Knowledge and Social Capital:  
Increasing Returns in Regional Growth

Roberta CAPELLO*, Andrea CARAGLiu*,** and Peter NIJKAMP**

Abstract
Knowledge drives the growth of nations and regions in a competitive space–economy. Hence, we would expect a strong correlation between investments in knowledge and learning processes, on the one hand, and productivity increases, on the other. However, the empirical evidence shows consistent discrepancies between knowledge inputs and economic performance across geographical units.

This paper addresses this issue from a regional perspective, by highlighting theoretically and empirically the strategic importance played by social capital in mediating between knowledge production and regional growth. The main proposition of the paper, subject to empirical testing, is that social capital amplifies the contribution of knowledge by determining the formation of increasing returns to knowledge exploitation.

1. Introduction

Culture exerts a powerful influence on economic performance. The way people are interacting with each other, the rules of such interactions and the punishment for infringements of such (usually informal) rules are a major determinant for the effectiveness of combining production factors, and may ultimately enhance our understanding of long-run growth processes. This argument is among others put forward by growth economists (Guiso et al. 2006, Barro 1997) and economic historians (Landes 1999 and Greif 2006, the latter arguing that culture is a necessary complement to institutions, representing the most important determinant). It is clearly a major temptation to indulge in an easy explanation, and to find a positive correlation between sound institutions, a competitive environment protecting private property and guaranteeing the rules of law, and a diffuse climate of work ethics on the one hand and economic success on the other. However, evidence from different countries, time periods and spatial scales suggest that indeed culture is a major ingredient for innovation and economic growth.

Much less clear is the role played by culture in terms of easing the creation, exploitation

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and diffusion of knowledge. Figure 1 shows the relationship between a measure of regional knowledge, viz. the percentage of citizens holding an ISCED 5 or 6 degree\(^1\), a standardized measure of social capital\(^2\) and the growth of regional GDP in the 27 countries of the European Union (EU27) between 1999 and 2005.

The shaded grey hyperplane represents the best fit of the relationship among the variables, which is positive and suggests some evidence on the existence of synergies among social capital and regional knowledge in the generation of regional performance.

This paper aims at exploring new horizons in this field by arguing that social capital may enhance the generation of increasing returns to knowledge exploitation at the regional level. In order to do so, the following steps will be followed. In Section 2, the relevant literature on social capital, and in particular how this concept can be related to knowledge, is critically

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\(^1\) “The International Standard Classification of Education (ISCED) was designed by UNESCO in the early 1970’s to serve ‘as an instrument suitable for assembling, compiling and presenting statistics of education both within individual countries and internationally’. It was approved by the International Conference on Education (Geneva, 1975), and was subsequently endorsed by UNESCO’s General Conference when it adopted the Revised Recommendation concerning the International Standardization of Educational Statistics at its twentieth session (Paris, 1978)” (from unesco.org).

\(^2\) This measure is actually used in the empirical section of this paper. Details on how it is constructed can be found in that section.
summarized. In Section 3 the notion of social capital is framed in the literature on territorial capital, while relevant theoretical expectations on the behavior of variables in the model are described. In Section 4 a simple neoclassical model is used to illustrate the main point of the paper. Section 5 then presents the baseline model results. Section 6 offers empirical estimates on the existence of decreasing returns to social capital. Finally, Section 7 concludes.

2. Social capital and regional knowledge

Among the many concepts used to describe and classify cultural values influencing a society’s tendency to innovate and grow, social capital enjoyed particular success in the past decades. In fact, in the 1990s and the early 2000s, there was hardly any economics department that had no research ongoing on the topic of social capital. A few influential studies (Coleman 1988, Bourdieu 1983, Putnam 2000, Putnam et al. 1993 and 2000, Fukuyama 1995) raised the interest of academicians, practitioners and policymakers on the rich topic of how norms, networks and institutions (in a single expression, social values) determine the way societies interact.

This strand of literature paved the way of social studies aiming at understanding the differential performance of countries, firms, and even individuals when subject to different social incentives. This burgeoning mass of research aimed to explain why, ceteris paribus, societies with similar endowments of physical capital performed so differently, even when accounting for a number of potentially relevant country-wide or firm-specific controls (i.e., the level of education of individuals and the workforce, the endowment with natural resources, potential access to rich markets etc.).

The main finding of most of these studies was to identify, understand and explain the main cultural and institutional determinants of social relations. Did the intensity of networks among people and the shared values which aroused from those networks influence the way people acted? Did more intense interactions between people generate a greater sense of community? Most often the answer of such studies has been a definite “yes”. Probably also due to what meta-analyses call a “publication bias”\(^3\), most empirical studies, in turn based on theoretical frameworks, find that higher levels of social capital lead to better economic and social performance.

From what summarized above, it should be clear that the concept of social capital poses huge definitional challenges. What exactly is social capital? Why do economists, sociologists, anthropologists use the concept of “capital”? In other words, does “social” capital accumulate, and, on the other hand, is it subject to depreciation?

