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Social Capital, Innovation and Growth: Evidence from Europe

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ABSTRACT

Social Capital, Innovation and Growth: Evidence from Europe*

This paper investigates the interplay between social capital, innovation and per capita income growth in the European Union. We model and identify innovation as an important mechanism that transforms social capital into higher income levels. In an empirical investigation of 102 European regions in the period 1990-2002, we show that higher innovation performance is conducive to per capita income growth and that social capital affects this growth indirectly by fostering innovation. Our estimates suggest that there is no direct role for social capital to foster per capita income growth in our sample of European Union countries.

JEL Classification: O1, O3, O52, Z13

Keywords: social capital, innovation, economic growth, European Union

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1 Introduction

In the economic literature social capital has been identified as an important determinant in explaining differences in income. Knack and Keefer (1997) and Zak and Knack (2001) have shown for a cross-section of countries that countries with higher levels of measured trust are richer. It is however not clear *how* social capital improves economic outcomes.

This paper argues first that current levels of social capital are formed by historical institutions and investments, such as early literacy, past political institutions and universities. This follows important recent empirical research by Hall and Jones (1999), Acemoglu, Johnson, and Robinson (2005) and Tabellini (2005), who basically apply the arguments developed in North (1981) that history matters for current economic outcomes.

Second, the idea that social capital improves economic outcomes is appealing, but it seems necessary to identify a third factor through which social capital improves outcomes. This paper suggests that innovation is an important channel by which social capital improves income growth. The idea is that more advanced historical institutions have established a higher stock of social capital. 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. Finally, as shown by e.g., Grossman and Helpman (1991) and Aghion and Howitt (1992), higher innovation output yields higher income per capita.

In the theoretical background of this paper we integrate social capital in a simple model of production. In this set up the accumulation of capital generates knowledge which benefits society and increases income. Knowledge grows because of research effort and the rate by which new discoveries are made. This way of modeling is consistent with the approach introduced by Romer (1986) and further developed by many others (see Aghion and Howitt (1998) for a review). We amend the accumulation of knowledge by introducing the stock of social capital. The stock of social capital has a positive effect on the accumulation of knowledge, which in turn increases output. The idea is that social capital has a positive effect on the investment in innovation. When researchers live in areas with a larger extent of social networks and have high norms, venture capitalists are more likely to invest in risky projects. This argument is similar to the one used by Guiso, Sapienza, and Zingales (2004), who argue that social capital yields higher financial development. We argue that it induces innovation.

We bring our framework to the data by applying it to 102 regions in the EU-14 (Luxembourg is excluded). The regions of the EU-14 are from a homogeneous set of countries that have operated under similar judicial and financial-economic regulation for some time now. Hence, variability in current formal institutions and capital markets is likely to be of minor importance only when investigating regional differences in economic performance. This is an important advantage of our approach, since the results presented in Knack and Keefer (1997) are based on a set of countries including next to OECD member states also less-developed countries (such as India, South Africa, Nigeria and Turkey) and a number of South-American countries that seem to be hard to compare in terms of economic conditions and institutions. Indeed, as shown by Beugelsdijk, de Groot, and van Schaik (2004), the presence of poor countries in cross-country samples affects both the significance and size of the effect of social capital on growth. So, showing that social capital affects welfare, even within a homogeneous group of countries, improves the credibility of our estimates.

There are important differences between EU regions and more interestingly regions within a country in terms of social capital and innovation performance. Recent work by Moesen, Van Puyenbroeck, and Cherchye (2000), Beugelsdijk and van Schaik (2005) and Iyer, Kitson, and Toh (2005) shows that nearly all dimensions of social capital display relatively large differences between regions. For instance, in our data the ratio of the highest and lowest trust score is around 1.2 in Germany and the United Kingdom and about 1.6 in Spain and Italy (with trust measured by aggregating the information from individuals to the regional level on a scale from 1 to 10). In addition, there are also differences in innovation inputs and performance and income across and within EU countries (e.g., Gambardella, Mariani, and Torrisi, 2002; Bottazzi and Peri, 2003; Bilbao-Osorio and Rodriguez-Pose, 2004; European-Commission, 2001). We discuss these differences in detail in Section 3. Finally, regional policies are increasingly strengthened and EU countries are delegating more responsibilities to regions for the design and implementation of innovation policies (e.g., European-Commission, 2003). This adds to the importance of the regional dimension of this research.

The creation of social capital and its measurement over time is important for the validity of our empirical analysis. Countries such as Italy, Spain, the United Kingdom and Germany were once composed of self-governed small states. For instance in the 18th and 19th century there were important social and economic differences between Italian regions under Papal order and regions that were free, or between Hamburg and the other German regions under Prussian order. We collect data for past political institutions, the presence of universities, literacy, and urbanization from 1600 onwards and show how historical developments affect the current stock of social capital. The argument is that these historical institutions have contributed to the early development of social capital (e.g., Tabellini, 2005) and in Appendix 2 we present the approach to dealing with these historical data.

We use information from the European Social Surveys (ESS) and the European Values Surveys (EVS) to obtain measures of the current stock of social capital. Innovation indicators are taken from Eurostat's regional database, which contains information on the number of R&D workers and the number of patent applications. Economic performance is measured as GDP per capita growth in the period 1990-2002.

The empirical analysis consists of three steps. We first establish a causal link between social capital and income per capita. Running regressions using historical institutions as instruments for current social capital results in robust and significant positive effects of social capital on income per capita. These estimates are economically meaningful and consistent with estimates from the literature (see Durlauf and Fafchamps (2005) for an overview). Next, we estimate the relationship between innovation output and social capital, using the relative number of patent applications as the dependent variable. Again we instrument social capital by using information about historical institutions. The estimates suggest that a higher stock of social capital yields higher levels of innovation. Finally, we apply a 3SLS strategy to estimate how historical institutions and investments influence current social capital, which in turn has an impact on innovation, which is a determinant of current income. Of course, social capital is also entered directly to address a possible direct link between social capital and income. The 3SLS estimates suggest a strong effect of innovation on income through social capital, and no direct effect of social capital on income. The estimates reveal that social capital is a determinant of innovation, which in turn explains on average approximately 15 percent of the change in income per capita in the 102 EU regions in our data between 1990 and 2002.

This paper proceeds as follows. Section 2 presents the theoretical background of the linkages among social capital, innovation and income. The data and descriptive statistics are presented and discussed in Section 3. In Section 4 we explain our empirical strategy. Section 5 contains the estimates and robustness and stability analyzes. Section 6 concludes.

2 Theoretical Background

Most of the existing literature focuses on the relationship between economic outcomes and innovation (e.g., Aghion and Howitt, 1998) or on the role of social capital for economic growth (e.g., Knack and Keefer, 1997; Zak and Knack, 2001). Our approach investigates the link between these literatures by introducing the role of social capital in fostering innovation, which in turn is a driver of economic outcomes. This approach introduces a number of causal links, which we systematically analyze in this section. Since the unit of analysis in our empirical work is an EU region, we set up the model in terms of individuals living in regions with regions operating in autarky.

The model we depart from is one in which differences cannot be due to differences in market incentives and appropriability of innovation outcomes only, since we focus on the regions of the EU-14 operating in the same capital market. We conjecture that differences in the way in which historical institutions have shaped social capital is an important channel by which innovation is stimulated. This approach is consistent with the notions summarized in Aghion and Howitt (1998) in which innovation occurs through incentives and is stimulated by creativity and market structure, which are determined by institutions. We add that next to these channels the channel through which social capital influences innovative activity is important to explain differences in income.

Our theoretical framework can be summarized as follows: A higher social capital stock, which is determined by historical institutions, increases the incidence of innovation. The reason for this is that investments in innovative activities are risky and capital providers want to receive commitment from researchers that their money is well spend. This is easier in an environment in which people trust each other. In turn, this increases income.

2.1 Framework

2.1.1 Production

Consider a simple model in which output in region J (Y^J) is produced by using the inputs labor (L^J) and capital (K^J):

$$Y = AK^{\alpha}L^{1-\alpha}, \tag{1}$$

where we suppress the superscript J when it does not lead to confusion. In this set up, there are constant returns to capital and labor. A is accumulated endogenously, which implies that production is characterized by increasing returns.

Assume now that the accumulation of capital generates new knowledge, which benefits the whole region. Also assume that everyone (all individuals and firms) takes the level of A^J as given and can not influence this effect when they invest in capital because they are small relative to the economy. For simplicity, this process takes the following form:

$$A = SK^{1-\alpha}, \tag{2}$$

where S is the stock of knowledge or developed ideas, as modeled and explained by Jones (2005). This set up implies that the accumulation of capital yields external beneficial effects to the people living in the region as a whole even when capital is paid its marginal product $\alpha Y/K$.

If we combine these two expressions we obtain

$$Y = SKL^{1-\alpha}. \tag{3}$$

In this model the accumulation of knowledge is treated as a by-product of capital accumulation. When we normalize L to one, we obtain the simple and now standard growth equation due to Romer (1986): $Y = SK$. Note that in this simple model we abstract from the underlying economics of the model, but that the outcomes are consistent with a more elaborate model of e.g., creative destruction with temporary monopoly rents in which three sectors (final goods, intermediate products and research) compose the economy. In such a model, due to Aghion and Howitt (1992), a Cobb-Douglas production technology, a continuum of intermediate products and arbitrage in the research sector between investment in capital and research, show that equation (1) is an adequate representation of production. We do not need this level of detail however for the analysis of income differences between EU regions.

The growth of the stock of knowledge ($\dot{S}$) is equal to the total effort (E) put in research (e.g., spending on R&D or the number of researchers working on the development of new ideas) multiplied by the rate at which discoveries take place. The innovation of our approach is that this rate is not a constant (as in Romer, 1986) or depended on (part of) the existing stock of knowledge (as in Jones, 2002), rather it also depends on the stock of social capital in a region (V): $\dot{S} = \chi E^{\beta} S^{\lambda} V^{\phi}$. For simplicity, we abstract from the effects of total research inputs and the existing stock of knowledge on the growth of the stock of knowledge and focus solely on the effects of social capital, which is equivalent to moving to the simplest version of the Romer-model extended with social capital:

$$\dot{S} = \Lambda V^{\phi}, \tag{4}$$

where Λ is a constant capturing the effects of the knowledge stock and total research inputs discussed above. In this equation $\phi > 0$ means that the productivity of research is increasing in the stock of social capital, which means that the existing stock of social capital contributes to the success of research. If $\phi < 0$, the stock of social capital is detrimental to research and if $\phi = 0$, the productivity of research is independent of the stock of social capital. We assume $\phi < 1$ to eliminate permanent growth differentials between regions, since we are more interested in changes in income levels and the fact that permanent growth effects are inconsistent with the data (Jones, 1995). The growth rate in this model along a balanced growth path is determined by the parameters of the production function for knowledge and the population growth rate (which is zero here).

Our conjecture is that $0 < \phi < 1$, which means that the stock of social capital increases the productivity and success of research, which increases output. This argument now needs a microfoundation.

2.1.2 Innovation and Social Capital

Suppose that there is a constant stream of ideas and that researchers develop these ideas on their own in small one-person firms. Define the utility of researcher i as $U_i = U(e_i, N^J, \rho_i, k_i)$, where $e_i \in \{0, 1\}$ is the decision to put in effort (1) or not (0) in developing an idea into productive knowledge, N^J are the social ties or is the extent of the social network in region J, ρ_i are the individual norms of the researcher, which can be low ρ_L or high ρ_H (with $\rho_H > \rho_L$) and k_i are the cost of cheating. Following the approach developed in Guiso, Sapienza, and Zingales (2004), there exists a cost threshold $\bar{k}_i$ below which the researcher is deciding $e_i = 0$. This decision is a function of his norms and the extent of the social network in the region: $\bar{k}_i = \bar{k}_i(\rho_i, N^J)$, where higher norms and a larger extent of a region's social network increase the threshold in the sense that it become harder for the researcher to not exert effort.

Venture capitalists are willing to invest in the idea of researcher i only if they know the researcher is exerting effort. This effort is not observable for the venture capitalists, only the outcome of the innovation process is, where we assume that if $e_i = 1$ the innovation is successful. For simplicity we assume many capital providers searching for returns, and a one period set up, with no opportunity to retaliate or learn. The probability that researcher i in region J will exert effort, depends positively on the fraction of researchers with high norms ρ_H in region J (defined as Γ^J) and the social network in region J (N^J). Together, the fraction of researchers of the high type and the extent of the social network in region J determine the stock of social capital. Now, the higher this stock the higher the willingness of investors to provide venture capital. The individual venture capitalist's investment in region J will then be

$$E_i = f(\Gamma^J, N^J) = g(V^J) \tag{5}$$

with $\partial E_i/\partial\Gamma^J > 0$, $\partial E_i/\partial N^J > 0$, $\partial E_i/\partial V^J > 0$. Here E_i is the amount of money the investor is willing to invest in innovation, which is either E_i or 0. We abstract from defining the investor's exact preferences and modeling the investor's utility but assume that the expected output of i's investment is $E(Y_i) = (1 - \pi^J)Y_H + \pi^J Y_L \geq rE_i$, where Y_H (Y_L) is the output when $e_i = 1$ ($e_i = 0$) and π^J is a function of Γ^J, with $\partial\pi^J/\partial\Gamma^J > 0$. This is similar to the exposition developed in Guiso, Sapienza, and Zingales (2004). Equation (5) now implies that investments in research are more productive in high social capital regions. Translating this to equation (4) implies that the social capital stock is a determinant of the translation of ideas into new knowledge.

