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İ. Semih Akçomak and Bas ter Weel

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United Nations University - Maastricht Economic and social Research and training centre on Innovation and Technology
Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 350 6300, Fax: (31) (43) 350 6399, e-mail: info@merit.unu.edu, URL: http://www.merit.unu.edu

Social Capital, Innovation and Growth: Evidence from Europe*

İ. Semih Akçomak and Bas ter Weel

Department of Economics and MERIT
Maastricht University,
P.O. Box 616, 6200 MD,
Maastricht, the Netherlands
s.akcomak@merit.unimaas.nl
b.terweel@merit.unimaas.nl

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Abstract
This paper investigates the interplay between social capital, innovation and economic growth in the European Union. We identify innovation as an important mechanism that transforms social capital into economic growth. In an empirical investigation of 102 European regions in the period 1990-2002, we show that higher innovation performance is conducive to economic growth and that social capital affects growth indirectly by fostering innovation. Our estimates suggest that there is only a limited role for a direct effect of social capital on economic growth.

JEL classification: O1; O3; O52; Z13
Key words: Social capital; Innovation; Economic growth; European Union

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1 Introduction

Social capital is an important determinant in explaining differences in economic growth. Knack and Keefer (1997) and Zak and Knack (2001) have shown for a cross-section of countries that countries with higher levels of social capital have experienced higher GDP growth rates. It is however not clear *how* social capital improves economic outcomes. For example, Dasgupta (2003) argues that social capital can have an impact on interpersonal network formation which increases human capital, but also on the nature of public goods which increases total factor productivity. Both channels are likely to increase GDP growth rates, but policy implications are different.

The idea that social capital improves economic outcomes is appealing, but it is necessary to identify a third factor through which social capital improves outcomes. This paper shows that innovation is an important channel by which social capital improves economic growth. The idea is that social capital is formed by historical institutions, such as early literacy, past political institutions and universities. More advanced historical institutions have established a higher level of social cohesion which has improved social capital. Social capital in turn influences the R&D process because the financing of risky but innovative projects involves relatively high levels of trust among researchers and capital providers. When levels of trust are higher, more potentially successful projects will be submitted and carried out, which improves innovation outcomes by means of more patents. Finally, higher innovation output yields higher economic growth.

In the empirical analysis we use 102 regions from the EU-14 countries (Luxembourg is excluded). This set of regions ensures that we take into account a relatively homogeneous set of countries that have operated under similar judicial and economic rules for some time now. Hence, variability in current formal institutions is likely to be a minor importance when investigating regional differences in economic performance. This is an important advantage of our data since the results presented by Knack and Keefer (1997) are based on a set of countries including next to OECD member states also countries such as India, South Africa, Nigeria, Turkey and a number of South-American countries that seem to be hard to compare in terms of economic conditions and institutions.

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

growth.

The empirical analysis consists of three steps. We first establish a causal link between social capital and economic growth. Running growth regressions using historical institutions as instruments for social capital results in robust and significant positive effects of social capital on economic growth. These estimates are consistent with the estimates from the literature (see Durlauf and Fafchamps (2004) for an overview). Next, we estimate the relationship between innovation output and social capital, by 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 higher levels of social capital yield higher levels of innovation. Finally, we apply a 3SLS strategy to estimate how historical institutions influence current social capital, which in turn has an impact on innovation, which is a determinant of economic growth. Of course, social capital is also entered directly to address a possible direct link between social capital and economic growth. The 3SLS estimates suggest a strong effect of innovation on economic growth through social capital, and only a weak direct effect of social capital on economic growth. The estimates suggest that social capital is a determinant of innovation, which in turn explains on average approximately 15 percent of economic growth in the EU regions between 1990 and 2002.

There are several relationships in our setup that need discussion. First, the relationship between historical institutions and social capital is discussed in 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 (2002) and La Porta, Lopez-de Silanes, Shleifer, and Vishny (1999) reveals that early institutions are important determinants of current outcomes.