Definitions of social capital vary, but the main aspects include citizenship, “neighbourliness”, social networks and civic participation. The Organization for Economic Co-operation and Development (OECD), for instance, defines social capital as:

\(^3\) “Publication bias arises from the tendency for researchers, editors, and pharmaceutical companies to handle the reporting of experimental results that are positive (i.e. they show a significant finding) differently from results that are negative (i.e. supported the null hypothesis) or inconclusive” (Wikipedia: http://en.wikipedia.org/wiki/Publication_bias, retrieved on November 2, 2009).
"networks together with shared norms, values and understandings that facilitate co-operation within or among groups" (Cote and Healy 2001)

This definition encompasses the two main axes along which social capital has been defined over the years, i.e., the economic value of personal relationships along with sharing common norms and values that provide informal sanctioning of deviating behaviour and provide positive incentives for respecting rules.

This general definition is not, however, generally shared. Some schools stress the network component of social capital. For instance, Bourdieu defines social capital as:

"the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu 1986, p. 248).

Likewise, Burt (1992) states that social capital is made up of

"Friends, colleagues, and more general contacts through whom you receive opportunities to use your financial and human capital" (Burt 1992, p. 9).

On the other hand, others have underlined more the trust and norms component of social capital. Among others, Fukuyama (1995) argues that social capital can be described as

"The ability of people to work together for common purposes in groups and organizations" (Fukuyama 1995, p. 10).

Analogously, Thomas (1996) identifies the main ingredients of social capital as

"Those voluntary means and processes developed within civil society which promote development for the collective whole" (Thomas 1996, p. 11).

A complete list of definitions may be quite long and probably require a book itself. The debate on the best possible definition of social capital, i.e. whether the most aggregate “trust, norms and networks” à la Putnam, or rather a more specific one on single sub-components, has not found generalized consensus. Bjørnskov (2006) documents this rich discussion and argues that a too general definition may miss important implications that may be intelligible only when adopting stricter definitions (and hence, using stricter measures) of social capital.

Most influential studies can be classified according to two main dimensions, i.e. whether they are laying the basis for the theory of social capital, or rather offer an empirical validation of theoretical expectations; and whether the underlying definition of social capital stresses more the trust and norms component, the network one or both simultaneously. The resulting classification is shown in Table 2.

For the purpose of this paper, a position on this ongoing debate needs to be made. Does social capital deal more with the norms regulating the interactions among citizens, in turn
shaping informal sanctions for deviating behaviour and underlying rules of the game, or is it more made up of the informal networks of sociability among citizens? Or, does social capital capture something general which is society-specific and encompasses both trust and norms and networks?

While critiques to general definitions stress relevant possible shortcomings of a broad view on the topic, they actually miss a major point. As an elusive concept, social capital indicates, rather than measures, society-wide trends and behaviours. Therefore, while trying to avoid redundant explanations of complex economic interactions among agents, whereas culture explains everything, one may also need to strictly define the problem analyzed and form educated expectations on the way culture may shape the final outcome of such problem.

In this paper, the concept of social capital is used to improve our understanding of the mechanisms leading to the more efficient creation, thicker exploitation, and faster diffusion of knowledge. These mechanisms may achieve increasing returns when regional societies are, in cultural terms, “well behaved”. In other words, knowledge creation, exploitation and diffusion may benefit from more cohesive societies, where sociable and networked persons, firms and institutions may interact more effectively, enjoying higher levels of trust, obeying similar codes of behaviour. Hence, there is no need for a more detailed definition of the concept of social capital, but rather a view analogous to Putnam (2000), according to which social capital is defined as follows: Social capital is defined as the economic value of a society’s capital of trust, norms and personal networks.

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4 This paper represents a methodological, rather than empirical, work. It aims at understanding the relative importance of the trust, norms and networks components of the general definition of social capital within a Putnam framework.
3. Social capital and increasing returns to regional knowledge

Regional growth results nowadays from the balanced presence of tangible and intangible elements originating in the economic and social spheres: the endowment of production factors, infrastructures, and human capital should be linked to the presence of social capital, a propensity for cooperation among actors, and the ability of people, firms and local institutions to learn.

The success of a territorial system therefore does not depend solely on the quantity and quality of the material resources with which it is endowed. It also, and crucially, depends on the richness of social elements, or the way individuals think and behave. As physical capital is highly mobile, and labour force can also migrate in search for better conditions, the competitiveness of regions depends on intangible resources and their development. Intangible elements connected with culture and innovative capacity accumulate through slow processes of individual and collective learning fuelled by information, interaction, and investments in research and training. They are therefore intrinsically localized and cumulative, embodied in human capital and local relational networks, in the labour market, and in the local context—and they are consequently highly selective in spatial terms (Camagni 2008)\(^5\).

Moreover, this paramount relevance notwithstanding, non-material growth determinants are seldom taken into account (Dasgupta 2000). Traditional growth models are “silent on the rectitude of such [rational and utility–maximizing] agents. We are not told if they are persons of honour, conditioned by their upbringing always to meet the obligations they have chosen to undertake, or if there is a background agency which enforces contracts, credibly threatening to mete out punishment if obligations are not fulfilled” (Dasgupta, 2000). Non-material growth determinants, and in particular social capital, have oftentimes found to be difficult to capture, especially within applied studies (Capello et al., 2010); for this reason, some scholars of the notions of social capital have suggested to use single axes of its definition (see among others Dasgupta, 2003, who focuses on the relevant role played by trust).