2.1.3 Putting the Arguments Together

This relationship between social capital and innovation is novel and the interpretation of the model needs discussion. There is an element of risk involved in innovation projects that shows up in different ways. The investor may be risk averse, internal capital constraints may be too high in a competitive market, monitoring costs are high, or information asymmetries and moral hazard problems hinder the financing of R&D (e.g, Leland and Pyle (1977), Bhattacharya and Ritter (1983), Myers and Majluf (1984), Boocock and Woods (1997), and Bougheas (2004) for the development of these arguments). For the model it does not matter where the barriers are coming from, as long as social capital can lower them. This is possible in at least three ways. First, social capital prevents egoistic behavior because of the enforcement of informal norms. In a signalling game researchers with "bad" projects can successfully mimic firms with "good" projects, leading to underinvestment in innovation. Social capital can alleviate this problem because of the fear that cheating affects reputation, which increases the threshold $\bar{k}_i$ below which the researcher is putting in effort and uses the effect of the strength of N^J on investment. Second, investors may finance an idea by considering the reputation of the firm. If a researcher displays an honest character by signalling the true quality of his ideas, his trustworthiness rises in the eyes of investors. Investors may change their expectations regarding the researcher, which would increase the probability of financing ideas in the region. This has the effect of increasing Γ^Jin a region. Finally, when the relationship between investor and researcher is based on trust, monitoring costs are low. Hence, an environment of trust would reduce monitoring costs and make innovation a more efficient investment. By the same token, it may reduce the costs incurred by the venture capitalist to gather information about the quality of firms and the projects. Note that we have included this effect of innovation through social capital next to a direct effect of innovation on output. This direct effect is included in the Λ-term in equation (4).

We also assume that the formation of the stock of social capital is a long-run process. In this we follow the recent work by Tabellini (2005). He shows for European regions that current culture is shaped by historical institutions in the period from 1600 to 1850. Research along similar lines by Acemoglu, Johnson, and Robinson (2005) and La Porta, Lopez-de Silanes, Shleifer, and Vishny (1999) reveals that early institutions are important determinants of current economic outcomes, such as income. We follow this argument for the stock of social capital. In the next section we discuss this use in more detail.

This simple set up does not present a detailed analysis of the relationship between social capital and innovation, but is consistent with the variety of channels social capital is able to increase innovation. Rather, this model, which can be easily extended to a full-blown endogenous model with a separate research sector in the spirit of Grossman and Helpman (1991) and Aghion and Howitt (1992) without changing the outcomes, puts the proposed causal relationship between social capital, innovation and income together at the regional level. Regions with higher levels of social capital are more successful in innovating and are therefore richer.

2.2 Empirical Implications

Turning now to measurement, our ideal empirical approach would contain measures of social networks and the norms of researchers on the one hand and measures of investment behavior of venture capitalists on the other hand. These are not observed in large enough databases, so we turn to output measures applied in previous social capital studies starting from Knack and Keefer (1997) and to patent data as measures of successful innovation outcomes. An important prerequisite for empirical analysis is that we have to make sure that the social-capital output measures are picking up the direct effect of social capital on innovation outcomes and are unaffected by other environmental variables. To make sure our estimates are reliable, we use an instrumental variables approach with historical social capital outcomes affecting the current stock of social capital but not current innovation and income changes. We specify our empirical strategy in Section 4 in more detail.

3 Data and Descriptives

The data span 14 EU countries divided into 102 regions defined according to the Nomenclature of Territorial Units for Statistics (NUTS). We excluded Canarias (ES7), Ciudad Autonoma de Ceuta (ES63), Ciudad Autonoma de Melilla (ES64), Aland (FI2), Departments D'outre-mer (FR9), Provincia Autonoma Bolzano (ITD1), Provincia Autonoma Trento (ITD2), Luxembourg (LU), Regiao Autonoma dos Açores (PT2) and Regiao Autonoma da Madeira (PT3) due to limited data availability. For Austria, Belgium, Denmark, Germany, Greece, Finland, France, the Netherlands and the United Kingdom the NUTS1 definition is used and for Ireland, Italy, Spain, Portugal and Sweden NUTS2 is applied.

We employ as many disaggregated regions as the available data permit. The basic reason to do so is to capture the existing differences even within relatively larger regions. For instance Navarra (ES22) and La Rioja (ES23) belong to the same NUTS 1 region Noreste (ES2), however for Navarra trust score is 35 percent and patent applications are 4 times larger than La Rioja. There were quite a number of universities in Navarra in 19th century but non in La Rioja. Similarly in Italy Liguria (ITC3) and Piemonte (ITC1) belong to the same NUTS 1 region but in Piemonte the executives had unlimited authority between 1600 and 1750 compared to Liguria that enjoyed substantial limitations on executive authority during the same period. Even in a relatively homogeneous country such as Sweden, Stockholm has much larger trust and innovation numbers when compared to regions such as Sydsverige and Norra Mellansverige.[1]

3.1 Social Capital

Measures of social capital are not without controversy. The fundamental premise behind the value-added contributions of social capital is that it complements traditional resources (physical capital, human capital, etc.) with other resources (social networks, trust, norms and values, etc.) to produce better outcomes (e.g., Coleman, 1988). Indeed, from an economist's point of view the beneficial impacts arise only in cases where social capital affects expectations. Granovetter (1985) stresses the networks of (social) relations in establishing expectations to generate trust to create and enforce norms. In a similar vein, Durlauf and Fafchamps (2005) argue that social capital yields positive externalities, which are achieved through shared values, norms and trust that affect expectations and behavior. However, it is not easy to come up with a social capital

[1] We have done similar investigations for 87 NUTS 1 regions and for 82 regions benefiting from the EU structural funds (e.g., Akçomak and ter Weel, 2008). The results display a similar character and do not pose fundamental changes to the conclusions reached here.

indicator capturing the above aspects. For instance, Fukuyama (1995) provides various cases on why trust matters for economic well-being. The empirical social capital literature focuses on explaining differences in economic growth and has benefited from "generalized trust" as a proxy for social capital, which measures the degree of opportunistic behavior (e.g., Knack and Keefer, 1997; Zak and Knack, 2001). Knack and Keefer (1997, p.1258) argue that trust "reflects the percentage of people in a society who expect that most others will act cooperatively in a prisoner's dilemma context".[2]

With this in mind, our main social capital indicator (*trust*) comes from the first round of European Social Surveys (ESS) conducted in 2002, a database designed to measure change and persistence of people's social and demographic characteristics, attitudes and values. The original data are adjusted by population weights to reduce the possibility of complications that might arise due to over-sampling.[3] The *trust*-indicator is constructed from the answer to the following statement: "Most people can be trusted or you can't be too careful". The answer category ranges from (0) "you can't be too careful" to (10) "most people can be trusted", with nine levels in between. The individual scores are weighted and aggregated to the regional level and range from 1.67 [Cantabria, ES13] to 7.05 [Denmark, DK0] with an average (std. dev.) of 4.88 (0.78) for all 102 regions. Previous studies also found large differences in social capital measures within countries (e.g., Beugelsdijk and van Schaik (2005) for European regions and Iyer, Kitson, and Toh (2005) for US regions). Aggregating regions to countries reveals that *trust* is highest in Denmark and lowest in Greece as can be seen from the column (7) in Table 1.

Previous studies mostly employed a trust indicator from the first round of European Values Study (EVS) conducted in 1990, in which the respondents were asked, "generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people" (*trust0*).[4] The interviewees were given two choices: (i) most people can be trusted or

[2] One reason why we exclusively relied on this measure is that there are some studies conducted for the United States and Germany that complement surveys with trust experiments. It is found that general trust questions are correlated with the actual behavior from the experiments (e.g., Fehr, Fischbacher, von Rosenbladt, Schupp, and Wagner, 2003; Glaeser, Laibson, Scheinkman, and Soutter, 2000). We have also benefited from questions that might represent other forms of social capital and are similar to the ones that are used in the literature. For instance, questions on whether individuals take part in social activities (*social*), whether individuals are politically active (*polactiv*) or whether they are active members of voluntary organizations (*putnam* and *olson* groups). We found some of them to be significant. See Section 5.3 for the details of this exercise.

[3] Countries participating in ESS have very different populations, but the sample presents information from 1,200 to 3,000 individuals for each country. For instance, the German sample is composed of 2,919 and Dutch sample is composed of 2,364 individuals. However, Germany is almost five times larger than the Netherlands. Especially in studies that compare countries or regions it is advised to correct the data with the population weight provided by the ESS. This minimizes the risk of over-representation of some countries.

[4] The European Values Survey (EVS) is designed to measure fundamental values and norms in ordinary life such as social-economic life, politics, family, marriage, religion etc. Unfortunately, the first round of EVS in 1990 covers only 13 European countries (not covering regions of Austria, Greece, Finland, Luxembourg and former

(ii) you can't be too careful. The ESS measure is preferred over this one because respondents can choose a level on a 0-10 likert scale.[5] The two trust scores from EVS and ESS are highly correlated as can be seen in Figure 1 (the correlation coefficient (0.65) is significant at the one percent level). Even though *trust0* is not available for all the EU-14 countries it is apparent that both trust indicators, *trust* and *trust0*, reveal that the northern European countries such as the Netherlands, Sweden and Denmark are characterized by higher generalized trust scores when compared to the southern European countries (Table 1, column (7) and (8)). In the next section we will report estimates for both trust indicators.

3.2 Innovation, Performance and Education

The innovation, education and economic performance measures are taken from Eurostat's regional database. We use two main indicators of innovation: Patent data to measure innovation output and R&D intensity to capture inputs.

We define the "total number of patent applications to the European Patent Office (EPO) by year of filing excluding patent applications to the National Patent Offices in Europe" per million inhabitants as a proxy for innovation output. These figures might not reflect the true regional innovative potential, but it reflects "commercially significant innovations at the world's technological frontier" (e.g., Furman, Porter, and Stern, 2002). Patents are an imperfect proxy for regional innovativeness (e.g., Pavitt, 1982, 1988), but are the only well-established source reflecting innovative activity (Trajtenberg, 1990). To avoid yearly fluctuations we use a three-year average around each point in time, so that *pat91* is the average of patent applications per million population in 1990, 1991 and 1992; and similarly *pat00* is the average of patent applications per million population in 1999, 2000 and 2001. Column (4) and (5) in Table 1 present the country averages of these indicators.

Our patent indicator reveals the following. First, the indicator displays considerable differences between regions supporting previous findings (e.g., Bottazzi and Peri, 2003), which also holds at the country level. The patent applications per million inhabitants in 1991 range from 0.6 [Centro, PT16] to 281.1 [Baden-Wurttemberg, DE1], with a mean (std. dev.) of 58.3 (61.6).

East Germany).

[5]EVS incorporates two other trust questions, (i) trust in country citizens, and (ii) trust in family. They are both measured on a 1-5 scale, (1) representing 'trust them completely' and (5) representing 'do not trust them at all'. When we reverse these scales so that higher scores would reflect higher trust, the mean (std. dev.) of trust in family, 4.73 (0.16), is much higher than trust in country citizens, 3.59 (0.30) for 72 EU regions. However, the latter also measures generalized trust akin to the trust measure employed by previous studies (*trust0*). This reveals that the respondents' perceptions are clearly different in each question, which can be seen as evidence that the trust question measures "generalized trust".

In 2000, it ranges from 1.8 [Kentriki Ellada, GR2] to 570.4 [Stockholm, SE01] with a mean (std. dev.) of 116.1 (124.4), which indicates that the differential is persistent in the 10-year period. Another observation is that patent applications of an average northern EU country such as Denmark, Finland and Sweden are almost ten times higher than an average southern EU country such as Greece, Portugal and Spain. Also, there seems to be convergence in patent applications over the 1990s, illustrated by a negative unconditional correlation of -0.589 (significant at 1 percent level) between the growth rate of patents between 1991-2000 and log of patents in 1991. This relationship is presented in Figure 2a. The horizontal axis measures the log of the number of patent applications per million inhabitants in 1991 and the vertical axis measures the growth of applications between 1991 and 2000.

R&D intensity is used as a proxy for innovation input. R&D intensity is defined as the percentage R&D personnel employment in total employment in the business enterprize sector in 1995.[6] This measure ranges from 0.06 [Valle D'Aosta, ITC2] to 3.53 [Stockholm, SE01], with a mean (std. dev.) of 1.16 (0.68). Comparison of the numbers in column (6) to the ones in column (4) and (5) in Table 1 shows that higher R&D intensity is generally associated with more patent applications. The correlation between our R&D measure and patent measures equals 0.748 in 1991 and 0.766 in 2000, both significant at the 1 percent level.

We measure economic performance by the growth rate of Gross Domestic Product (GDP) per capita between 1990 and 2002. Column (1) in Table 1 presents this rate and column (2) shows GDP per capita in 1990. The data suggest convergence in economic performance over the 1990s because the correlation between the growth rate of per capita GDP and initial GDP is -0.701, which suggests that lagging regions in 1990 are catching-up in the last decade. This relationship is presented in Figure 2b.

Finally, we capture human capital as the share of tertiary level students (levels 5, 6 and 7) in all students in 1993, according to the International Standard Classification of Education 1976 (ISCED76) definitions. The reason for not following the literature (e.g., Barro, 2001) which uses differences in primary and secondary education level is that there is hardly any heterogeneity in these levels of education within our sample of high-developed EU-countries. There are significant differences between European regions and countries. Column (3) in Table 1 shows that Finland and Belgium have the highest proportion of tertiary students, while Ireland and the United

[6]Information on other measures, such as R&D expenditures, is not available for the full sample (more than 15 regions are missing). We also could not employ earlier years because of the same problem. However, we think that our measure is a satisfactory input measure considering the correlation between R&D intensity and other R&D measures. The correlations are 0.756 and 0.759 with total and business R&D expenditures for 89 regions. Both coefficients are significant at the 1 percent level.

