		0.629		0.653	
Log-likelihood	-624.705		-627.011		-625.698		-626.783		-625.075		-560.782	
Number of observations	315		315		315		315		311		279	

Notes: The dependent variable is the growth rate of technology. Standard errors are reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05 and 0.01 levels, respectively. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.The set of instrumental variables common to all specifications are dated $t-2$ and earlier to allow for the MA(1) error structure in these first-differenced model specifications. In more detail, we use lagged observations dated to $t-2$ on $t-6$ of the log value of per-capita GDP and the share of private capital in GDP and technology, and employ lagged observations dated $t-2$ and $t-3$ on a set of additional instruments (trade as a share of GDP and government spending as a share of GDP). The instrumental variables are the first lag of the growth rate of per-capita GDP and the levels and first differences of the shares of private capital and technology. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.

specification (not reported). The six columns of Table 3 report the results for specifications respectively including the sequential addition of each of the identified variables, describing low levels of institutional quality that reflect the theoretical outline in accounting for the negative externality η^e. In greater detail, we consider four variables measuring institutional factors: voice and accountability, government effectiveness, control of corruption and the rule of law. We include the GINI index of income distribution to account for social sustainability, and consider variations in energy intensity to gauge environmental sustainability. The sequential inclusion of these variables crucially depends on strong correlations between the different identified elements, which may bias the estimated parameters, and accordingly the elasticity measures reported after the estimated parameters. Along with short-run elasticity measures for the full-sample analysis, we report another four sets of measures obtained by replicating the analysis reported in Table 2 for each sub-sample. Where the estimated parameters for each of the sub-samples are not statistically significant, we omit the corresponding elasticity measure.

The first line of Table 3 accounting for voice and accountability reveals that the extent to which a country's citizens are able to participate in selecting their government, freedom of expression, freedom of association and a free media have the greatest effect on the growth rate of technology, with a coefficient of 0.072. This empirical result is in line with the results of studies on the effect of political institutions on economic growth (Knack and Keefer, 1997; Tabellini, 2010; Zak and Knack, 2001), and is consistent with the analyses of relationships between good institutions, innovation and growth discussed in the previous section (Dias and Tebaldi, 2012; Tebaldi and Elmslie, 2008, 2013). A similar consideration may also be applied when the rule of law is taken into account. Efficient judicial institutions are crucial for innovation because they guarantee the protection of property rights (Haggard and Tiede, 2011). Especially in the advanced world context, when the cost of innovation increases, an efficient judicial system strengthens incentives for firms to make risky investments in innovative products. The importance of the political institutions and quality of governance described by these first two variables is also evidenced by the short-run elasticity measures reported in the middle of the table. The first column demonstrates that a 1% variation in voice and accountability lifts technology growth rate by about 1.12%, with a maximum value of 1.29% among the low network interaction sub-sample. Moreover, a 1% increase in the rule of law increases the technological growth rate by about 0.97%, with a maximum value of about 1.02% in the low network interaction sub-sample. As expected, the effects of these two variables are more important in the low trust and low competition sub-samples.

Continuing with the estimation outline presented in subsection 2.7, columns II and III report results for the influence of corruption control and government effectiveness on the technology growth rate. Following previous contributions to this field of research (d'Agostino et al., 2012; Pieroni and d'Agostino, 2013), the control of corruption variable captures the political dimension of corruption, and is more strongly linked to political power, whereas government effectiveness may also be seen as a proxy for the bureaucratic dimension of corruption, having a greater link to the effectiveness of services provided by government to firms and citizens. On this basis, the positive influence these variables appear to exert the less advanced economies. Nonetheless, despite the lower levels of corruption perceived in EU-15 countries, our estimates suggest that corruption is also an issue relevant to highly developed countries, as it conditions their rates of technological progress. This result is in line with the findings of Salinas-Jimenez and Salinas-Jimenez (2006). When short-run elasticities are considered, we find that 1% variation in control of corruption or government effectiveness produces about a 1% increase in technology growth, and that these effects are greater in the low network interaction sub-sample.