All these aspects are nowadays conceptualised in the concept of territorial capital. Territorial capital was first proposed in a regional policy context by the OECD in its Territorial Outlook (OECD, 2001), and has been recently reprised by DG Regio of the Commission of the European Union: “Each region has a specific ‘territorial capital’ that is distinct from that of other areas and generates a higher return for specific kinds of investments than for others, since these are better suited to the area and use its assets and potential more effectively. Territorial development policies (policies with a territorial approach to development) should first and foremost help areas to develop their territorial capital” (European Commission, 2005, p. 1, as cited in Camagni 2008).

The concept of territorial capital entails all material and non-material, private and public assets that play a role in defining economic performance. An interesting taxonomy of territorial capital assets has been recently suggested by Camagni (2008). According to this

\(^5\) Although these concepts have solid theoretical foundations, and sound reasonable for the type of economic interaction that is measured in the lines of research similar to ours, their conceptualization is far from straightforward and their operationalization oftentimes faces several difficulties. Therefore, we believe the present contribution to represent the first step of a possibly long line of research.
<table>
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<tr>
<th>High rivalry</th>
<th>Relational private services operating on:</th>
<th>Human capital:</th>
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<tr>
<td>(private goods)</td>
<td>- external linkages for firms</td>
<td>- entrepreneurship</td>
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<td>- transfer of R&amp;D results</td>
<td>- creativity</td>
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<td>University spin-offs</td>
<td>- private know-how</td>
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<td>Pecuniary externalities (soft)</td>
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<th>Cooperation networks:</th>
<th>Relational capital:</th>
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<td>(club goods)</td>
<td>- strategic alliances in R&amp;D and knowledge</td>
<td>- cooperation capability (in trust-based relationships)</td>
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<td>(impure public goods)</td>
<td>- p/p partnerships in services and schemes</td>
<td>- collective competencies</td>
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<td>Governance on land and cultural resources</td>
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<tr>
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<th>Mixed goods</th>
<th>Intangible goods</th>
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<td>(hard)</td>
<td>(hard+soft)</td>
<td>(soft)</td>
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<td>Resources:</td>
<td>Agencies for R&amp;D transfer</td>
<td>Social capital:</td>
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<td>- natural</td>
<td>Receptivity enhancing tools</td>
<td>- conventions</td>
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<td>- cultural (punctual)</td>
<td>Connectivity</td>
<td>- behavioural codes</td>
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<tr>
<td>Social overhead capital:</td>
<td>Agglomeration and district economies</td>
<td>- norms</td>
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<td>- infrastructure</td>
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<td>- values</td>
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**Materiality**

Figure 2: A classification of territorial capital according to materiality and rivalry. Source: Camagni (2008), own elaboration.

view, territorial capital can be classified according to their degree both of materiality and rivalry; the resulting matrix is represented in Figure 2. For the sake of the present paper, the materiality dimension of territorial capital is of major relevance. The pure material elements that characterize territorial capital are the easiest to identify. They often come in quantities (physical capital, labor and infrastructure); therefore, they can enter directly a traditional production function. Intangible elements instead are characterized by less sharply defined boundaries and more complex definitions. They enjoy a mixed material–intangible nature, like social capital; however, they form the glue of a society, stemming from complex social and cultural processes that are cumulated in a society over time. As such they act on knowledge creation and knowledge exploitation, and therefore on the way in which physical factors (capital, labor and human capital) are combined, giving rise to increasing returns.
This point is made graphically in Figure 2. This shows an arrow originating from the social capital square, and pointing towards the knowledge one. The main idea exploited in this paper is that social capital, i.e. the wealth of trust, norms and values that shape a society and contribute to its capability of collective learning, represents a potential source of additional returns to knowledge exploitation. For this reason, among all intangible elements, in this paper the attention focuses on social capital.

In fact, social capital elements in general affect cognitive mechanisms when linked to the rich literature on transaction costs (Williamson, 2002). When people share the same social language, it becomes easier to understand each other. Estimates from different authors point out that at least some of the process of adding value in modern economies is attributable to talking (Mc Closkey and Klamer 1995, for example, estimate that “one quarter of GDP is persuasion”). The consequent reduction of the frictions of communicating can represent a source of productivity increases.

Belonging to a strongly identified community may foster economic activity; in this case, a burgeoning evidence is summarized in Putnam (2000). Better mutual understanding may also reduce transaction costs: whenever people get together to start a business, this is based on reciprocal trust. If this is true for large organizations (La Porta et al. 1997), the same can be expected for societies as a whole. When trust is insufficiently available, people must set up efficient rules and punishments for breaking them; and this process is costly. Knowing other people’s expected behaviour, as in a coherent and homogeneous society, may reduce the risks of cheap talk to fail to reach stable equilibria (Farrell, 1995). Finally, the concept of herd behaviour represents an alternative key to understand the effect of trust and social capital in economic performance. Sociologists and economists found in countless experiments that people tend to be influenced by peers when forming a judgment or an evaluation of a process. People reflect their surroundings when deciding how to act: political beliefs tend to display strong geographical and social patterns (see Shiller, 1995).

From what said before, we expect that the higher the wealth of the social capital in a region, the higher the capacity to exploit knowledge and to achieve increasing returns in growth processes. Social capital is expected to act as a catalyst to economic interactions. It mediates between factors and long run performance; in other words, it can enhance factors’ efficiency on regional growth by making personal interactions more effective.