Second, it is impossible to define the nature of R&D ex ante, which makes forming expectations regarding the result of the R&D challenging (e.g., Jones and Williams, 2000). This element of risk involved in R&D projects may show up in different ways. The investor may be unwilling to invest simply because of the higher relative probability of failure of the emerging innovation. In more complex scenarios, information asymmetries and moral hazard problems may severely hinder the financing of R&D. For instance, Leland and Pyle (1977) and Myers and Majluf (1984) argue that investors are not fully able to differentiate between "good" and "bad" R&D projects that might constrain firms to attract external funding. Distinguishing lemons might become easier if the firm reveals the true quality

of the R&D project. On the one hand, firms may disclose technological information and enable investors to assess the R&D project more easily. But, this information might be useful to other competitors and eventually decrease the private returns of the firm. Bhattacharya and Ritter (1983) show that, when the firm is large enough, it may choose to finance R&D projects internally to avoid this cost. Yet, for most innovative firms such costs are unavoidable. On the other hand, firms may reveal the quality of the project by investing more in it (in terms of using own financial resources or increasing effort). Signaling in this way would also produce a welfare loss resulting from investment in one's own project beyond the point that would be optimal if the true quality of the project could be communicated without incurring costs. Nevertheless, R&D projects may be financed by outside capitalists, at the risk of firms misusing the funds made available by the third party. Of course one straightforward way to overcome such a problem is to monitor the firm (or the research unit) and to control whether the firm is investing in R&D rather than misusing the funds.[1] However, high monitoring cost may also make investors hesitant to invest in R&D projects as shown by Boocock and Woods (1997). Given that venture capital markets are critical for innovation (e.g., Kortum and Lerner, 2000), higher levels of social capital may alleviate these problems and yield higher innovation output by

i) *Preventing egoistic behavior*: This is mainly achieved through the enforcement of informal norms. For instance firms with "bad" projects may cease to mimic firms with "good" projects because of the fear that this will affect their reputation.

ii) *Changing expectations*: Investors may finance an R&D project by considering the reputation of the firm. For example, if a firm displays a reputable character by signaling the true quality of its projects for a certain period, this would increase the trustworthiness of the firm in the eyes of the investors. Investors may change their expectations regarding the firm, which would increase the probability of financing the R&D project.

iii) *Reducing transaction costs*: Supposedly, if the relation between the financier and the firm is characterized by trust, monitoring costs are low. Hence, an environment of trust would reduce monitoring costs. By the same token, it may reduce the costs incurred by the financier to gather information about the quality of firms and the projects.

These channels compose our link from social capital to innovation.

The final relationship is the one between innovation and economic growth. There is a

[1] Bougheas (2004) shows that there are strong incentives for banks to monitor their clients in such cases.

long tradition in the economic literature, trying to explain the relationship between innovation and economic growth starting from Solow (1956) and Swan (1956) and summarized in Grossman and Helpman (1991), Barro and Sala-i Martin (1995) and Aghion and Howitt (1998). The general message is that if there is no technological progress economic growth ceases.

Our analysis is related to a number of recent papers investigating the relationship between regional innovation and economic outcomes in the member states of the European Union. Bilbao-Osorio and Rodriguez-Pose (2004) analyze whether policies to foster R&D are paying off but do not find strong correlations between innovation performance and economic growth. Gambardella, Mariani, and Torrisi (2002) find that patents, employment density and openness affect labor productivity in European regions. However, these papers do not take into account social-economic variation in terms of social capital and trust, which affect the capacity to perform R&D. Two other papers address the relationship between trust and regional economic growth. Moesen, Van Puyenbroeck, and Cherchye (2000) and Beugelsdijk and van Schaik (2005) find that higher levels of social capital in a region are positively correlated with economic growth in the most recent period. These papers do not analyze how social capital is transformed into growth but stop at the level of establishing correlations.

This paper proceeds as follows. The next section presents the data and descriptive statistics. In Section 3 we explain our empirical strategy. Section 4 contains the estimates and robustness and stability analyzes. Section 5 concludes.

2 Data and Descriptives

The data span 14 EU countries divided into 102 regions defined according to the 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 definition is applied.

2.1 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 (2004) 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 indicator capturing the above aspects. 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".

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. The indicator *trust* 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 scores 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. Aggregating regions to countries reveals that *trust* is highest in Denmark and lowest in Greece as can be seen from the first column 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*).[2] The interviewees were given two choices: (i) most people

[2]The European Values Survey (EVS) is designed to measure fundamental values and norms in ordinary

can be trusted or (ii) you can't be too careful. The ESS measure is preferred because respondents can choose a level on a 0-10 likert scale.[3] 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 the 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 (cf. Table 1, the first two columns). In the next section we will report estimates for both trust indicators.