Kingdom are among the lowest in our sample.

3.3 Institutions, Literacy and Universities

To estimate causal links between social capital, innovation and per capita income growth we need a set of instruments. To find instruments we use historical information from institutions.

3.3.1 Historical Data on Literacy

Education is an important determinant of economic growth (e.g., Barro, 2001). Sandberg (1982) shows for 21 European countries that there exists a relationship between the literacy rates in 1850 and per capita income in 1970, but not between literacy and income in 1850, suggesting that literacy affects economic well-being in the very long-run. This finding is further supported by Nunez (1990) for 49 Spanish provinces. Unfortunately, in most of these studies it is unclear how literacy translates into better economic outcomes.

A not so emphasized aspect of education is that it facilitates an environment in which "good" cultural character can form. For instance, Cipolla (1969) argues that literacy in the 17th and 18th century served as a basic intellectual and cultural humus for the development of both mechanical and organizational innovations in the industrial revolution.[7] So, regions lacking solid educational institutions several centuries ago are likely to have poorer cultural character when compared to regions with well-established educational institutions (Tabellini, 2005) and these "good" cultural traits may have an impact on current income levels. For instance, Lazear (1999) shows how common culture and language facilitates trade between individuals. It is true that trade still exists in the case of multiculturalism but only with intermediaries and in a world of second best where transactions are costly. In the presence of more social capital these transaction costs are falling. The argument here is that, besides a direct effect of education on income, an indirect effect that operates through social capital exists as well.

We use literacy rates in the 1870s and 1880s as a proxy for education. Although the information differs slightly for different regions, in most cases the collected information refers to the percentage of the population that is able to read and write − including the people who are able to read only − in 1870s and 1880s. Except for Austria, Greece, France, Portugal and Sweden we found data at the regional level. The data reveals that literacy rates in northern countries were on average about three times larger than the southern countries in the 19th century. Moreover

[7] In his words "...widespread literacy meant not only an elastic supply of literate workers but also a more rational and more receptive approach to life on the part of the population"(Cipolla, 1969, p. 102).

more-developed countries such as the UK, Germany and France are characterized by relatively homogeneous literacy rates across regions compared to countries such as Spain and Italy where differences are considerably higher. In Italy, Piemonte had a literacy rate of 68 almost five times larger than Calabria (14.6). We collected the data from several different sources, which are discussed in Appendix 2.1. Column (9) in Table 1 presents country averages, with low early literacy rates in Southern European countries and high ones in the Nordic countries.

3.3.2 Historical Data on Universities

Universities are institutions that blend educational, social and cultural elements. Readings (1996) argues that the evolution of culture can be understood in a framework of struggle between the state and the university. Especially until the end of 19th century universities have been the primary institution of national culture and identity and played a central role in national liberation movements. For instance, in the early 19th century after the battle of Jena, it was not surprising that one of the first actions of Napoleon was to suppress Halle University (Saxony-Anhalt, Germany) (e.g., Rudy, 1984).

Universities not only create graduates with a common world view educated in the same cultural tradition but also indirectly shape the future of a region or a state by integrating their graduates in the existing social structure. If universities are successful in transferring this vision to the public, then this dynamic structure can serve to raise "good citizens" who behave well and act collectively to reach a certain state of solidarity. In this respect, universities provide an important public good that cannot be provided in other ways (e.g., Cowan, 2005).

We employ two different variables on the history of European universities. First, *univF* is defined as "2000 minus the foundation date of the university" to measure the period of existence of universities in a particular region. The latter part refers to the date of foundation of the first university established in a region. By construction, higher values reflect the existence of universities in a region for longer periods. The second variable, *univN* captures the density of universities. It is defined as the number of universities per 100,000 inhabitants around 1850. A detailed inspection of the data shows that countries that are relatively richer such as Germany, the UK and Belgium had a more uniform distribution of universities per population. In countries such as Greece, Italy, Portugal and Spain, universities were clustered in particular regions. In northern countries such as Sweden and the Netherlands universities were generally clustered in regions close to the sea.[8] The main argument behind the hypothesized effects of these variables

[8] For a brief discussion of the state of the European Universities from 1500 to 1800 see Ridder-Symoens (1996).

is that universities establish a basis where regional culture or identity nurture. This basis would eventually transform informal institutions and affect the formation of social capital.

Along the same line of argument we develop two other historical measures. First, the arithmetic average of the standardized values of *univF* and *univN*. Second, the first principal component of the standardized values of the two variables. The major sources for these variables are Ridder-Symoens (1996) and Jilek (1984). Further information can be found in Appendix 2.4. Country averages of these variables are displayed in Table 1.

3.3.3 Historical Data on Institutions

Tabellini (2005) argues that the current state of informal institutions is shaped by the history of its formal institutions, such as political, legal and economic institutions. This assertion becomes even stronger when considering that EU regions belonging to the same country now were governed by different political power and institutions especially before the 19th century. The argument here is that political liberalism has a positive impact by nurturing "good" cultural character, whereas "bad" cultural character might be a reflection of rigid autocratic political power in the past.

Several authors have argued that a political system inclined towards institutional liberalism, in which the supreme authority is constrained, is beneficial for economic well-being. For instance, North and Weingast (1970) argue that England's unique political institutions play a major role in economic development at a later stage. In a study on European cities, De Long and Shleifer (1993) show that absolutist monarchs discouraged growth of commerce and industry in Western European cities in the period 1000-1880. In a similar vein, Acemoglu, Johnson, and Robinson (2005) argue that, during the period 1500-1850, substantial economic gains occurred only in nations where the existing political institutions were able to place significant checks and balances on political power. Most important to our research is the effect of past political liberalism on the evolution of cultural traits. In a seminal study that compares the Maghribi and Genoese traders in the late medieval period Greif (1994) argues that divergent political and social histories and cultural heritages between the Maghribis and Genoeses gave rise to different cultural beliefs that later affected the evolution of the societal organizations. He shows that collectivist cultural beliefs, characterizing Maghribis, led to a societal organization in which the economic, social and moral sanctions against aberrant behavior were applied (and controlled) by certain group(s); whereas individualist cultural beliefs, characterizing Genoeses, resulted in an organizational structure in which each group's ability to use economic, social and moral sanctions against individual members was limited. In this respect, for example, "the medieval Latin individualist society may have cultivated the seeds of the 'Rise of the West' " (Greif, 1994, p. 943).

As a proxy for past political institutions, we employ data on "constraints on the executive" defined in the POLITY IV project, Political Regime Characteristics and Transitions, 1800-2002.[9] It is coded on a scale of 1 to 7, (1) representing "unlimited authority" and (7) "accountable executive constrained by checks and balances". More information on the coding can be found in Appendix 2.3. This variable presumably captures "institutionalized constraints on the decision making powers of chief executives, whether individuals or collectivities" and hence higher values are associated with a tendency towards democratic institutions and political liberalism.

Most of the observations in our data come from Acemoglu, Johnson, and Robinson (2005) and Tabellini (2005). In some cases we draw on the website of the POLITY IV project. Over 70 regions in our data set are coded using the above sources. We coded the variable "constraints on the executive" in the same way as POLITY IV for the remaining regions (or countries). If the region had no (or little) political autonomy then all regions are assigned the same value. In doing so, we consider the political institutions in a 40-year window around each date (for instance for 1850, we consider the period 1830-1870). Information is available for five dates: 1600, 1700, 1750, 1800 and 1850. In the second half of the 19th century most countries in our sample completed their unification process, so after 1850 we expect regional differences to be less important. Detailed information on how the variables are coded is presented in Appendix 2.3.

Our data on institutions display some interesting features. More democratic institutions are associated with higher current social capital. Up to 1750 there were no considerable changes in constraints on the executive. Then, within a hundred years, European regions display a gradual improvement in limiting the power of the chief executives and move towards democracy. Second, countries such as Ireland, Belgium, Denmark and the UK rapidly moved towards a more democratic setting after 1700. Around the second half of the 19th century in the Netherlands, Ireland and the UK the chief executives were almost completely controlled either by the parliament or the governing body. On the other hand in countries such as Austria, Greece, Italy and Portugal change was relatively slow and even in the 19th century these countries were far below the level of the Netherlands and the UK. Lastly, in Germany, Greece and Italy there were important differences between regions as opposed to other countries that display more homogeneous

[9]For more information see http://www.cidcm.umd.edu/inscr/polity/ and Eckstein and Gurr (1975).

distribution.

Following Tabellini (2005) we define two variables. First, *instAVR* is the arithmetic average of five variables, *inst1600*, *inst1700*, *inst1750*, *inst1800* and *inst1850*. The variables *instXXXX* are defined as the political institutions in year *XXXX*. Second, we define *instPC*, as the first principal component of the five variables.[10] The final columns in Table 1 present country averages for these variables.

Appendix 1.1 provides the definitions of all variables used in the empirical analysis. Table 2 shows summary statistics for the core variables applied in this paper. Due to space limitations the data in Table 1 are published at the country level. Information at the regional level can be obtained from the authors upon request.

4 Empirical Strategy

To show that social capital improves economic outcomes, the literature has used two strategies. The conventional method is estimating a growth equation using OLS, in which per capita GDP growth is regressed on usual determinants (such as the initial per capita GDP, investment, education) and a set of social capital indicators (for instance trust, membership to voluntary organizations etc.). However, the problem of reverse causation is fundamental in estimating these relationships because current levels of social capital are likely to be influenced by past and current economic conditions. Hence, OLS correlates of the relationship between social capital and economic outcomes could be biased and cannot be interpreted as reflecting causal effects of social capital on per capita income growth. To estimate causal relationships Knack and Keefer (1997) use the number of law faculty graduates as an instrument for social capital and Tabellini (2005) employs information on history of political institution between the 17th to 19th century and literacy rates at the end of 19th century as instruments for culture.

Our empirical implementation differs in three ways from the existing literature. First, social capital is positively correlated with levels of education. Higher levels of education would generally result in denser networks in which social capital forms and higher social capital would also lead to better education opportunities. This dynamic relation has not been incorporated in previous research analyzing the effect of social capital on growth. In terms of the methodology, this suggests considering interaction terms between social capital and education. We expect the

[10] The eigenvalue for the first component is 3.72 and describes 75 percent of the total variation in the five variables. The first eigenvector ranges between 0.39 and 0.50, suggesting roughly an equal weight for each variable.

coefficient of the interaction term to be positive. In terms of the model this might show up as higher N^J or in a more elaborate version of the model relatively more skilled workers feeding back into higher N^J.

Second, we know that economic performance is positively correlated with innovative activities. It is also known that societies in which people enjoy each other's confidence experience a higher level of economic performance. This implies that societies with a higher level of trust are better able to manage the process of innovation and that creative effort will be rewarded in relatively trusting societies. To illustrate this we plot trust against patent applications in 1991 and 2000 and the results suggest a strong relation between the two indicators (see Figure 2c and 2d). The correlation coefficients equal 0.433 and 0.453, respectively. We incorporate this relation in our framework by employing a patent regression, in which we explain patent applications with R&D intensity, education and trust.

Third, an important difficulty is to combine these causal relations (i.e., from trust to growth; from trust to innovation; from innovation to growth) into one structure. In addition to simultaneity problems, both the growth and innovation equation contain *trust*, which is endogenous to the system either as a result of omitted variables or measurement error: Regions with higher levels of social capital may facilitate a structure in which it is easier and more effective to implement policies to further foster economic development and boost innovation (Akçomak and ter Weel, 2008). Nevertheless, it is hard to measure policy success. Assuming that such indicators on policy success are measurable and relevant, they are omitted from both equations (6) and (7). So, it is reasonable to assume that *trust* may be correlated with the error term. This suggests an estimation method in which *trust* is instrumented.

A solution to this problem is to add a third equation to the system, i.e. a linear projection of the endogenous variable on all exogenous variables in the simultaneous system. In addition to the exogenous variables, including instruments that are correlated with *trust* would alleviate weak instrument problems. We instrument *trust* with the historical information collected on literacy rates, universities and political institutions. Estimating this system with 3SLS produces consistent estimates (Wooldridge, 2002, chap. 9).

The following system is then estimated:

$$\begin{aligned} growth &= \beta_0 + \beta_1 gdppc90 + \beta_2 pat91 + \beta_3 trust + \\ &\quad \beta_4 educ + \beta_5 urban + \epsilon \end{aligned} \tag{6}$$

$$pat91 = \alpha_0 + \alpha_1 R\&Dintns + \alpha_2 trust + \alpha_3 educ + \upsilon \tag{7}$$

$$\begin{aligned} trust &= \delta_0 + \delta_1 literacy + \delta_2 instPC + \delta_3 univPC + \\ &\quad \delta_4 X + \eta, \end{aligned} \tag{8}$$

where the subscript J for regions has been suppressed for notational convenience, and the error terms comply with the assumptions described above. *Growth* is the per capita GDP growth in the period 1990-2002 and *pat91* is the log of patent applications per million inhabitants in 1991. We include the log of initial GDP per capita, *gdppc90*, as a measure of convergence. *R&Dintns* represents our measure of R&D intensity. We employ the *trust* measure from the ESS. Our education variable *educ* captures the current effect of education on growth next to the effect through our historical data. *Urban* is a proxy for the economic development around 1850s. The reason for including this covariate is that Tabellini (2005) shows that the historical instruments influence current economic growth through social capital rather than a long-run process of per capita income growth. The last column in Table 1 shows country averages for this variable. In equation (8), X denotes the vector of variables exogenous to the system consisting of *gdppc90*, *R&Dintns*, *educ* and *urban*. The instruments are the following: *literacy* is the literacy rate in 1880; *univPC* is the first principal component of two indicators measuring the intensity and the period of existence of universities in the 19th century; and *instPC* represents the first principal component of five indicators measuring the state of political institutions between 1600 and 1850. All the equations include country fixed effects.