The idea that social capital may indirectly impact economic performance through enhancing innovation creation and adoption is not entirely new. Recently, Akçomak and ter Weel (2008) have suggested that indeed social capital may represent an asset for regional economies, as it would reduce transaction costs and facilitate the possibility of entrepreneurs to take on risk. In their words,

“Social capital in turn influences the innovation process because the financing of risky innovative projects requires that researchers and capital providers trust each other. When they do so, more successful projects are carried out, which improves innovation outcomes by means of more patents” (Akçomak and ter Weel 2008, p. 4).

Our perspective moves along the lines sketched by the above mentioned authors. In the
present paper, social capital represents a lens to innovation and knowledge performance. Ceteris paribus, in the empirical application in this paper the returns of knowledge on regional growth are modeled as being positively dependent on social capital increases\(^6\). This represents a departure from Akçomak and ter Weel (2008), where in fact the opposite happens: innovation acts as a channel to the impact of social capital. Because the true direction of the causal arrow is not yet fully clear, both models may be tested. A deeper understanding of the true causal link would, among all possibilities, require time series data on social capital issues, in the line of the US surveys used in Putnam (2000) (e.g., US Bureau of Economic Analysis and DDB Life Style data).

The literature has also stressed that the effects of social capital on economic performance may not just be positive. Putnam (2000) dedicates a full chapter to this issue (“The dark side of social capital”). As any other non-material production factor, the concept of social capital has in fact attracted critiques. In particular, it has raised the point that in the past, a relative higher endowment of social capital in the United States triggered social exclusion and intolerance. Figures suggest that in periods when most indicators of sociability were peaking, surveys concerning tolerance on diversity (in terms of race, sexual orientation, religion) showed dismal results. Inward-looking neighbourhoods would exercise an obsessive control over any form of deviation from the accepted behaviour, and this would in the end generate a rat race (the attempt to “keep up with the Joneses”) that would damage the quality of life of individuals, rather than improving it. In other words, critiques of the concept of social capital claim that the decline of sociability in the US was offset by the positive effects of an increased individual freedom. Michael Schudson wrote “The decline in organizational solidarity is truly a loss, but is also the flip side of a rise in individual freedom, which is truly a gain” (Schudson 1998).

This possibility has been described by Putnam (2000) as the difference between bridging and bonding social capital, the idea being also empirically tested in Beugelsdijk and Smulders (2003). Bridging social capital “can be defined as bonds of connectedness that are formed across diverse social groups, whereas bonding social capital cements only homogenous groups” (Beugelsdijk and Smulders 2003, p.147). A second contribution of the present paper is to provide evidence on the existence of decreasing returns to knowledge exploitation for the data sample analyzed.

4. Social capital and its returns to knowledge: empirical estimates

4.1 The model

In this section we present a conceptual and analytical model, in which the effects of knowledge on GDP growth is measured taking into account the level of the social capital in the region. To achieve our goal, we start by presenting and estimating a simple Cobb-Douglas production function with three standard production inputs, viz. physical capital, labour and human capital, plus social capital. The Cobb Douglas approach enjoys attractive properties for regional economists. Glaeser and Gottlieb (2009) summarizes such properties as follows:

\(^6\) More details on this relevant topic are described in Section 5.
“The production function $A: F(K,L)$, is particularly natural for empirical work. This can be either be thought of as an aggregate production function or a firm-level production function in a world with an elastic supply of firms” (Glaeser and Gottlieb 2009, p. 991).\footnote{Alternative empirical specifications have been tried, in particular non-linear specifications of the social capital term such as the quadratic form. However, the main results of the paper do not change significantly, while empirical tests depart significantly from the assumed model. Results of estimating alternative (non-linear) models are available upon request from the authors.}

Our production function may be written as:

$$Y_{r,t} = K^r_{r,t}L^r_{r,t}H^r_{r,t}SC^r_{r,t}$$ (1)

where subscripts indicate the region ($r$) and time ($t$) of analysis. $\alpha$, $\beta$ and $\gamma$ are the parameters to be estimated (in equilibrium equal to the factor shares). Notice that, in analogy with the Cobb–Douglas production function sketched in Glaeser and Gottlieb (2009), a region–time specific parameter, which captures our measure of regional knowledge, is also included.

The inclusion of human capital and social capital in a Cobb–Douglas production function is a known tool of modern growth theory, in order to escape from the decreasing return behaviour displayed by the classical Solow–Swann model. In particular, it has been employed, among others, in Mankiew et al. (1992) and Ishise and Sawada (2009), for human and social capital respectively.

Eq. (1.) can be log-linearized to obtain:

$$y_{r,t} = \alpha k_{r,t} + \beta l_{r,t} + \gamma h_{r,t} + \delta sc_{r,t}$$ (2)

where lowercase letters indicate natural logs of the original variables. Let us now assume that human capital adds to wealth production not only per se, but also through the presence of social capital. We might think of this as the increasing returns mechanism put in practice when societies display high reciprocal trust, strong political participation, careful attention to environmental issues and thick interpersonal linkages.