The last two columns of Table 3 report estimation results for the GINI index of income distribution and variations in energy intensity. The positive sign of the first variable (the parameter of the GINI index is 0.016) could be seen as counterintuitive: following our hypothesis, inclusive institutions, which are also those that provide for more equitable income distribution, positively affect technological progress. One possible explanation for this finding concerns the reliability of the Gini coefficient measure, because our data refer to gross inequality rather than ex post income inequality (i.e., income measured net of redistributive public expenditure). However, even when we recognise this drawback due to the lack of available data, we can reconcile the estimated result with our framework, considering that inventions are characterised by a high degree of uncertainty and require the concentration of high-ability individuals and resources in technologically advanced sectors (Banerjee and Duflo, 2003; Galor and Tsiddon, 1997). During the process of diffused innovation across the overall economy, once new technologies become more accessible, the positive relationship between inequality and technological change declines and disappears in the long-run. Our estimate is thus in line with analyses showing that technological inventions produce co-movement between technological progress and income inequality in the short run (Banerjee and Duflo, 2003; Galor and Tsiddon, 1997). This argument may explain why we find short-run elasticity in technology for the GINI index of about 0.40, whereas the positive influence of income inequality dissipates in estimates related to private capital and GDP growth. Partial confirmation of this insight emerges when we consider high network interaction sub-sample. In this case, the sign of the elasticity coefficient is reversed, and we find that a 1% increase in the GINI index reduces technological growth. Because this sub-sample includes all countries where informal rules create fertile ground for cooperation, particularly among small and medium firms, we can argue that where income distribution is more equitable and generalised trust is high, the risks of innovative activities, tacit knowledge and information are shared among firms connected by dense network relationships, thus promoting innovation. In other words, when social cohesion is strong, cooperation spurs both inventions and

Table 4: Pooled results for regression of inclusive institutions on private capital growth

	I		II		III		IV		V		VI	
γ^k_{t-1}	0.756	***	0.801	***	0.767	***	0.731	***	0.704	***	0.543	***
	(0.063)		(0.066)		(0.061)		(0.058)		(0.058)		(0.060)	
Voice and accountability	0.049											
	(0.037)											
Government effectiveness			0.056	**								
			(0.030)									
Control of corruption					0.036	*						
					(0.016)							
Rule of law							0.017					
							(0.028)					
GINI index									-0.023	**		
									(0.012)			
Variance in energy intensity											-0.229	***
											(0.051)	
Private capital fixed effect	yes		yes		yes		yes		yes		yes	
Short-run elasticity Full-sample	-		2.272		1.444		-		-1.444		-1.089	
Short-run elasticity High network interaction	-		-		-		-		-5.571		-3.908	
Short-run elasticity Low network interaction	-		3.077		2.543		-		-2.209		-0.394	
Short-run elasticity High competition	-		-		-		-		-		-3.808	
Short-run elasticity Low competition	1.656		1.323		0.887		-		-		-0.559	
Hansen J test	17.772		18.427		18.017		17.122		17.150		17.084	
	0.471		0.428		0.455		0.515		0.513		0.517	
Kleibergen-Paap test	16.095		15.991		15.612		15.837		16.890		17.544	
	0.651		0.658		0.683		0.668		0.597		0.553	
Log-likelihood	-1000.118		-1004.553		-1001.226		-997.784		-981.662		-848.406	
Number of observations	300		300		300		300		296		264	

Notes: The dependent variable is the growth rate of private capital as a share of GDP. Standard errors are reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05 and 0.01 levels, respectively. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.The set of instrumental variables common to all specifications are dated $t-2$ and earlier to allow for the MA(1) error structure in these first-differenced model specifications. In more detail, we use lagged observations dated to $t-2$ on $t-6$ of the log value of per-capita GDP and the share of private capital in GDP and technology, and employ lagged observations dated $t-2$ and $t-3$ on a set of additional instruments (trade as a share of GDP and government spending as a share of GDP). The instrumental variables are the first lag of the growth rate of per-capita GDP and the levels and first differences of the shares of private capital and technology. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.

more rapid diffusion of innovations.

Our hypothesis on energy intensity is that inclusive institutions provide incentives for the adoption of the best available technologies, particularly for those that are more environmentally friendly (Acemoglu et al., 2012). Indirectly, this hypothesis is consistent with the Porter hypothesis, which states that properly designed environmental regulation can stimulate innovation (Lanoie et al., 2011; Porter and van der Linde, 1995). Our empirical results confirm that nations that adopt a strategy of sustainable growth, proxied by lower energy intensity variation, achieve more rapid technological change.