Table 3 presents the correlations between our measure of social capital and the instruments. Literacy and trust are strongly and positively correlated as well as trust and institutions. The correlations between trust and the measures of the presence and density of universities are positive but less strong.

5 Estimation Results

5.1 The Effect of Social Capital on Growth

Table 4 first presents estimates of the effect of social capital on per capita income growth for 102 regions by estimating

$$growth = \beta_0 + \beta_1 gdppc90 + \beta_2 educ + \beta_3 urban + \beta_4 trust + \epsilon, \quad (9)$$

using OLS. The estimates suggest that higher levels of *trust* yield higher GDP growth in the period 1990-2002. The estimate suggests that a one standard deviation (0.78) increase in social capital increases regional per capita income growth by 14 percent. This result is consistent with the estimates presented in Knack and Keefer (1997) for a cross-section of countries over the period 1980-1992. In column (2) we added an interaction term to capture the possible complementarity between social capital and education. The results do not change. Using *trust0* − the trust indicator from EVS90 − yields similar estimates.

Social capital is endogenous and column (3) in Table 4 reports the first stage of the instrumental variables strategy. The first-stage estimates suggest that all instruments are positively and significantly correlated with *trust.* This correlation is not surprising given the individual correlations between the instruments and *trust* from Table 3 above. F-tests for the joint significance of the instruments always exceed the critical value of 10, suggested by Staiger and Stock (1997). Finally, the 2SLS estimates reported in column (4) of Table 4 imply that there is a strong and significant impact of social capital on per capita income growth in the period 1990-2002. Hausman, Sargan and F-tests reported at the bottom of Table 4 suggest that these estimates are robust.

Table 5 reports first-stage and second-stage estimates using the instruments individually in three sets of regressions. The estimates suggest that the coefficient of social capital is somewhat sensitive to the use of different instruments, but the effects remain qualitatively similar compared to the estimates in Table 4. We have estimated a number of alternative equations using instruments of groups of two or three and they always produced a *trust* coefficient significant at the five percent level. We never encountered a case of weak instruments in the first stage because all instruments returned an F-test of joint significance greater than 10. Also the null-hypothesis that the over-identifying restrictions are valid is never rejected.[11]

[11] We also conducted a detailed analysis in which we consider four university indicators, *univPC, univAVR, univF* and *univN.* This analysis consists of estimating 29 regressions. In this case we found that only the indicator *univF* has a relatively poor performance as an instrument for *trust* with significance only at the ten percent level.

5.2 The Effect of Social Capital on Innovation

Table 6 first reports the results from estimating

$$pat91 = \beta_0 + \beta_1 R\&Dintns + \beta_2 educ + \beta_3 trust + \epsilon, \tag{10}$$

and

$$pat00 = \beta_0 + \beta_1 R\&Dintns + \beta_2 educ + \beta_3 trust + \epsilon, \tag{11}$$

using OLS. The estimates suggest that a region's innovative output is higher when its level of social capital is higher. These estimates are consistent with the ones presented by Fritsch (2004). He finds that cooperation increases the efficiency of R&D activities, which most likely yields higher numbers of successful innovations and patents.

To address the endogeneity of social capital we have used the same three indicators as instruments as for the analysis reported in Table 4 and 5. Both the first-stage (column (3)) and second-stage estimates (column (4) and (5)) are consistent with higher levels of social capital yielding higher levels of innovative output in terms of patents both in 1991 and 2000.

Table 7 reports a number of alternative specifications in which we included the three instruments separately. In addition, we again analyzed the behavior of the instruments individually or as a group in 2SLS estimations, which resulted in estimating 17 2SLS regressions. All regressions produced a *trust* coefficient significant at the 5% percent level. The regressions do not suffer from weak instrument problems and the null-hypothesis that the over-identifying restrictions are valid is never rejected. Only *univPC* fails to produce a significant *trust* coefficient in the second stage for the patent regression (column (8) and (9)).

5.3 Stability

Despite its popularity, the empirical literature economic growth is criticized regarding the robustness of the results achieved. Levine and Renelt (1992) assessed the robustness of the conclusions of cross-country growth regressions and found that almost all results are fragile. To assess the robustness of our findings we investigate how responsive the estimates of *trust* are to the inclusion of other relevant variables that might have an impact on GDP growth or patent growth.

The methodology simply involves assessing the fragility of an independent variable to a change in the information set. The analysis starts by estimating equations of the form

$$Y = F\alpha_j + \beta_{ij} X_i + \gamma_j S_j + \epsilon_j \tag{12}$$

where Y is a vector of GDP per capita growth rates or patent applications, F is a matrix of independent variables that are always included in the regressions, X is our social capital measure, S_j is a set of switch variables that are hypothesized to have a relation with the dependent variable and ϵ_j is the error term. The subscript i indexes *trust* and j indexes the different combinations of switch variables. The analysis assesses the sensitivity of β_{ij} when different sets of switch variables are added to the regression.[12]

We conducted robustness analysis for both per capita GDP growth and patent models (equations (6) and (7), respectively). In the former model the dependent variable is the growth of per capita GDP 1990-2002 and the fixed variables are log of initial GDP, education, trust and urbanization rates in 1850 (Table 4, column (1)). For the latter the dependent variable is the patent applications to EPO 1991 and the fixed variables are R&D intensity, education and trust (Table 6, column (1)). The regressions also include a constant term and country dummies.

Following Beugelsdijk, de Groot, and van Schaik (2004) we selected switch variables from a pool of independent variables from the ESS and Eurostat databases that are exogenous to *trust*. In selecting these variables we considered two criteria:

i) The correlation between a switch variable and *trust* should be less than 0.50 in absolute value; and

ii) The correlation within switch variables should be less then 0.50 in absolute value.

We identified 29 switch variables, which are presented in Appendix 1.2. These switch variables are introduced to the primary regression in all combinations of 1 to 3 variables at a time. In the first column of Tables 8 and 9 we present how many times a variable appeared in a regression for the growth and patent regressions, respectively. For example, in assessing the robustness of *trust*, 4,090 regressions are estimated implying that *trust* appeared in all of these regressions and the statistics provided are calculated by taking all of these regressions into account. We assess the robustness of our results by employing six different tests.

i) *Strong sign test*: All coefficients for *trust* have the same sign.

ii) *Weak sign test*: 90% of the coefficients for *trust* have the same sign.

iii) *Strong extreme bounds test*: This analysis was introduced by Leamer and Leonard (1983).[13] The relationship between the dependent variable and *trust* is robust if all estimated

[12] In employing such a methodology we benefited from MetaGrowth, a computer program designed specifically to assess robustness issues, developed by Heijungs, de Groot, and Florax (2001). For an application of the program on the findings of Knack and Keefer (1997) and Zak and Knack (2001) see Beugelsdijk, de Groot, and van Schaik (2004).

[13] See also Leamer (1983) and Levine and Renelt (1992) for an application to growth literature.

coefficients for *trust* have the same sign and are statistically significant at the same time.

iv) *Weak extreme bounds test*: Sala-i Martin (1997) relaxes the above criterion arguing that the relationship between the dependent and the independent variable is robust if 90% of the estimated coefficients for the independent variable have the same sign and are significant at the same time.

v) *Weighted extreme bounds test*: This test refers to the weighted weak extreme bounds test. The weights are defined as the value of the likelihood of the regression. It is robust if 90% of the estimated coefficients for *trust* have the same sign and are significant at the same time.

vi) *Value of the cumulative density function*: This test is based on the fraction that lies at the right side of zero of the cumulative density function. A variable passes the test (at a 10% significance level) if the test score is smaller than 0.10 or larger than 0.90.

The results of this exercise are summarized in Tables 8 and 9 and highlight a number of points. First, the relationship between *trust* and per capita GDP growth is robust to inclusion of other variables. *Trust* passes 4 of the 6 tests and about 80 percent of the time the resulting coefficient is significant (Table 8). Furthermore, in the patent regressions (Table 9), *trust* passes all of the tests and for all of the estimated regressions the estimated coefficient is significant.[14]

Second, for the growth regressions two indicators from ESS, *help* and *opinion*, display robust results and both have a positive impact on growth. The former can be viewed as a social capital indicator since it is derived from a question asking "How often do you help others not counting work or voluntary work". The latter can be viewed as an indicator of culture. The respondents were asked to rate "To be a good citizen. How important is to form independent opinion?" on a scale from 0 "extremely unimportant" to 10 "extremely important". Apart from these, shares of agricultural and industrial employment seem to have robust impacts on growth. Finally, the indicators discussed above also display a robust character in the patent regression. But additionally, we found strong evidence on the robustness of the indicator *skill*. This can be viewed as a measure of openness and it is constructed from a question asking "all countries benefit if people can move where their skills are most needed".[15]

[14] We have replicated the analysis allowing arbitrary correlations within countries (i.e., with clustered standard errors at the country level). Employing normal or clustered standard errors does not display significant differences. We present a summary of the results for the stability of *trust* in different specifications when we interchange between normal and clustered standard errors in Appendix 4. To maintain the similarity with the original paper of Beugelsdijk, de Groot, and van Schaik (2004) we only present detailed results with normal standard errors in Tables 8 and 9.

[15] For the indicator *help*, the answer categories ranges from (1) "everyday" to (6) "less often than" and for *skill*, the answer categories ranges from (1) "agree strongly" to (5) "disagree strongly". We reversed these scales so that higher values are expected to associate with better innovative and economic outcomes.

Appendix 3 presents a more detailed discussion of the impact of the presence of certain switch variables on the probability of obtaining a significant *trust* coefficient. We find that most regressions in which the *trust* coefficient is insignificant includes other statistically significant measures of social capital such as, *help*, *polactiv* and *opinion*.

5.4 Social Capital, Innovation and Growth

Incorporating trust and innovation in a growth regression is possible by estimating a simple OLS regression in which growth is the dependent variable (see Table 10, column (1)). The results suggest that innovation and social capital have a positive but insignificant correlation with growth. However, *trust* and *pat91* are highly correlated and considering both of them as independent variable may result in misleading findings because of possible multicollinearity problems. The final step in the estimation of the model is to estimate the full model by using the 3SLS strategy. Table 10 reports the results from estimating this model. The core message from these estimates is that more advanced past institutions, such as universities, stable political environments and early literacy, yield higher levels of present social capital (column (8)). This social capital is a strong determinant of innovation outcomes along with traditional inputs such as education and R&D investments (column (7)). Finally, innovation determines growth, but there is not a strong direct impact of social capital on growth (column (2) and (6)). The results of the full model are represented in columns (6) to (8) and the first stage in columns (3) to (5) in Table 10. In column (2) we present the 3SLS estimation result only for growth when trust equation does not include country dummies. The magnitude of the direct effect of *trust* on growth is rather similar, however not significant. A one standard deviation (0.77) change in *trust* is associated with a change in patent applications of 0.94 of a standard deviation, much higher than the impact of *R&Dintns* and *educ*. The effect of social capital on growth seems to work through innovation. Together, our findings imply that social capital is a significant determinant of innovation, which in turn explains approximately 15 percent of per capita income growth in the EU regions between 1990 and 2002.

We have conducted a restricted version of the stability analysis of *trust* for the 3SLS estimates. Benefiting from the results in Section 5.3 we took out 10 switch variables that never turned out to be significant neither in the patent nor in the growth stability analysis and included them individually and in groups of two to ran 1,559 3SLS regressions in total. The results for *trust* and *pat91* are summarized in Table 11. *Trust* returns a positive but insignificant coefficient for more than 99 percent of the cases in the growth equation. In all the estimations performed *pat91* in the growth equation and *trust* in the patent equation are always found to be positive and significant. We also found *skill*, *agremp* and *indemp* to be significant in some cases in the patent equation. Only the importance to obey in law (*implaw*) returns significant coefficients in the growth equation. Finally it seems that *trust* is negatively affected by heterogeneity in the population as in some cases we found the coefficient of *minority* to be significant.[16]

These results have important implications for the literature on relating a region's (or country's) social capital to economic performance. Mostly these studies have been concerned with the causal relationship between social capital and economic outcomes, neglecting explicit definitions of why social capital should have a direct impact or indirect impact through a third factor on economic growth. Our estimates suggest that innovation is an important third factor explaining how social capital increases economic outcomes, largely neglected by this literature.

6 Conclusion

In cross-country comparisons measures of social capital have a direct effect on economic outcomes, such as growth and investments (e.g., Knack and Keefer, 1997). It is however not clear how social capital improves outcomes. This paper identifies innovation as an important channel by which social capital influences per capita economic growth.

Our framework shows how social capital helps in the process of stimulating innovation. The model focuses on differences in social capital across regions and shows that a higher stock of social capital yields more innovation. The main reason for this is that innovation is a risky activity, so the venture capitalist and researcher are both helped if they can trust one another. This is easier in an environment in which people trust each other more. This positive relationship between social capital and innovation feeds back into the production process and increases per capita income.