This can be written in economic terms as an assumption on the $\gamma$ coefficient. Suppose that:

$$\gamma = \gamma_0 + \gamma_1 sc_{r,t}$$ (3)

where “$sc$” is our measure of social capital. Inserting eq. (3.) into (2.) we obtain:\footnote{This specification for the interaction term allows us to include both the non material elements in levels as well as the interaction term between them, following the lines suggested in Brambor et al. (2006).}

$$y_{r,t} = \alpha k_{r,t} + \beta l_{r,t} + \gamma_0 h_{r,t} + \gamma_1 (h_{r,t}^* sc_{r,t}) + \delta sc_{r,t}$$ (4)

Equation (4.) indicates that GDP\footnote{The analyses in this paper are based on GDP. However, a more reliable measure could be Gross Regional Product (GRP). This is “conceptually equivalent to gross domestic product (GDP); the latter measures newly created value through production by resident production units (or residents in short) in the domestic economy, while for the former measures newly created value through production by regional production units (or regional residents in short) in the regional economy, be it a state, province or a district” (Quang Viet 2010). However, no such statistic is available for the EU27 regions.} is associated with labour, capital and human and social
capital endowment, but the role of the latter on GDP is also dependent on the presence of social capital (in the the interaction term); this is expected to play the role of knowledge catalyst, allowing for increasing efficiency of knowledge accumulation on regional growth.

4.2 The database

Equation (4.) is our baseline model, which in our empirical analysis is estimated for all European regions (NUTS 2 regions)\(^{10}\) with a dataset built from two main sources: the EUROSTAT Regio data base and the European Values Study (henceforth, EVS\(^{11}\)) dataset. Data for economic performance have been collected from EUROSTAT. To estimate labour, the total labor force at NUTS2 level is used. The stock of physical capital is estimated by means of the perpetual inventory method, starting from the gross fixed capital formation available in the EUROSTAT database.\(^ {12}\) GDP is estimated by using GDP at constant 2000 prices. When GDP growth is calculated, this is done for the period 1999–2005. Human capital is measured with the percentage of citizens holding an ISCED 5 or 6 degree (see footnote 1). To assess social capital, measures have been chosen, following Putnam (2000), aiming at capturing collective action and cooperation capabilities of the regions. Therefore, we looked for measures of the share of people participating in clubs and voluntary association, the share of people developing voluntary work in any community activity and participating in any social activity and the share of people trusting neighbouring people. All variables measured in the 1999–2000 EVS wave, and the relative questions are summarized in Table 2.

EVS individual data are aggregated across regions, to obtain mean values for each region. In order to summarize the information of each of the above described variables, a principal component analysis was run taking into consideration the proxies listed in Table 2. For countries whose EVS interviews have only a NUTS 1 reference, individual responses have been averaged across NUTS 1 regions and those values have been assigned to the NUTS 2 regions constituting the larger NUTS 1.

The results of the principal component analysis are presented in Table 3, where the relative scores for the components in the eigenvectors are presented for the four components that exhaust the original variance in the original vectors.

These findings can be interpreted in the following way. The first factor obtained can be considered to be a good proxy for the presence of a social capital, when the latter resides on the ability of a region to enable economic actors to work together under conditions of uncertainty, or solidarity, mutual assistance and co-opting of ideas. For this reason this

\(^{10}\) The data set covers 260 NUTS2 regions: French overseas departments and Spain's Ceuta and Melilla are missing, due to the lack of data.

\(^{11}\) EVS consists of a set of individual questionnaires administered to European citizens. Data have been collected in four waves: this paper uses the 1999–2000 wave, as it is the first to comprehensively cover the regional dimension of the analysis.

\(^{12}\) The perpetual inventory method to assesses the stock of physical capital accumulated starting from the gross fixed capital formation level, transformed in a stock by multiplying it by a factor which takes into account capital’s depreciation, productivity growth (which makes preinstalled capital obsolete) and labor force increase. Calculations assume 1999 as the base year, where data are available—otherwise the first year for which data are available is used. Results do not heavily depend on the chosen base year: by rolling the base year on the 1999–2005 sample and calculating linear correlations, same years values calculated with different base years correlate around 0.7.
factor will be used in our empirical analysis. From a statistical point of view, this factor captures 53% of total variance in the data; besides, it also satisfies the criterion of being the only factor beyond the absolute value of one threshold.

5. The role of social capital as a catalyst for knowledge exploitation: estimation results

We will now proceed by estimating an econometric model on the role of social capital. Equation (4) has been estimated using a standard least squares regression as a baseline model, which however suffered from spatial autocorrelation of the dependent variable. Tests for spatial autocorrelation have been run and estimates were adjusted for spatial lags and spatial errors. The choice of spatially augmented models is motivated by a significant, albeit not particularly high, positive autocorrelation in the dependent variable, which is reflected in a Moran’s I coefficient of 0.05, significant at the 1% level. This is also shown, for non spatially-augmented models, in the last line of Table 4.

As the data set is organized in pooled form (each region is observed over 7 years and then the next region is observed), our weight matrix is a simple inverse distance matrix. It has
a block diagonal form like (eq. 5):

\[
W = \begin{bmatrix} w & 0 & 0 \\ 0 & w & \ldots \\ 0 & \ldots & 0 \\ 0 & 0 & w \end{bmatrix}
\]

(5.)

where a lower-case w indicates a 260x260 weight matrix, repeated seven times across the main diagonal, and the zero matrices indicate that the overall weight matrix W has zero elements everywhere else, as we chose data to cover fixed NUTS definitions in the 1999–2005 time span.