2.2 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.

Our patent indicator reveals the following. First, the indicator displays considerable differences between regions, which also holds at the country level (see Table 1, the third

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 East Germany).

[3]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 revert these scale 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".

of fourth column). 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). 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 2. The horizontal axis measures the number of patent applications per million inhabitants 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.[4] 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). As displayed in Table 1, higher R&D intensity is generally associated with more patent applications. The correlation between our R&D measure and patent measure 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. 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 3.

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. It is interesting to see that even in terms of human capital there are significant differences between European regions and countries. The final column in Table 1 shows that Finland and Belgium have the highest proportion of tertiary students, while Ireland and the United Kingdom are among the lowest in our sample.

[4]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 R&D intensity is a good 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 1 percent level.

2.3 Institutions, Literacy and Universities

To estimate causal links between social capital, innovation and economic growth we need a set of instruments. To find instruments we use historical information from institutions, following a recent trend in the literature (e.g., Acemoglu, Johnson, and Robinson, 2002; Tabellini, 2005).

2.3.1 Historical data on literacy

Education is an important determinant of economic growth (e.g., Barro, 2001). Sandberg (1982) showed 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.[5] 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 economic growth. 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 economic growth, 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 can read and write − including the people who can read only − in 1870s and 1880s. Except for Austria, Greece, France, Portugal and Sweden we found data at the regional level. We collected the data from several different

[5] 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).

sources, which is discussed in more detail in Appendix 2.1.

2.3.2 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 had been the primary institution of national culture and identity and played central role in national liberation movements. For instance, in the early 19th century after the battle of Jena, it is 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 quite 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. The main argument behind the hypothesized effects of these variables 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.

2.3.3 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 in 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 toward 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 (2002) 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.[6] It is coded on a scale 1 to 7, (1) representing "unlimited authority" and (7)

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

"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 (2002) 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.

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.[7]

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.

3 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 of growth (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

[7]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 0.49, suggesting roughly an equal weight for each variable.

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 economic 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 coefficient of the interaction term to be positive.

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 our assertion we plotted trust against patent applications in 1991 and 2000 and the results suggest a strong relation between the two indicators (see Figure 4 and 5). The correlation coefficients equal 0.433 and 0.453, respectively. We incorporate this relation to 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, 2005). Nevertheless, it is hard to measure policy success but assuming that such indicators are relevant, they are omitted from both equations (1) and (2). 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 estimated using this strategy:

$$\begin{aligned} growth &= \beta_0 + \beta_1 gdppc90 + \beta_2 pat91 + \beta_3 trust + \\ &\quad \beta_4 educ + \beta_5 urban + \epsilon \end{aligned} \tag{1}$$

$$pat91 = \alpha_0 + \alpha_1 R\&Dintns + \alpha_2 trust + \alpha_3 educ + \upsilon \tag{2}$$

$$\begin{aligned} trust &= \delta_0 + \delta_1 literacy + \delta_2 instPC + \delta_3 univPC + \\ &\quad \delta_4 X + \eta, \end{aligned} \tag{3}$$

where the subscript r 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 economic growth. In equation (3), X denotes the vector of variables exogenous to the system consisting of *gdppc90*, *R&Dintns*, *educ*, *urban* and the three instruments. 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.

Figures 6-9 and Table 3 present the correlations between our measure of social capital and the instruments. Literacy and trust are strong and positively correlated as well as trust and institutions. The correlation between trust and the measure of the presence and density of universities is positive but less strong.

4 Estimation Results

4.1 The Effect of Social Capital on Growth

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

$$growth = \beta_0 + \beta_1 gdppc90 + \beta_2 educ + \beta_3 urban + \beta_4 trust + \epsilon, \tag{4}$$

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 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 Figures 6 to 9 and 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 economic 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.[8]

4.2 The Effect of Social Capital on Innovation

Table 6 first reports the results from estimating

$$pat91 = \beta_0 + \beta_1 R\&Dintns + \beta_2 educ + \beta_3 trust + \epsilon, \tag{5}$$

and

$$pat00 = \beta_0 + \beta_1 R\&Dintns + \beta_2 educ + \beta_3 trust + \epsilon, \tag{6}$$

using OLS. The estimates suggest that a region's innovative output is higher when it 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. Both the first-stage (columns (3)) and second-stage estimates (columns (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 (columns (8) and (9)).