The empirical contribution of this paper is to show for 102 regions of the EU-14 that early institutions shape current social capital, which in turn influences innovation in regional comparisons. Innovation has an impact on per capital income growth, but the direct effect of social capital on per capita income growth vanishes. These results are obtained using 3SLS estimates in which it is assumed that past institutions and literacy rates are valid instruments for social capital. We show that our methods and estimates are valid and robust.

[16] The results of the robustness analysis for 3SLS should be interpreted with some caution. The reason for this is that each switch variable added in equation (6) or (7) automatically appears in the trust equation hence in some models trust is explained by another social capital indicator besides other variables. This may have produced complications in the analysis.

An implication of this result is that historical differences between regions of an otherwise relatively homogeneous set of countries seem to have a lasting effect on social capital. The contribution of social capital to creating an environment in which capitalists and entrepreneurs are able to strike the best deals improves innovation outcomes, which are different between regions, holding constant any unobserved national variable and contemporaneous education and urbanization rates. Of course, social capital and innovation are not treated at the microeconomic level, so the exact transformation of social capital into innovation remains unclear. But, the estimates suggest that research into this direction is promising.

The idea that the effect of social capital on per capita income growth works through innovation has policy implications for Europe. The findings suggest that backward regions cannot improve fast in terms of innovation and per capita income growth, because the shaping of social capital is crucial and takes long to develop. It also suggests that public investments in R&D might not be beneficial because in all likelihood the private sector has trouble investing money efficiently. These regions would benefit probably more from investments in education, because human capital and social capital are likely to be complementary.

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Table 1: Growth, trust, innovation and historical variables by country

	growth	gdppc90	educ	pat91	pat00	R&Dintns	trust	trust0	literacy	instAVR	instPC	univAVR	univPC	urban
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Austria	0.47	15680.07	14.40	91.90	149.39	0.35	5.10		91.50	1.20	-1.70	0.19	0.27	10.16
Belgium	0.47	17376.70	15.47	62.69	148.98	0.48	4.68	0.30	69.00	3.00	0.56	-0.11	-0.15	19.74
Denmark	0.52	19762.00	14.51	89.99	187.89	0.50	7.05	0.58	97.00	2.20	-0.48	0.20	0.28	9.97
Finland	0.22	21258.40	19.11	108.21	320.02	0.61	6.46		97.50	1.00	-1.90	-0.12	-0.17	0.00
France	0.41	15828.25	13.91	82.89	123.08	0.34	4.45	0.23	75.60	2.40	-0.39	0.51	0.72	11.96
Germany	0.54	15582.99	12.17	104.11	207.41	0.38	4.57	0.38	94.69	1.53	-1.23	0.06	0.09	19.62
Greece	0.72	6403.90	14.86	2.93	6.01	0.07	3.69		20.00	1.20	-1.70	-0.41	-0.57	13.84
Ireland	1.12	9602.69	11.53	18.48	74.1	0.29	5.47	0.48	76.50	4.60	2.71	-0.46	-0.66	5.98
Italy	0.36	14236.47	14.55	30.01	58.37	0.12	4.57	0.32	35.24	1.62	-0.96	0.12	0.16	6.76
Netherlands	0.60	14489.32	14.03	105.75	225.12	0.35	5.69	0.53	89.00	5.00	3.60	0.04	0.05	10.38
Portugal	0.79	5405.60	11.69	1.76	4.16	0.03	4.46	0.23	18.00	2.20	-0.31	0.00	0.00	7.61
Spain	0.48	10376.69	12.40	7.27	20.86	0.10	4.94	0.38	36.01	1.91	-0.87	0.18	0.25	9.20
Sweden	0.23	20955.79	11.91	125.92	282.57	0.47	6.06	0.67	99.00	2.80	0.52	-0.49	-0.70	5.60
UK	0.61	13740.83	11.44	65.04	111.59	0.28	5.06	0.43	75.98	5.52	3.98	-0.18	-0.25	26.65
Overall	0.50	13872.62	13.08	58.29	116.10	0.25	4.88	0.39	62.98	2.50	0.03	0.02	0.02	12.71

Note: Each entry is the average of the regional figures of a particular country. The mean score of *trust0* for Germany is calculated as the average of 10 regions that belong to former West Germany.

Table 2: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
growth	0.50	0.21	0.08	1.18
gdppc90	13872.62	5412.90	4389.00	30263.90
educ	13.08	4.77	1.88	24.95
pat91	58.29	61.64	0.60	281.17
pat00	116.10	124.42	1.82	570.44
R&Dintns	0.25	0.22	0.00	1.00
trust	4.88	0.78	1.66	7.05
trust0	0.39	0.13	0.05	0.77
literacy	62.98	29.90	14.60	99.00
instAVR	2.49	1.48	1.00	5.60
instPC	0.03	1.98	-1.90	4.10
univF	377.38	264.70	0.00	800.00
univN	0.15	0.20	0.00	1.43
univAVR	0.02	0.60	-0.86	1.71
univPC	0.03	0.84	-1.22	2.42
urban	12.71	20.35	0.00	100.00

Table 3: Simple pairwise correlations between the instruments and trust

	trust	instPC	instAVR	univPC	univAVR	literacy
trust	1					
instPC	0.37***	1				
instAVR	0.36***	0.99***	1			
univPC	0.02	-0.17*	-0.16	1		
univAVR	0.02	-0.17*	-0.16	1	1	
literacy	0.43***	0.31***	0.31***	-0.05	-0.05	1

* significant at 10%; ** significant at 5%; *** significant at 1%

Note: The principal component analysis puts exactly the same weight for *univF* and *univN* and explains 62 percent of total variation. Hence the first principal component is calculated as: pca1 = 0.71(*univF*) + 0.71(*univN*) after standardizing both variables. Therefore *univAVR* and *univPC* are perfectly correlated. The principal component analysis for the institutional variables also put similar weights on each variable. The first principal component explains 75 percent of the variation and it is calculated as: pca1 = 0.40(*inst1600*) + 0.49(*inst1700*) + 0.50(*inst1750*) + 0.44(*inst1800*)+ 0.39(*inst1850*) after standardizing all five variables.

Table 4: Social capital and per capita income growth

	(1) OLS growth	(2) OLS growth	(3) OLS trust	(4) 2SLS growth
gdppc90	-0.189	-0.184	0.326	-0.241
	(0.021)***	(0.021)***	(0.144)**	(0.033)***
	[0.045]***	[0.045]***	[0.110]**	[0.046]***
educ	0.017	0.019	-0.101	0.016
	(0.015)	(0.015)	(0.109)	(0.020)
	[0.008]**	[0.009]*	[0.077]	[0.011]
urban	0.024	0.024	-0.119	0.040
	(0.012)**	(0.012)**	(0.079)	(0.017)**
	[0.012]*	[0.012]*	[0.070]	[0.013]***
trust	0.031	0.036		0.159
	(0.015)**	(0.015)**		(0.047)***
	[0.011]**	[0.013]**		[0.079]*
trust*educ		0.017		
		(0.013)		
		[0.007]**		
instPC			0.455	
			(0.184)**	
			[0.174]**	
literacy			0.392	
			(0.226)*	
			[0.135]**	
univPC			0.222	
			(0.092)**	
			[0.083]**	
constant	0.357	0.506	0.066	0.308
	(0.101)***	(0.063)***	(0.473)	(0.174)*
	[0.056]***	[0.066]***	[0.207]	[0.179]*
Hausman				20.43
				(0.000)***
F-test			148.04	
			(0.000)***	
Sargan-test				0.69
				(0.700)
N	102	102	102	102
R-squared	0.83	0.83	0.68	0.68
Adj R sqr	0.79	0.80	0.61	0.62

Standard errors in parentheses and clustered standard errors in brackets. Clustered standard errors are clustered at the country level to allow arbitrary correlations within a country.
* significant at 10%; ** significant at 5%; *** significant at 1%.
All the regressions include country dummies.
Hausman is a test of endogeneity. Null hypothesis is that *trust* is exogenous.
F-test is a test of joint significance of the instruments.
Sargan is a test of over identification. Null hypothesis: Over-identifying restrictions are valid.

Table 5: Alternative specifications for per capita income growth

	(1) OLS trust	(2) 2SLS growth	(3) OLS trust	(4) 2SLS growth	(5) OLS trust	(6) 2SLS growth
instPC	0.532					
	(0.184)***					
	[0.226]**					
univPC			0.232			
			(0.097)**			
			[0.065]***			
literacy					0.604	
					(0.227)***	
					[0.279]**	
trust		0.160		0.123		0.199
		(0.069)**		(0.072)*		(0.085)**
		[0.133]		[0.081]		[0.091]**
gdppc90	0.289	-0.241	0.491	-0.226	0.312	-0.257
	(0.144)**	(0.039)***	(0.144)***	(0.038)***	(0.143)**	(0.047)***
	[0.165]	[0.067]***	[0.246]*	[0.051]***	[0.150]*	[0.030]***
educ	0.019	0.016	-0.109	0.016	0.005	0.015
	(0.102)	(0.020)	(0.115)	(0.018)	(0.103)	(0.023)
	[0.052]	[0.011]	[0.049]**	[0.010]	[0.066]	[0.012]
urban	-0.158	0.040	-0.090	0.036	-0.127	0.045
	(0.081)*	(0.018)**	(0.083)	(0.017)**	(0.081)	(0.021)**
	[0.067]**	[0.012]***	[0.094]	[0.017]**	[0.075]	[0.020]**
constant	0.150	0.304	2.301	0.567	-0.230	0.211
	(0.554)	(0.212)	(0.682)***	(0.098)***	(0.487)	(0.255)
	[0.259]	[0.310]	[0.240]***	[0.066]***	[0.377]	[0.229]
Hausman		7.83		2.58		11.72
		(0.006)***		(0.110)		(0.000)***
F-test	5.53		12.91		4.69	
	(0.035)**		(0.003)***		(0.049)**	
N	102	102	102	102	102	102
R-squared	0.64	0.68	0.63	0.75	0.64	0.58
Adj R sqr	0.57	0.61	0.56	0.70	0.57	0.49

Standard errors in parentheses and clustered standard errors in brackets. Clustered standard errors are clustered at the country level to allow arbitrary correlations within a country.
* significant at 10%; ** significant at 5%; *** significant at 1%.
All the regressions include country dummies.
Hausman is a test of endogeneity. Null hypothesis is that *trust* is exogenous.
F-test is a test of joint significance of the instruments.

Table 6: Social capital and innovation

	(1) OLS pat91	(2) OLS pat00	(3) OLS trust	(4) 2SLS pat91	(5) 2SLS pat00
R&Dintns	0.292	0.292	0.035	0.239	0.243
	(0.061)***	(0.053)***	(0.099)	(0.078)***	(0.069)***
	[0.094]***	[0.061]***	[0.047]	[0.099]**	[0.060]***
educ	0.219	0.188	-0.028	0.182	0.154
	(0.050)***	(0.044)***	(0.084)	(0.063)***	(0.056)***
	[0.052]***	[0.049]***	[0.096]	[0.045]***	[0.050]***
trust	0.226	0.164		0.637	0.545
	(0.062)***	(0.054)***		(0.174)***	(0.155)***
	[0.054]***	[0.055]**		[0.076]***	[0.070]***
instPC			0.494		
			(0.186)***		
			[0.191]**		
univPC			0.194		
			(0.090)**		
			[0.093]*		
literacy			0.478		
			(0.231)**		
			[0.187]**		
constant	-0.303	0.164	-0.287	-0.238	-0.718
	(0.435)	(0.378)	(0.461)	(0.369)	(0.328)**
	[0.198]	[0.145]	[0.264]	[0.105]**	[0.089]***
Hausman				11.72	13.57
				(0.001)***	(0.000)***
F-test			91.21		
			(0.000)***		
Sargan				1.86	1.20
				(0.393)	(0.548)
N	102	102	102	102	102
R-squared	0.85	0.88	0.66	0.78	0.82
Adj R sqr	0.83	0.86	0.58	0.74	0.78

Standard errors in parentheses and clustered standard errors in brackets. Clustered standard errors are clustered at the country level to allow arbitrary correlations within a country.
* significant at 10%; ** significant at 5%; *** significant at 1%.
All the regressions include country dummies.
Hausman is a test of endogeneity. Null hypothesis is that *trust* is exogenous.
F-test is a test of joint significance of the instruments.
Sargan is a test of over identification. Null hypothesis: Over-identifying restrictions are valid.