Results are reported in Table 4 (columns 1–3). Columns 1 to 3 differ in that they show increasingly complex models, where first the simple production function augmented with human capital is presented, then the production function is augmented with the social capital measure, and finally the interaction term between human and social capital is included in column 3. Columns 4 and 5 present the most general model, estimated with the spatial autoregressive and the spatial error model.

All coefficients are significant with the expected sign. The interest of our analysis lies in the coefficient associated to the interaction term, \( \gamma_i \), which is positive and significant across all specifications.

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<tr>
<th>Table 4 : Estimates of the equation in levels (eq. (4.) and (5.))</th>
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<tbody>
<tr>
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<td>Labour force</td>
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<td>Human capital</td>
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<td>Social capital</td>
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<td>Human capital* social capital</td>
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<td>Constant term</td>
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<td>Adj. R²</td>
</tr>
<tr>
<td>Log likelihood</td>
</tr>
<tr>
<td>Robust LM test (lag/error)</td>
</tr>
<tr>
<td><strong>Moon's I</strong></td>
</tr>
</tbody>
</table>

Legend * : 90% significance level. ** : 95% significance level. *** : 99% significance level.
When corrected for spatial autocorrelation patterns, the interaction term results remain stable: the interaction term coefficient shows a positive and significant value.

In order to measure the marginal effects of knowledge on GDP, the first partial derivative of GDP with respect to knowledge has been calculated as follows:

$$\frac{\partial Y_{r,t}}{\partial h_{r,t}} = \gamma_0 + \gamma_1 sC_{r,t} \quad (6.)$$

and plotted for different levels of social capital. The results are shown in Figure 3, which shows that:

- knowledge generates per se a positive effect on GDP production, in line with the relevant literature on human capital;
- its effects are magnified, when a consistent stock of social capital is present. In other words, where people easily understand each other or where they trust peers, the transfer of knowledge is more fluid, and therefore the positive effects of human capital on GDP production are larger.

Does this relationship hold in a dynamic context as well? To analyze this point we start from dividing the analyzed sample into two symmetric parts, according to the distribution of our standardized measure of social capital. If dynamic marginal returns to knowledge are also positively dependent on social capital, and social capital tends to accumulate over time, we should find that the sign of the interaction term remains constant in both samples. If

---

![Figure 3: Marginal effects of knowledge on GDP for different levels of social capital](image)

---

13 Statistically significant observations are bounded by dashed lines. Statistical significance is calculated as follows. We calculate first a marginal effect for each observation; this is then divided by the observation’s standard error. Statistically significant observations are those for whom this ratio in absolute value exceeds 1.96; the value is chosen according to a 95% confidence level.
Table 5: LS estimates of eq. (4.), social capital distribution split into bottom and top 50%

<table>
<thead>
<tr>
<th>Quantile</th>
<th>Lower than average social capital</th>
<th>Higher than average social capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock of capital</td>
<td>0.70*** (0.01)</td>
<td>0.65*** (0.02)</td>
</tr>
<tr>
<td>Labour force</td>
<td>0.29*** (0.02)</td>
<td>0.39*** (0.02)</td>
</tr>
<tr>
<td>Human capital</td>
<td>−0.08** (0.05)</td>
<td>0.30*** (0.05)</td>
</tr>
<tr>
<td>Social capital</td>
<td>0.36*** (0.03)</td>
<td>0.04*** (0.02)</td>
</tr>
<tr>
<td>Human capital* social capital</td>
<td>−0.13*** (0.03)</td>
<td>0.03** (0.01)</td>
</tr>
<tr>
<td>Constant term</td>
<td>0.60*** (0.15)</td>
<td>−0.91*** (0.18)</td>
</tr>
</tbody>
</table>

Number of obs. 749 602
R² 0.95 0.94
Adj. R² 0.95 0.94

Legend *: 90% significance level. **: 95% significance level. ***: 99% significance level.

Instead social capital displays some form of increasing or decreasing marginal returns, then we should have different coefficients, or even opposite signs, associated with higher levels of social capital; in other words, we should detect signs of decreasing dynamic marginal returns. The empirical results are shown in Table 5.

Table 5 allows us to draw some interesting tentative conclusions. While returns to physical factors remain substantially constant over the sample, the same cannot be said for non-material ones. Human capital shows consistently higher returns in the top 50% of the social capital distribution in European regions. In other words, in regions richer in social capital, it pays more off to study for a longer time. Vice versa, in regions that are relatively deprived in social capital, returns to schooling are much lower. However, returns to social capital per se also display decreasing returns, with the bottom 50% of the distribution enjoying returns about 9 times as large as in the top 50%. Finally, the interaction term also displays an increasing sign.

Therefore, it seems that social capital helps fostering knowledge exploitation especially for those regions that are richest in such non-material factor. This forces us to reflect on the possibility that the positive effects of social capital on the marginal effects of knowledge on regional growth may be subject to decreasing returns. We investigate this issue in the next section.