Table 4 presents the results for the dynamic equation of the growth rate of investment in physical capital described in (17). The table is organised in the same manner as Table 3. The estimated results generally show that when assessing growth in the share of private capital, not all characteristics of inclusive institutions are statistically significant. Columns II and III demonstrate that control of corruption has a strong positive influence (through either its political or bureaucratic dimension) whereas columns V and VI show that the GINI index and energy intensity variation have strong negative effects. Taking voice and accountability and the rule of law into account produces insignificant results. In greater depth, the short-run elasticity measures (reported in the middle of the table), highlight some interesting findings. First, although 1% increase in voice and accountability boosts private capital growth by about 1.6% when low competition sub-sample is taken into account, the results for this variable are not significant in either the full-sample or the other sub-samples. Second, similar to the elasticity results for technological growth, we find strongly positive elasticities for corruption control and government effectiveness of 2.272% and 1.444% respectively. This means that small variations in these variables may also result in significant variations in the growth rate of the share of private capital. Moreover, it demonstrates that government effectiveness in particular conditions this growth rate. This result is not surprising, and is in line with findings reported in extensive literature on the relationship between corruption and private capital, identifying the crowding-out effect of corruption on private investment as one of the most important channels through which corruption spreads into the economic system (Mauro, 1995; Mauro, 1996). The magnitude of our elasticity measures still grows in the low network interaction sub-sample, showing that a 1% increase in government effectiveness raises private capital share growth by about 3%, that the same size shock to corruption control lifts private capital share growth by about by about 2.5%.

Moreover, greater inequality in income distribution and positive variations in energy intensity reduce the rate of growth in the private capital share of GDP. Our findings that inequality has a negative influence on investment and thus on economic growth is in line with that of García-Peñalosa and Wen (2008), who argue that redistribution provides insurance to agents undertaking risky activities, which reduces income uncertainty, thus inducing more entrepreneurship. This result also confirms the well-established relationship between inequality and institutions: a robust body of literature establishes that the inequitable distribution of resources creates rent-seeking policies and exploitative and inefficient economic institutions that stifle entrepreneurship and growth (Acemoglu, Johnson and Robinson, 2001; Banerjee and Iyer, 2005; Engerman and Sokoloff, 2005). As a consequence, reducing high levels of inequality is important in influencing the quality of institutions to remove socio-institutional frictions that hinder investment and economic growth. Returning to the estimation results, the short-run elasticities for the GINI index are up to three times greater in the high network interaction sub-sample than in the full-sample, for which the measure is -1.444%. A similar effect is found for variations in energy intensity: the short-run elasticity measures for energy intensity variation in the high network interaction and high competition sub-samples are three times greater than those in the full-sample analysis. Once again, these results show that the sub-samples chosen for this study are crucial in giving a clear and comprehensive view of the link between private investment growth and inclusive institutions.

As a final step to complete the outline described in subsection 2.7, Table 5 reports the estimates for the per-capita GDP growth rate taking account of the six different variables linked to inclusive institutions. As the table shows, all of the variables other than the GINI index of income distribution are statistically significant with the expected signs. The GINI index has a significant direct effect only in the high network interaction and high competition sub-samples. In these contexts, as shown by the short-run elasticity measures reported in the middle of the table, we find that income distribution becoming more unequal has a negative effect on the per-capita GDP growth rate. A similar pattern appear when energy intensity variations are considered. In addition, where we find a significant effect in the full-sample analysis for energy intensity variations, the short-run elasticity measures for the high network interaction and high competition sub-samples are higher than those for the other two sub-samples. However, the opposite pattern emerges when the institutional components are considered. Similar to the estimates obtained for technology, we find that voice and accountability (column I) and the rule of law (column IV), as characteristics of the efficiency of political and judicial powers, have highly significant effects on the economic growth rate. In particular, the short-run elasticity measures shows that a 1% increase in voice and accountability lifts γ_t^c by about 0.60%, while the effect of a 1% variation in the rule of law is about 0.45%. This pattern in the elasticity results becomes more pronounced when we consider countries with low network interactions. Furthermore, they remain valid when control of corruption and government effectiveness are considered. We find strong effects in this case, especially in countries with low network interactions. Moreover, looking at the combined

Table 5: Pooled results for regression of inclusive institutions on per-capita GDP growth