Table 7: Alternative specifications for innovation

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) OLS	(5) 2SLS	(6) 2SLS	(7) OLS	(8) 2SLS	(9) 2SLS
	trust	pat91	pat00	trust	pat91	pat00	trust	pat91	pat00
instPC	0.559								
	(0.183)***								
	[0.303]*								
literacy				0.682					
				(0.230)***					
				[0.363]*					
univPC							0.164		
							(0.096)*		
							[0.095]*		
trust		0.573	0.398		0.859	0.638		0.407	0.717
		(0.231)**	(0.189)**		(0.303)***	(0.243)**		(0.359)	(0.445)
		[0.179]***	[0.227]		[0.240]***	[0.080]***		[0.419]	[0.441]
R&Dintns	0.072	0.247	0.262	0.068	0.210	0.230	0.130	0.269	0.220
	(0.102)	(0.062)***	(0.063)***	(0.103)	(0.099)**	(0.079)***	(0.103)	(0.079)***	(0.098)**
	[0.041]	[0.049]**	[0.059]***	[0.048]	[0.101]*	[0.060]***	[0.072]*	[0.102]**	[0.096]**
educ	0.041	0.188	0.167	0.053	0.162	0.146	0.046	0.202	0.139
	(0.084)	(0.062)***	(0.051)***	(0.084)	(0.079)**	(0.064)**	(0.089)	(0.061)***	(0.076)*
	[0.057]	[0.049]***	[0.039]***	[0.071]	[0.044]***	[0.056]**	[0.086]	[0.065]***	[0.082]
Constant	2.415	-1.141	-0.610	1.052	-1.893	-1.240	2.593	-0.581	-0.462
	(0.736)***	(0.776)	(0.637)	(0.735)	(1.008)*	(0.811)	(0.714)***	(0.580)	(0.717)
	[0.265]***	[0.436]**	[0.620]	[0.430]**	[0.640]**	[0.191]***	[0.080]***	[0.638]	[0.653]
Hausman		3.52	2.10		12.13	8.69		0.28	3.67
		(0.064)*	(0.150)		(0.008)***	(0.004)***		(0.594)	(0.058)*
F-test	3.40			3.54			2.93		
	(0.080)*			(0.082)*			(0.110)*		
N	102	102	102	102	102	102	102	102	102
R-squared	0.62	0.80	0.86	0.61	0.68	0.78	0.59	0.84	0.74
Adj R sqr	0.54	0.76	0.83	0.54	0.62	0.74	0.51	0.81	0.69

Standard errors in parentheses and clustered standard errors in brackets. Clustered standard errors are clustered at the country level to allow arbitrary correlations within a country. * significant at 10%; ** significant at 5%; *** significant at 1%.

All the regressions include country dummies. Hausman is a test of endogeneity. Null hypothesis is that *trust* is exogenous. F-test is a test of joint significance of the instruments.

Table 8: Stability of the growth regressions

	no of regress. appeared	mean value	std. dev.	left confid. interv.	right confid. interv.	fract. of (-) values	fract. of (+) values	fract. of signf. (-) values	fract. of signf. (+) values	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
trust	4,090	0.029	0.004	0.028	0.030	0.00	1.00	0.00	0.79	YES	YES	NO	NO	YES	0.97
educ	4,090	0.019	0.006	0.017	0.020	0.00	1.00	0.00	0.07	NO	YES	NO	NO	YES	0.88
gdppc90	4,090	-0.194	0.010	-0.196	-0.192	1.00	0.00	1.00	0.00	YES	YES	YES	YES	YES	0.00
urban	4,090	0.018	0.006	0.017	0.020	0.00	1.00	0.00	0.34	NO	YES	NO	NO	YES	0.93
help	407	0.048	0.008	0.045	0.051	0.00	1.00	0.00	0.61	YES	YES	NO	NO	YES	0.96
opinion	407	0.062	0.008	0.060	0.065	0.00	1.00	0.00	1.00	YES	YES	NO	YES	YES	1.00
agremp	407	-0.005	0.001	-0.006	-0.005	1.00	0.00	1.00	0.00	YES	YES	NO	YES	YES	0.00
indemp	407	0.003	0.001	0.003	0.003	0.00	1.00	0.00	0.42	YES	YES	NO	NO	YES	0.94

The dependent variable is growth rate of per capita GDP 1990-02. The fixed independent variables are *gdppc90*, *educ*, *trust*, *urban* and country dummies.

Test 1: Strong sign test (all equal sign passed?)

Test 2: Weak sign test (90% equal sign passed?)

Test 3: Strong extreme bounds test (all significant and equal sign passed?)

Test 4: Weak extreme bounds test (90% significant and equal sign passed?)

Test 5: Weighted extreme bounds test (90% significant and equal sign passed?)

Test 6: Cumulative density function test: A variable passes the test at 10%significance level if the value for the test score is less than 0.10 or higher than 0.90.

Table 9: Stability of the innovation regressions

	no of regress. appeared	mean value	std. dev.	left confid. interv.	right confid. interv.	fract. of (-) values	fract. of (+) values	fract. of signf. (-) values	fract. of signf. (+) values	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
trust	4,090	0.205	0.021	0.200	0.209	0.00	1.00	0.00	1.00	YES	YES	YES	YES	YES	1.00
educ	4,090	0.220	0.034	0.213	0.227	0.00	1.00	0.00	1.00	YES	YES	YES	YES	YES	1.00
R&Dintns	4,090	0.288	0.025	0.282	0.293	0.00	1.00	0.00	1.00	YES	YES	YES	YES	YES	1.00
skill	407	0.396	0.091	0.363	0.429	0.00	1.00	0.00	1.00	YES	YES	NO	YES	YES	1.00
help	407	0.276	0.042	0.261	0.292	0.00	1.00	0.00	0.96	YES	YES	NO	YES	YES	0.99
opinion	407	0.281	0.063	0.258	0.305	0.00	1.00	0.00	1.00	YES	YES	NO	YES	YES	1.00
agremp	407	-0.033	0.003	-0.035	-0.032	1.00	0.00	1.00	0.00	YES	YES	YES	YES	YES	0.00
indemp	407	0.030	0.003	0.028	0.031	0.00	1.00	0.00	1.00	YES	YES	YES	YES	YES	1.00

The dependent variable is the patent applications in 1991. The fixed independent variables are *R&Dintns*, *educ*, *trust*, and country dummies.

Test 1: Strong sign test (all equal sign passed?)

Test 2: Weak sign test (90% equal sign passed?)

Test 3: Strong extreme bounds test (all significant and equal sign passed?)

Test 4: Weak extreme bounds test (90% significant and equal sign passed?)

Test 5: Weighted extreme bounds test (90% significant and equal sign passed?)

Test 6: Cumulative density function test: A variable passes the test at 10%significance level if the value for the test score is less than 0.10 or higher than 0.90.

Table 10: Social capital, innovation and growth (3SLS Estimates)

	(1)OLS	(2)3SLS	(3) 1st	(4) 1st	(5) 1st	(6)	(7)	(8)
	growth	growth	growth	pat91	trust	growth	pat91	trust
gdppc90	-0.228	-0.285	-0.213	0.344	0.336	-0.279		0.412
	(0.022)***	(0.026)***	(0.020)***	(0.084)***	(0.151)**	(0.027)***		(0.096)***
	-1.046	*-1.309*				*-1.280*		
pat91	0.090	0.194				0.191		
	(0.024)***	(0.062)***				(0.063)***		
	0.413	*0.890*				*0.876*		
trust	0.016	0.034				0.025	0.724	
	(0.014)	(0.052)				(0.053)	(0.149)***	
	0.073	*0.158*				*0.114*		
educ	0.002	-0.019	0.002	0.095	-0.100	-0.017	0.174	-0.098
	(0.014)	(0.017)	(0.014)	(0.061)	(0.109)	(0.018)	(0.062)***	(0.085)
	0.007	*-0.089*				*-0.079*		
urban	0.032	0.050	0.020	-0.110	-0.117	0.044		-0.143
	(0.011)***	(0.012)***	(0.010)*	(0.044)**	(0.079)	(0.012)***		(0.048)***
	0.148	*0.229*				*0.202*		
R&Dintns			0.038	0.192	-0.024		0.228	-0.037
			(0.013)***	(0.056)***	(0.101)		(0.076)***	(0.088)
univPC			0.022	0.110	0.225			0.165
			(0.012)*	(0.052)**	(0.093)**			(0.056)***
literacy			0.083	0.413	0.397			0.501
			(0.029)***	(0.127)***	(0.228)*			(0.127)***
instPC			0.062	0.178	0.458			0.353
			(0.024)**	(0.103)*	(0.185)**			(0.113)***
constant	0.374	0.513	0.617	0.097	0.073	0.519	-1.538	0.335
	(0.094)***	(0.064)***	(0.062)***	(0.265)	(0.476)	(0.064)***	(0.637)	(0.435)
	0.596	*0.435*				*0.075*		
N	102	102	102	102	102	102	102	102
R-squared	0.85	0.81	0.87	0.89	0.68	0.82	0.74	0.68

Standard errors in parentheses. Standardized coefficients in italics. Columns 3, 4 and 5 are the first stage results of the 3SLS estimation

* significant at 10%; ** significant at 5%; *** significant at 1%

All the regressions include country dummies. Column (2) presents only the 3SLS results for the growth equation when *trust* equation do not include country dummies. Hansen-Sargan overidentification statistic for 3SLS estimation $\chi^2(6) = 3.16(0.79)$.

Joint significance of the instruments in the first stage in *trust* equation F-test = 61.94(0.00).

Table 11: Stability of *trust* in 3SLS estimations

equation	stability of variable	mean value	std. dev.	fract. sign. (+) values
growth	trust	0.036	0.024	0.01
growth	pat91	0.156	0.058	1.00
patents	trust	0.655	0.076	1.00

Total number of 3SLS estimations is 1559.

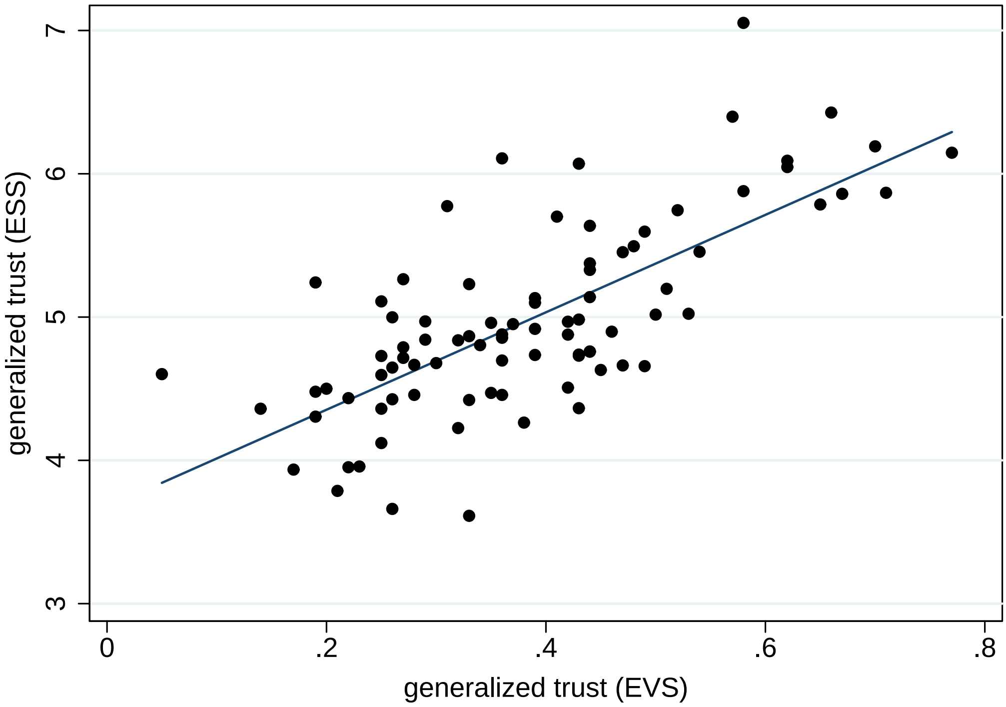
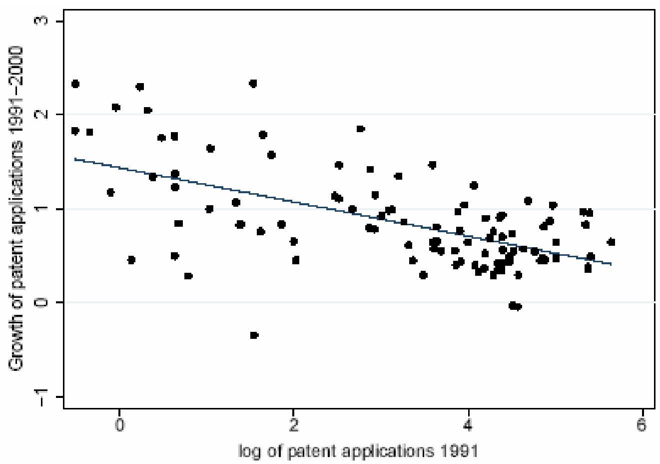
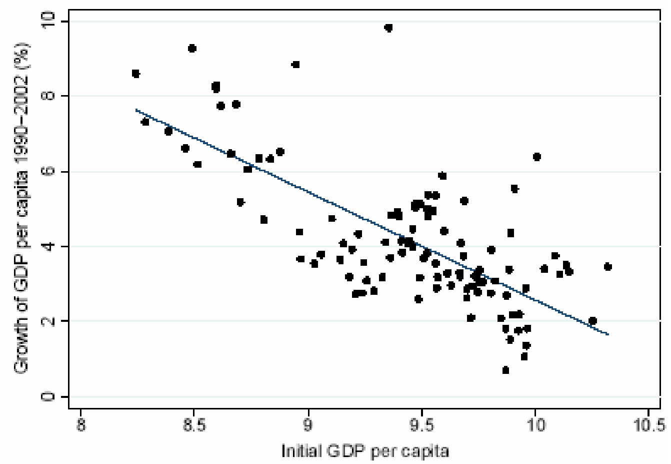


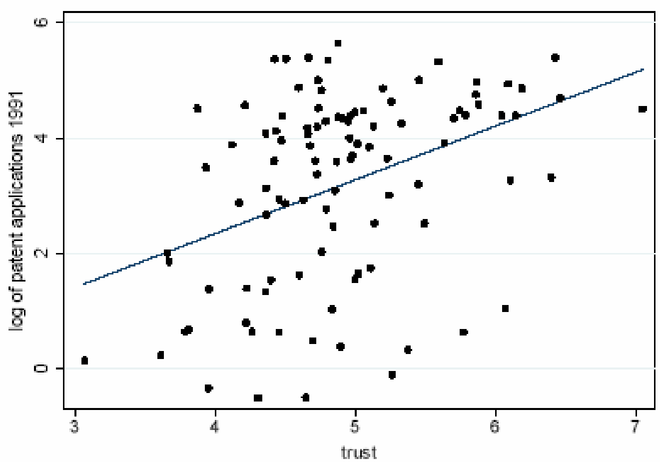
Figure 1: Generalized trust scores, EVS vs. ESS