6. Do increasing returns exist in the role of social capital as a catalyst of growth?

In order to investigate the existence of decreasing returns in the role social capital plays in regard to the marginal effects of knowledge on regional growth, we now calculate the total time derivative of eq. (4.), which which represents our regional growth equation:

$$\dot{y}_{r,t} = a \dot{k}_{r,t} + \beta \dot{l}_{r,t} + \gamma_0 \dot{h}_{r,t} + \delta \dot{s}c_{r,t} + \gamma_1 (\dot{h}_{r,t} - \dot{s}c_{r,t})$$

(7)
Eq. (7.) can be rewritten as
\[ \dot{y}_{r,t} = a \dot{h}_{r,t} + \beta \dot{l}_{r,t} + \gamma_0 \dot{h}_{r,t} + \delta \dot{c}_{r,t} + \gamma_1 \dot{h}_{r,t} \dot{s}c_{r,t} + \gamma_1 \dot{h}_{r,t} \dot{s}c_{r,t} \] (8.)
and then rearranged in order to isolate the terms measuring the change in human and social capital as follows:
\[ \dot{y}_{r,t} = a \dot{h}_{r,t} + \beta \dot{l}_{r,t} + (\gamma_0 + \gamma_1 \dot{s}c_{r,t}) \dot{h}_{r,t} + (\delta + \gamma_1 \dot{s}c_{r,t}) \dot{c}_{r,t} \] (9.)
From eq. (9) we can next calculate the derivative of knowledge accumulation on GDP growth as:
\[ \frac{\partial (\dot{y}_{r,t})}{\partial (\dot{h}_{r,t})} = \gamma_0 + \gamma_1 \dot{s}c_{r,t} \] (10.)
Changes in social capital are here measured as follows. EVS data so far have been used to calculate a PCA over individual responses in the 1999–2000 EVS wave (so far, the most recent available, though a new wave is currently being administered). However, data are available, with regional georeferentiation and similar caveats, also for a 1990 wave. As our sample covers the period 1999–2005, we assume a constant linear change rate between 1990 and 2000 of the variables chosen to measure social capital (i.e., trust, volunteering, formal and informal sociability) and project those change rates over the period 1999–2005. The results of estimating eq. (9) are presented in Table 6\textsuperscript{14}.
This is made up of the following columns. Columns 1–3 replicate in dynamic terms columns 1–3 in Table 5 (i.e., the baseline model is first augmented with the social capital measure, and then with the interaction term). Columns 4 and 5 (indicated as “SAR” and “SEM” exploit the spatial dimension of our data, and show spatial autoregressive and spatial error model estimates, based on a positive (equal to 0.21) and significant value of the Moran’s I statistic. Finally, columns 6 and 7 (labeled as “Fixed effects” and “Arellano–Bond”) make us of the panel structure of our data, by first adding region–specific fixed effects, in order to take into account region–specific characteristics left unaccounted for in our model, and then instrumenting all variables with their differences as suggested in Arellano and Bond (1991).
The interaction term has a negative sign for the GDP growth model over all specifications (columns 3 to 7), but loses significance when using panel models. The first result may suggest a negative effect of social capital on changes in the marginal effects of knowledge on regional growth. The second result may instead point at the inherently region–specific (i.e., territorial) processes that determine the positive synergy between social and human capital. Typically, region–specific immobile resources such as social capital are immobile and represent a wealth of resources that stems from continuous interactions, based on reciprocal trust, and allowing agents easier mutual understanding, with the use of tacit modes of knowledge transfer (Storper and Venables 2004). All these specific and spatially–bounded characteristics may be wiped out with the use of panel techniques.
The values of eq. (10.) are plotted in Figure 4, for different levels of social capital.

\textsuperscript{14} Our estimates include the pure interaction term between the accumulation of social and human capital as a relevant control. Results for the other variables do not differ significantly. The real interaction between social and human capital is analyzed in more detail with the help of an interaction graph later in this Section.
Table 6: Estimates of growth equations (eq. 7).

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Growth of regional GDP, 1999–2005</th>
<th>Fixed effects</th>
<th>Arellano-Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Initial GDP</td>
<td>0.01***</td>
<td>0.01***</td>
<td>0.01***</td>
</tr>
<tr>
<td>Time lag of GDP</td>
<td>0.02***</td>
<td>0.02***</td>
<td>0.02***</td>
</tr>
<tr>
<td>Growth of the stock of capital</td>
<td>0.24***</td>
<td>0.24***</td>
<td>0.24***</td>
</tr>
<tr>
<td>Growth of labour force</td>
<td>0.18***</td>
<td>0.18***</td>
<td>0.18***</td>
</tr>
<tr>
<td>Growth of human capital</td>
<td>0.03</td>
<td>0.01</td>
<td>0.01***</td>
</tr>
<tr>
<td>Growth of social capital</td>
<td>0.04</td>
<td>0.05</td>
<td>0.12*</td>
</tr>
<tr>
<td>Growth of human capital*</td>
<td>0.06***</td>
<td>0.07***</td>
<td>0.06***</td>
</tr>
<tr>
<td>Growth of social capital</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Constant term</td>
<td>0.02***</td>
<td>0.07***</td>
<td>0.07***</td>
</tr>
</tbody>
</table>

Spat. Autocorr. coeff.