	I	II	III	IV	V	VI
γ^c_{t-1}	0.665 ***	0.681 ***	0.635 ***	0.648 ***	0.747 ***	0.742 ***
	(0.081)	(0.074)	(0.056)	(0.058)	(0.047)	(0.051)
Voice and accountability	0.085 ***					
	(0.027)					
Government effectiveness		0.059 ***				
		(0.018)				
Control of corruption			0.057 ***			
			(0.013)			
Rule of law				0.056 ***		
				(0.015)		
GINI index					0.001	
					(0.008)	
Variance in energy intensity						-0.075 ***
						(0.017)
Private capital fixed effect	yes	yes	yes	yes	yes	yes
Short-run elasticity Full-sample	0.593	0.522	0.504	0.443	-	-0.078
Short-run elasticity High network interaction	-	-	-	-	-0.234	-0.081
Short-run elasticity Low network interaction	1.046	1.320	1.179	0.860	-	-0.059
Short-run elasticity High competition	0.462	0.411	0.415	0.332	-0.208	-0.103
Short-run elasticity Low competition	0.348	0.241	0.183	0.172	-	-0.038
Hansen J test	26.867	24.005	19.919	18.895	17.099	17.836
	0.082	0.155	0.337	0.398	0.516	0.467
Kleibergen-Paap test	26.065	24.577	18.691	18.349	18.496	18.227
	0.128	0.175	0.477	0.499	0.490	0.507
Log-likelihood	-671.993	-671.027	-671.644	-673.001	-664.093	-578.284
Number of observations	300	300	300	300	296	264

Notes: The dependent variable is the growth rate of per-capita GDP. Standard errors are reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05 and 0.01 levels, respectively. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.The set of instrumental variables common to all specifications are dated $t-2$ and earlier to allow for the MA(1) error structure in these first-differenced model specifications. In more detail, we use lagged observations dated to $t-2$ on $t-6$ of the log value of per-capita GDP and the share of private capital in GDP and technology, and employ lagged observations dated $t-2$ and $t-3$ on a set of additional instruments (trade as a share of GDP and government spending as a share of GDP). The instrumental variables are the first lag of the growth rate of per-capita GDP and the levels and first differences of the shares of private capital and technology. Standard errors robust to heteroskedasticity and autocorrelation are used across all reported estimates.

short-run elasticity measures linked to institutional factors (columns I-IV), we find that improving each institutional factor by 1% directly increases the per-capita GDP growth rate by about 2%. This direct effect becomes even more prominent when indirect links through private capital and technology are added to the analysis.

5 Conclusions

The main focus of this paper is to explore the relationship between inclusive institutions, innovation and economic growth. We provide a coherent theoretical framework for this relationship and describe an empirical analysis consistent with the proposed model. Our empirical investigation yields a number of policy implications regarding the economic growth priority of EU strategy. In sum, our empirical findings first demonstrates that improvements in political institutions and the quality of the governance have significantly positive effects on the growth of technology and investment, and that these effects are magnified in a context characterised by low levels of trust and competition. Second, while a more equitable distribution of income spurs investment, the influence of a reduction in income inequality on technology growth is significant only when generalised trust is high. Third, environmentally sustainable institutions positively affect technology and investment growth and directly increase GDP growth, especially in countries with high levels of trust and competition. Fourth, the direct effects of political institutions and good governance on GDP growth are broader in countries with a low level of trust, while the effect of income inequality on GDP growth is significantly negative in countries characterised by high levels of trust and competition.

Our results provide compelling evidence that to improve economic performance, national policies should prioritise interventions targeting social and institutional conditions. To be effective, traditional policies of subsidising firms for innovation and providing incentives to innovate, must be accompanied by appropriate social and institutional conditions delivering the kind of interaction and feedback that translate innovative efforts into economic growth. As a consequence, reforming institutions with the aim of improving governance, social inclusion and environmental sustainability may generate strong incentives for knowledge diffusion and the adoption of technological innovation, thus promoting economic growth.

Our empirical analysis also provides an other interesting policy implication. Our estimates show that to be effective, a strategy of institutional reforms in Europe aimed at increasing social inclusion, innovation and economic growth should be targeted at the specific mix of social, institutional and economic features present in each European country. As we have seen, the effects of reforms of the political system, quality of governance, and the social and environmental sustainability of policies are on balance sensitive to informal rules (network interactions) and the degree of market competitiveness. The implication of this result is that the strategy defined by Europe 2020, which identifies general targets without considering the relationship among different institutions in specific contexts or addressing the appropriate sequencing of reforms, could either smooth or nullify the effects of policies adopted by individual European countries.

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