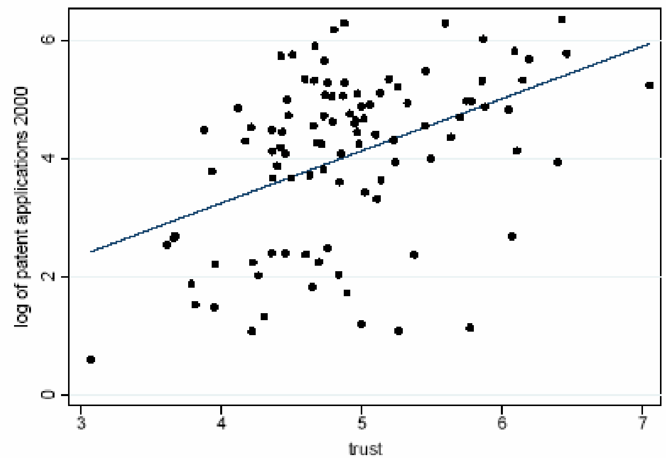
(a) Growth of patents 1991-2000



(b) Growth of per capita GDP 1990-2002



(c) Patent applications 1991 and trust



(d) Patent applications 2000 and trust

Figure 2: Social Capital, Innovation and Income Growth 1990-2002

Appendix 1: Variable Definitions and Data Sources

Appendix 1.1: Variable Definitions and Data Sources

Variable	Definition
growth	Growth of per capita GDP 1990-2002, defined as the log difference of GDP per capita in the period 1990-2002. Source: Eurostat.
gdppc90	log GDP per capita in 1990. Source: Eurostat.
educ	Education defined as the share of tertiary level students (levels 5, 6 and 7) in the total number of all students in 1993, according to the International Standard Classification of Education 1976 (ISCED76) definitions. ISCED 5 covers programs that generally do not lead to a university degree but usually require successful completion of a program at the upper secondary level. ISCED 6 covers programs that lead to an award of a first university degree and ISCED 7 covers programs that lead to an award of a second or further university degree. Source: Eurostat.
pat91	Patent applications per million inhabitants centered around 1991 (average of 1990, 1991, 1992). The number of patent application is measured as "total number of patent applications to the European Patent Office(EPO) by year of filing, excluding patent applications to the national patent offices in Europe". Source: Eurostat.
pat00	Patent applications per million inhabitants centered around 2000 (average of 1999, 2000 and 2001). Source: Eurostat.
R&Dintns	R&D intensity defined as R&D personnel employment as a percentage of total employment in the business enterprize sector in 1995. Source: Eurostat.
trust	Generalized trust using the answer to the following question; "Most people can be trusted or you cannot be too careful". The answer category ranges from (0) "you can't be too careful" to (10) "most people can be trusted", with nine levels in between. The mean (std. dev.) of this measure for EU-14 countries is 4.945 (2.395) N=25,268. Source: European Social Surveys (ESS) first round in 2002.
trust*educ	Interaction variable of *trust* and *educ*.
literacy	Literacy rates around 1880. See Appendix 2.1 for details.
trust0	Generalized trust from EVS 1990. The respondents are asked "generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people". The interviewees were given two choices: (i) most people can be trusted or (ii) you can't be too careful. The mean value of this measure for 11 European countries is 0.369 (0.482), N=17,322. Source European Values Survey (EVS) in 1990.
instXXXX	Proxy for past political institutions as measured by "constraints on the executive" as defined in the POLITY IV data set. This variable captures "institutionalized constraints on the decision making powers of chief executives" coded on a scale 1 to 7, 1 representing "unlimited authority" and 7 "accountable executive constrained by checks and balances". Information is available separately for five dates: 1600, 1700, 1750, 1800, 1850. See Appendix 2.3 for details.
instAVR	Average of *inst1600, inst1700, inst1750, inst1800 and inst1850.* See Appendix 2.3 for details.
instPC	First principal component of *inst1600, inst1700, inst1750, inst1800 and inst1850.* See Appendix 2.3 for details.
univF	Measures the period of existence of a university in a region defined as "*univF* = 2000 minus the foundation date of the university". Higher values reflect the existence of universities in a region for longer periods. See Appendix 2.4 for details.
univN	The density of universities defined as the number of universities per 100,000 population around 1850. See Appendix 2.4 for details.
univAVR	Average of the standardized values of *univF* and *univN*. See Appendix 2.4 for details.
univPC	First principal component of standardized values of *univF* and *univN*. See Appendix 2.4 for details.
urban	Urbanization rates defined as the share of population living in towns greater than 30,000 in total population in 1850. See Appendix 2.2 for details.

Appendix 1.2 Variables Employed in the Stability Analysis

Variable	Definition
polactiv	Could take an active role in a group involved in political issues.
trustlgl	Trust in legal system.
trustep	Trust in European Parliament
ginveco	The less government intervenes in economy the better it is.
lawobey	The law should always be obeyed.
ecohenv	Economic advances harm the environment.
immig	Immigration good or bad for country's economy.
skill	All countries benefit if people can move where their skills are needed.
minority	People of minority/ethnic group in ideal living area.
shrtrad	Better for a county if almost everyone share the same customs and traditions.
shrreli	Better for a country if almost everyone share the same religion.
help	How often help others not counting voluntary work.
impsupport	To be a good citizen: How important to support people worse off.
implaw	To be a good citizen: How important to always obey in laws.
opinion	To be good citizen: How important to form independent opinion.
social	Take part in social activities compared to others in the same age.
cath	Percentage of Catholic.
prot	Percentage of Protestant.
orth	Percentage of Orthodox.
othc	Percentage of other Christian.
jewi	Percentage of Jewish.
isla	Percentage of Islam.
east	Percentage of eastern religions.
olson	Active member of Olson groups such as, trade unions, political groups or parties and professional associations. These groups are believed to hamper economic growth because of lobbying cost for instance. See Olson (1982) for details.
putnam	Active member of Putnam groups such as religious organizations, education and cultural groups, and youth work associations. Putnam (1993) suggests that these groups enhances trust and civic life hence are conducive to growth.
domgr	Dominant religious group, share in total population.
lrscale	Political opinion: Left-right scale.
shragremp	Share of agricultural employment in total employment 1990. Source: Eurostat.
shrindemp	Share of industrial employment in total employment 1990. Source: Eurostat.

Data source for all the variables, except *shragremp* and *shrindemp*, is ESS.

Appendix 2: Further Details on Historical Data

A2.1 Historical Data on Literacy Rates

Data on literacy come from different sources. Below we present in detail the variable definition and the data source for each country. For most of the cases the information available is the percentage of the population that can read and write − including the people who can read only − in 1870s and 1880s.

Country	Variable definition and data source
Austria	The literacy rate is defined as the percentage of the population that is able to read and write including people who can read only in 1880. The data for West-Osterreich is the average of Salzburg, Tyrol and Voralberg. Data source: Flora (1983).
Belgium	Percentage of the population that is able to read and write in 1880. The percentage of the population who can read only is higher than the percentage of people who can read and write by about 15 percent. We therefore inflated each regional figure by 15 percent. Data source: Flora (1983).
Denmark	Percentage of the population that is not literate (100 − illiteracy). Information available only for males in 1860. Data source: Cipolla (1969).

Country	Variable definition and data source
Finland	Percentage of the population, 10 years or older, that is able to read and write and read only in 1880. Data source: Flora (1983).
France	We have used the average of three source of information available: (i) percentage of the population able to read (69.2%) in 1871/72, (ii) army recruits able to read (83%), (iii) percentage of bridegrooms and brides able to write their names (84% and 74%), respectively. No regional information available around 1880s. Data source: Flora (1983).
Greece	Approximate figure: Greece was occupied by the Ottoman empire till the 1830s and then ruled by the Bavarian Prince Otto (later changed name to Othon). In several sources it is mentioned that, in the rural areas of Greece the education level was very low in the second half of the 19th century. Given that urbanization rates were well below the average and the similarity of the Greek regions with other Mediterranean regions, (such as Southern Italy 20.4%, Southern Spain around 20%, Serbo-Croation estimated as 22-29% in 1870s and 80s) we suppose the literacy rate in Greece was about 20 percent in 1880s. No regional information available. Data source: Cipolla (1969) and Flora (1983).
Germany	Literacy defined as (100 − illiteracy in population aged 10 years or older) in 1871. For Baden-Wuttemberg, Bayern, and Thuringen we took the average of the neighboring regions Hessen-Nassau, Westfalia, Saxony. The figure for Bremen and Hamburg is the average of Hannover and Schleswig-Holstein. Since there is not an exact correspondence to Saarland in the source data, we replace it with the available information on Rheinland-Pfalz. The correspondence of the remaining current regions and regions in Cipolla (1969) is as follows : Berlin (Berlin), Brandenburg (Brandenburg), Hessen (Hessen-Nasau), Mecklenburg-Vorpommern (Pomerania), Niedersachsen (Hannover), Nordrhein-Westfalen (Westfalia), Rheinland-Pfalz (Rheinland), Sachsen (Saxony), Sachsen-Anhalt (Saxony) and Schleswig-Holstein (Schleswig-Holstein). Data source: Cipolla (1969).
Ireland	The data represent the average of percentage of people, +5 and +10 years old, respectively who are able to read in 1880. Data source: Flora (1983).
Italy	Literacy defined as (100 − illiteracy in population aged 5 years or older) in 1881. For cases in which there are no explicit regional matches between the current Italian regions and the source(s), we employed the following correspondence: Valle D'Aosta (Piemonte), Friuli-Venezia-Giulia (Veneto). For Umbria there are important differences between two data sources, so we have used the average (in Cipolla (1969) 26%; in Flora (1983) 33%). Data source: Cipolla (1969) and Flora (1983).
Netherlands	Percentage of army recruits able to read in 1880. No regional data are available. Data source: Flora (1983).
Portugal	Literacy rate as defined by Tortella (1994). No regional information is available.
Spain	Literacy rates for the population aged 10 and older. Data source: Nunez (1990).
Sweden	Percentage of army recruits able to read and write and percentage of recruits able to read in 1880. Data source: Flora (1983).
UK	Literacy figures are derived from the percentages of brides and grooms signing the marriage registers with marks in 1870. The numbers were aggregated using the population statistics in Mitchell (1988). The correspondence of current UK NUTS1 definitions and regions in Stephens (1973) are as follows: North East (Durham, Northumberland); North West (Cheshire, Cumberland, Lancashire, Westmorland); Yorkshire-Humber (Yorkshire); East Midlands (Derbyshire, Leicestershire, Lincolnshire, Northamptonshire, Nottinghamshire, Rutland); West Midlands (Herefordshire, Shropshire, Staffordshire, Warwickshire, Worcestershire); East of England (Bedforshire, Cambrisdgehire, Essex, Hertfordshire, Huntingdonshire, Norfolk, Sufflok); Greater London (London, Middlesex); South East (Berkshire, Buckinghamshire, Hampshire, Kent, Oxfordshire, Surrey, Sussex); South West (Cornwall, Devonshire, Dorset, Gloucestershire, Somerset, Wiltshire); Wales (South Wales, North Wales, Monmoutshire). Data for Scotland are for 1871 and from Cipolla (1969). Data for Northern Ireland are from Flora (1983) and represent the percentage of people able to read in 1880. Data source: Cipolla (1969), Stephens (1973) and Flora (1983).

A2.2 Historical data on Urbanization and Population

The population of each region is calculated from the available data at
http://www.library.uu.nl/wesp/populstat/populhome.html.
The original data sources can be found at
http://www.library.uu.nl/wesp/populstat/sources.html. In general, the regional population data belong to years ranging from 1849 to 1861. Specifically: Belgium (1849); Austria, Denmark, Germany, Finland and Portugal (1850); Netherlands and Spain (1849/50); Greece and Sweden (1850/51); France and UK (1851); Italy (1861). For Greece we manage to find regional information only for region Attiki. The scores for other three regions are simply the country average.

The urbanization rate is defined as the percentage of population living in towns with more than 30,000 residents about 1850. The city population data are mainly from Bairoch, Batou, and Chèvre (1988). We also calculated urbanization rate considering cities with more than 20,000 residents. The difference between the two variables is less then 5% for most of the regions, excluding Mecklenburg-Vorpommern (DE8), Cantabria (ES13), Navarra (ES22), Valenciana (ES52), Illes Balears (ES53), Andalucia (ES61), Murcia (ES62), Nord-Pas-De-Calais (FR3), Puglia (ITF4), Sicilia (ITG1), Sardegna (ITG2), Oost Nederland (NL2), Zuid-Nederland (NL4) and North East (UKC).

A2.3 Historical Data on Institutions

To capture the impact of past political institutions on current social capital we employed the data on "constraints on the executive" as a proxy as defined in the POLITY IV project, Political Regime Characteristics and Transitions, 1800-2002. This variable captures "institutionalised constraints on the decision making powers of chief executives, whether individuals or collectivities". It is coded on a scale 1 to 7, (1) representing "unlimited authority" and (7) "accountable executive constrained by checks and balances", categories (2), (4) and (6) referring to intermediate situations. Below we summarize each category according to the POLITY IV Project, Dataset Users Manual (pages 23-24) accessible also via the POLITY IV web page available at http://www.cidcm.umd.edu/inscr/polity/.