Number of obs. | 1197 | 1143 | 1143 | 1331 | 1351 | 1143 | 952
R² | 0.21 | 0.20 | 0.20 | 0.20 | 0.25 | 0.25 | 0.13
- Between | 0.06*** | 0.06*** | 0.06*** | 0.06*** | 0.06*** | 0.06*** | 0.24
- Within | 0.24*** | 0.24*** | 0.24*** | 0.24*** | 0.24*** | 0.24*** | 0.24
Adj. R² | 0.21 | 0.20 | 0.20 | 0.95 | 0.95 | 0.95 | 0.21
Log likelihood | 0.21 | 0.20 | 0.20 | 4048.93 | 4048.93 | 4048.93 | 0.21
Robust LM test (lag/error) | 191.64 (0.00) | 191.64 (0.00) | 191.64 (0.00) | 191.64 (0.00) | 191.64 (0.00) | 191.64 (0.00) | 0.21
Moran’s I | 0.21*** | 0.21*** | 0.21*** | 0.21*** | 0.21*** | 0.21*** | 0.21***

Legend*: 90% significance level. **: 95% significance level. ***: 99% significance level.

Equation (10) represents the change (the second derivative) in the elasticity of GDP growth to changes in knowledge, for different levels of social capital. Its negative slope implies that the elasticity of GDP to knowledge can be represented by an inverted U-shaped curve, as in Figure 5. Decreasing marginal returns in the role social capital has as catalyst for the exploitation of knowledge for regional growth appear to exist from a certain threshold of social capital.

Besides, this relationship remains remarkably significant over the whole sample. Notice, however, the interaction graph crosses the zero line around half of the social capital distribution. This translates into Figure 5, which shows that after increasing in the first half of social capital’s distribution, the marginal contribution of knowledge on GDP decreases again. The maximum contribution of social capital on knowledge exploitation seems to be set around the 5th decile of the distribution, when, in Figure 4, the second order derivative crosses the X axis. Thus, from the perspective of a social cost–benefit analysis, the benevolent planner may want to foster mutual trust, the transfer of knowledge, participation in social and common activities, but only up to a certain point. After that threshold, marginal costs may exceed marginal benefits, by creating a set of exclusive, Olson-type groups where the sense of belonging may even hamper some social interactions and some economic transactions.
Marginal Effect of knowledge on GDP growth as social capital changes

Dependent variable: regional GDP growth

Figure 4: Marginal effects of knowledge accumulation on GDP growth for different levels of social capital

Figure 5: Overall marginal effects of knowledge on wealth creation
7. Conclusions

This paper builds on previous studies on the relationship between innovation and economic growth. We first claim that the former does not necessarily lead to the latter. The reason why this step may not be automatic is assumed to emerge from the presence of social capital in the region: this allows a local actor to transform knowledge into innovation, cooperative or market interactions into productivity and growth increases.

We have tested this hypothesis in a simple neoclassical framework. We explore the role of social capital in explaining the formation of increasing returns to regional knowledge. We found that collective learning, mutual understanding, reciprocal trust and social commitment all play a major role in determining economic performance, by magnifying the effects of knowledge creation (and accumulation) on wealth formation.

We believe this to be only the first step towards a more comprehensive model of the spatial and territorial characteristics that may enhance or hamper the effectiveness of human capital and knowledge in a modern regional economy. In fact, results are robust for what concerns the way in which social capital acts as a knowledge catalyst: the presence of higher stock of social capital is associated with higher impacts of knowledge on GDP. What is still an area in which further fruitful research can be developed is the existence of non-linearities in the role intangible elements play as a knowledge catalyst. In this area, our results do not always lead to an irrefutable message: thus, we believe there is still space for future research in this issue.

In particular, our model does not incorporate human capital externalities (learning or dynamic agglomeration economies) that represent a frontier theme in regional science. Although we believe the NUTS2 spatial scale not to be the best scale at which such externalities may show, our model might be extended to take into account this issue. This could represent the focus of future research.

Also, estimates based on different spatial and panel techniques suggest a high degree of nonlinearity in the knowledge–social capital relationship. Besides, in the European context data on social capital characteristics of regions are simply insufficient to draw certain conclusions about the true microfoundations of such nonlinear relations.

Trust, collective action and cooperation capability, all trigger the generation of an increased collective capability to exploit new knowledge, decode and diffuse it with the maximum efficiency. However, the real territorial channels through which this happens are still missing from the picture. Estimates at the regional level result in averaging individual values over single territories, which fits the theoretical assumptions of the present paper. However, cultural and social values would need a more thorough analysis of individual incentives and of the mechanisms through which they are aggregated. For this reason, two major improvements may consist in a more profound analysis of the different elements that are part of the territorial capital stock, and the collection of much richer individual data sets, with more information on individual values. So far only a few surveys, with all their limitations and flaws, have been gathering evidence on the values of European citizens. An insufficient coverage of territories may cause a loss of relevant spatial disparities in such values, which in turn may blur our picture of the real map of EU citizens values.
This contribution also brings forward interesting policy implications. Policies like the Lisbon Agenda, which aim to foster Europe’s competitiveness in terms of innovation performance, could benefit from our empirical analysis, which reminds that innovation policies have different effects in different areas, according to the presence of social capital. The latter is in fact able to increase the economic effects of knowledge on growth, and to guarantee a self-cumulating learning process. Once these elements are not sufficiently present in an area, effective innovation-enhancing policies should be developed together with accompanying measures aiming at developing these soft elements; ignoring them would determine a suboptimal regional performance.

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