(1) *Unlimited authority*: Refers to cases in which there are no regular limitations on the executive's actions. For instance, situations in which constitutional restrictions on executive action are ignored; constitution is frequently revised/suspended; there is no legislative assembly or even if there is one it is dismissed at the executive's initiative.

(3) *Slight to moderate limitation on executive authority*: Existence of some real but limited constraints on the executive. Example evidences: Legislature can initiate some categories of legislation independently of the executive and is able to block implementation of executive acts and decrees or cases in which independent judiciary is present.

(5) *Substantial limitations on executive authority*: The accountability group has substantial constraints on the executive. For instance cases in which a legislature or a party council can modify or defeat executive's proposals or in which the accountability group makes important appointments to administrative posts.

(7) *Executive parity or subordination*: In most areas of activity the legislature or the parliament has effective authority equal to or greater than the executive. Examples of evidence: The accountability group initiates most important legislation; the executive is dependent on the legislature's continued support to remain in office.

We manage to compile information for most of the data points in our data set following Acemoglu, Johnson, and Robinson (2005) and in particular Tabellini (2005). In case of missing observations for some regions and countries the POLITY IV data set available from the web page of the POLITY IV project has been consulted. Above data sources enabled us to gather information on more than 70 EU regions in our data set. For regions for which no data are available, we coded the variable "constraints on the executive" in the same way as the POLITY IV dataset considering the political institutions in a 40-year window around each date. Information is available for five dates: 1600, 1700, 1750, 1800 and 1850. Below we present detailed information on how we coded some regions as well as the data sources for each country.

Country	Brief historical information and data source
Austria	At the end of 17th century most of the current Austrian lands were under the control of Habsburgs, accept the ecclesiastical states Salzburg and Voralberg. This situation did not change till the beginning of 18th century; the Habsburgs gain more power and control over the territories. After the Habsburgs, the area was dominated by the Austrain Empire. The states did not have individual power and the political environment in this period can be identified as an absolutist monarchy. Polity IV data set codes Austria as (3) only after 1860 and before that it is coded as (1). Acemoglu, Johnson, and Robinson (2005) code 1850 as (2) and all remaining years as (1). Since we are interested in a 40-year window around 1850, we coded 1850 as (2) suggesting a transitory period.
Belgium	Data source: Tabellini (2005)
Denmark	Data source: Acemoglu, Johnson, and Robinson (2005)
Finland	Finland was an integral part of Sweden till 1803 and then mainly dominated by Russia. As the executives of both countries were mainly absolutist, Acemoglu, Johnson, and Robinson (2005) codes Finland as (1) for all periods. We also coded Finland as (1) for all of the 5 data points.
France	Data source: Tabellini (2005)
Greece	Greece was under the domination of the Ottoman Empire during most of the period and only after 1830s emerged as a separate country (by the Convention of May 11, 1832), but still under the dominance of the Bavarian prince Otto of Wittelsbach. The administration and the army of the country was mainly ruled by the Bavarian officials, until 1843 when a revolt broke out in Athens due to accumulated Greek discontent. King Othon (Otto adopted the name Othon) had to convene the National Assembly and granted a constitution in 1843. The POLITY IV data set codes Greece as (3) after this date. However the Greek territory in the 1840s and 1850s does not match with the current Greek territory. According to the historical maps, Voreia Ellada and Nisia were still under the control of the Ottoman Empire for about another 30-40 years. Considering this we coded Voreia Ellada and Nisia as (1) for all years. Kentriki Ellada and Attiki are coded as (3) in 1850 and as (1) for the remaining years.
Germany	For Baden-Wurttemberg, Bayern, Bremen, Hamburg, Hessen, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland and Schleswig-Holstein we use Tabellini (2005). Berlin and Brandenburg: Berlin was under the dominance of Brandenburg (and later Prussia) in most of the period that we are interested in. The period 1648-1790 is described as the period of absolutism for Brandenburg and Prussia (Holborn, 1982). Therefore, 1600, 1700, 1750 and 1800 are coded as (1). The POLITY IV data set codes Prussia as (1) between 1800-1839; (2) between 1840-58; and (3) between 1859-1889. Therefore, we coded 1850 as (2) suggesting a transitory state. Mecklenburg-Vorpommern: Even after the separation in 1815, Mecklenburg-Vorpommern was mostly affected by absolutism. Therefore, in line with the other German states we code 1850 as (2) and all four dates before 1850 as (1). Sachsen: Under domination of Saxony. POLITY IV codes Saxony as (1) between 1806-30 and (3) between 1831-1871, except a period of 8 years between 1840-47. All dates were coded as (1) before 1850 and 1850 is coded as (3). Sachsen-Anhalt: Sachsen-Anhalt was part of Saxony. POLITY IV codes Saxony as (1) between 1806-30 and (3) between 1831-1871, except a period of 8 years between 1840-47. However northern part of Saxony, which is roughly the current Sachsen-Anhalt region, was lost to Prussia with the Congress of Viennna in 1814-1815. Since POLITY IV codes Prussia as (2) between 1840-1858, we therefore coded Sachsen-Anhalt as (2) in 1850. All other dates are coded as (1). Thuringen: Coded as (1) for 1600-1800 and (2) in 1850 in line with the other German states. For Germany we benefited from Tabellini (2005), POLITY IV dataset and Holborn (1982), as well as various historical maps in Holborn (1982) and at http://www.zum.de/whkmla/index.html.
Ireland	Both regions, Border-Midland-Western and Southern and Eastern are coded the same. Data source Acemoglu, Johnson, and Robinson (2005).
Italy	Data source: Tabellini (2005)
Netherlands	Data source: Tabellini (2005)
Portugal	Data source: Tabellini (2005)
Spain	Data source: Tabellini (2005)

Country	Brief historical information and data source
Sweden	Regions of Sweden did not have political autonomy. For this reason, the regional scores represent the country score. The POLITY IV data set codes Sweden as (3) between 1812-1854 and (4) between 1855-1869. We coded Sweden as (3) for 1850 and as (1) for all the other periods. Data source: Acemoglu, Johnson, and Robinson (2005).
UK	Data source: Tabellini (2005)

A2.4 Historical Data on Universities

We employed two different variables to capture the possible impact of universities (as historical institutions blending educational, cultural and social aspects) on current social capital. First, to measure the period of existence of universities in a particular region we formed the *univF* variable defined as "$univF = 2000 -$ the foundation date of the university", the latter part referring to the date of foundation of the first university established in a region. In forming this variable we carefully examined the foundation dates (and re-foundation dates if applicable) of all the universities in a region to make sure that for the whole period at least one university was operational. Higher values reflect the existence of universities in a region for longer periods.

The second variable, *univN* measures the density of the universities in a particular region defined as the number of universities per 100,000 inhabitants around 1850. We started from the 13th century and matched each university to a corresponding region. The original data sources present information on the city and we matched cities to corresponding regions. Details on the population data can be found in Appendix 2.2. We had to pay special attention on three points to avoid double counting: *(i)* whether the university ceases to exist at a later time, *(ii)* whether the university was re-founded at a later date under the same name (or under a different name), *(iii)* whether the university is merged with another university. We formed two other variables, one is simply the arithmetic average of the standardized values of *univF* and *univN* and the other is the first principal component of the standardized values of the two variables. The major sources for these variables are Ridder-Symoens (1996), and Jilek (1984).

Appendix 3: Further Analysis on the Stability

In this appendix we discuss in more detail the robustness analysis conducted in Section 5.3. We investigate whether the significance level of *trust* in the growth regressions is affected by the presence of particular switch variables. We conducted a meta-analysis on the 4,090 regressions estimated in the robustness analysis in which every coefficient constitutes one observation.

Meta-analysis is a quantitative literature review aiming at harmonizing and evaluating empirical results of an existing literature (e.g., Stanley, 2001; Florax, de Groot, and de Mooij, 2002). In meta-analysis the dependent variable is usually an estimated coefficient reported in earlier studies and the independent variables are moderator variables measuring different features in the original studies (for instance, existence of certain variables, research design, sample etc.). Despite its disadvantages and limitations meta-analysis has been widely used in economics in recent years. The analysis presented here is not affected by these usual limitations because all observations are from this paper only. This means that the research design, variable definitions and sample are exactly the same for all observations in the meta-analysis. We are only interested whether the presence of certain switch variables have an impact on the likelihood of obtaining a significant *trust* coefficient.

We defined a dummy variable for *trust* taking a value of 1 whenever *trust* is significant in a regression and taking a value of 0 otherwise. For all the other switch variables we defined dummy variables in the same manner. The analysis then constitutes of estimating a probit model, regressing the trust dummy on all other dummy variables created for each switch variable. This type of analysis is common in other meta-analyzes (e.g., Waldorf and Pillsung, 2005; van der Sluis, van Praag, and Vijverberg, 2005; Koetse, de Groot, and Florax, 2006). We put special emphasis on the switch variables that returned a high fraction of significant estimates as it is not worthwhile to assess the effect of switch variables that are significant in only few regressions.

The results of the probit analysis is presented below in Table A3.[17] The variables are defined in Appendix 1.2. The results suggest the following. First, few variables were dropped from the analysis automatically as the presence of these variables predicts a failure (i.e. a non-significant *trust* coefficient) perfectly (not shown in the table below). Among them the most important is *help.* All 250 regressions in which *help* is significant, *trust* is insignificant. This suggests that the presence of *help* reduces the likelihood of obtaining a significant *trust* coefficient. On the other hand, results of the probit analysis show that including two other cultural factors, *polactiv* and *opinion* increases the chance of obtaining a significant *trust* coefficient. What is more interesting is that the simple correlation between these three variables and *trust* is lower than 0.20 but the correlation among them is higher than 0.50. Moreover all three variables in all estimations (in growth regressions) return a positive coefficient.[18] This suggests that these variables might be capturing another element of social capital other than *trust.* However given the complex nature of social capital it is not straightforward to test this claim, and we leave this for future research.

Second, the presence of variables on religion reduces the probability of obtaining a significant *trust* coefficient although most of these variables do not survive in the stability analysis. Similarly, there are only a few cases in which *immig* and *skill* return significant coefficients in the main regressions, however the former seems to augment and the latter seems to reduce the probability of obtaining a significant *trust* coefficient. Finally, the share of agricultural employment affects the significance level of *trust* positively whereas the share of industrial employment decreases it.

In sum, the detailed analysis reveals that certain switch variables have an impact on the significance level of the coefficient of *trust.* There are 530 (13% of all estimated regressions in the stability analysis) cases in which *trust* is not significant but social capital might be captured by the presence of *opinion, help* and *polactiv.* This supports our findings in the sense that at least one proxy for social capital has a positive and significant impact on growth in about 95% of all 4,090 regressions estimated in the stability analysis.

Table A3: Results of the probit analysis on the stability regressions

	coefficient		marginal effect	
polactiv	2.159	(0.180)***	0.716	(0.035)***
immig	2.563	(0.336)***	0.772	(0.036)***
skill	-1.522	(0.257)***	-0.181	(0.010)***
opinion	1.187	(0.075)***	0.410	(0.028)***
cath	-0.789	(0.148)***	-0.147	(0.017)***
orth	-1.184	(0.347)***	-0.166	(0.018)***
jewi	-1.002	(0.278)***	-0.159	(0.020)***
isla	-1.783	(0.227)***	-0.219	(0.009)***
east	-0.915	(0.335)***	-0.150	(0.027)***
shragremp	0.823	(0.077)***	0.273	(0.029)***
shrindemp	-0.627	(0.197)***	-0.124	(0.026)***
constant	-0.897	(0.032)***		
Psuedo R square	0.205		0.205	
LR $\chi^2(15)$ / Wald $\chi^2(15)$	844.4		605.3	

Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

[17] To save space, we present only the results for the variables that returned significant coefficients. The detailed results are available upon request.

[18] In almost all regressions *opinion* has a significant positive impact on growth. When only these regressions are considered, the coefficient of *trust* is significant in 223 cases and insignificant in 183 cases.

Appendix 4: Further Analysis on the Stability of *TRUST*

Table A4: Stability of *trust* in different specifications

equation	method	base equation	type of s.e.	mean trust	std. dev.	fract. of (+) values	fract. of signf. (+) values	Test 1	Test 2	Test 3	Test 4
growth	OLS	Table 4, col 1	normal	0.029	0.004	1.00	0.79	YES	YES	NO	NO
growth	OLS	Table 4, col 1	clustered	0.029	0.004	1.00	0.95	YES	YES	YES	YES
growth	2SLS	Table 4, col 4	normal	0.152	0.012	1.00	1.00	YES	YES	YES	YES
growth	2SLS	Table 4, col 4	clustered	0.152	0.012	1.00	0.83	YES	YES	NO	NO
patent	OLS	Table 6, col 1	normal	0.205	0.021	1.00	1.00	YES	YES	YES	YES
patent	OLS	Table 6, col 1	clustered	0.205	0.021	1.00	1.00	YES	YES	YES	YES
patent	2SLS	Table 6, col 4	normal	0.565	0.067	1.00	1.00	YES	YES	YES	YES
patent	2SLS	Table 6, col 4	clustered	0.565	0.067	1.00	1.00	YES	YES	YES	YES

For each specification we ran 4090 regressions. Mean *trust* is the average value of the coefficient of *trust* in each specification

Test 1: Strong sign test (all equal sign passed?)

Test 2: Weak sign test (90% equal sign passed?)

Test 3: Strong extreme bounds test (all significant and equal sign passed?)

Test 4: Weak extreme bounds test (90% significant and equal sign passed?)