[8]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.

4.3 Stability

Despite its popularity the literature on empirical 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 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

$$Y = F\alpha_j + \beta_{ij}X_i + \gamma_j S_j + \epsilon_j \tag{7}$$

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 be in 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.[9]

We conducted robustness analysis for both per capita GDP growth and patent models (equations (1) and (2), 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

[9]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).

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

We identified 29 switch variables, which are presented in a table in Appendix 2.1. 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).[10] The relationship between the dependent variable and *trust* is robust if all estimated coefficients for *trust* have the same sign and are statistically significant at the same time.

iv) *Weak extreme bounds test*: Sala-i Martin (1997) relaxed 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

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

(Table 9), *trust* passes all of the tests and for all of the estimated regressions the estimated coefficient is significant.

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".[11]

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*.

4.4 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 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 (5)). This social capital is a strong determinant of innovation outcomes along with traditional inputs such as education and R&D investments (column (4)). Finally,

[11]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.

innovation determines growth, but there is not a strong direct impact of social capital on growth (columns (2) and (3)). The results of the full model are presented in column 92) of Table 10 and the separate steps are reported in columns (3)-(5). 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 economic growth in the EU regions between 1990 and 2002.

These results have important implications for the literature on relating a region's (or country) 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.

5 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 economic growth.

The main 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 economic growth, but the direct effect of social capital on economic 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.

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 economic growth works through innovation has policy implications for Europe. The findings suggest that backward regions cannot improve fast in terms of innovation and economic 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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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 enterprise 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.

Variable	Definition
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 thier 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.
putnam	Active member of Putnam groups.
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).
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).

Country	Variable definition and data source
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).
The 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).

Country	Variable definition and data source
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 (2002) 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 (2002) 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 (2002)
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 (2002) 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.

Country	Brief historical information and data source
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 (2002).
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 (2002).
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).

Table A2.4.1 Historical Data on Universities

NUTS	Region	univF	univN	univAVR	univPC
AT1	Ost-Osterreich	635	0.06	0.55	0.39
AT2	Sud-Osterreich	415	0.11	0.06	0.04
AT3	West-Osterreich	380	0.25	0.21	0.15
BE1	Brussels	166	0.30	-0.27	-0.19
BE2	Vlaams Gewest	575	0.09	0.44	0.31
BE3	Region Wallone	185	0.06	-0.63	-0.44
DE1	Baden Wurttemberg	615	0.13	0.62	0.44
DE2	Bayern	598	0.13	0.57	0.40
DE3	Berlin	190	0.24	-0.31	-0.22
DE4	Brandenburg	502	0.05	0.19	0.13
DE5	Bremen	30	0.00	-1.14	-0.80
DE6	Hamburg	81	0.00	-1.00	-0.71
DE7	Hessen	473	0.14	0.26	0.19
DE8	Mecklenburg-Vorpommern	581	0.32	0.85	0.60
DE9	Niedersachsen	425	0.09	0.05	0.04
DEA	Nordrhein-Westfalen	612	0.20	0.73	0.52
DEB	Rheinland-Pfalz	546	0.05	0.30	0.21
DEC	Saarland	52	0.00	-1.08	-0.76
DED	Sachsen	591	0.12	0.54	0.38
DEE	Sachsen-Anhalt	498	0.05	0.17	0.12
DEF	Schleswig-Holstein	348	0.11	-0.12	-0.08
DEG	Thuringen	621	0.21	0.77	0.54
DK0	Denmark	525	0.07	0.28	0.20
ES11	Galicia	474	0.06	0.13	0.09
ES12	Asturias	426	0.20	0.24	0.17
ES13	Cantabria	0	0.00	-1.22	-0.86
ES21	Pais Vasco	0	0.00	-1.22	-0.86
ES22	Navarra	460	1.43	2.42	1.71
ES23	La Rioja	0	0.00	-1.22	-0.86
ES24	Aragon	646	0.24	0.89	0.63
ES3	Madrid	413	0.49	0.70	0.49
ES41	Castilla Y Leon	782	0.28	1.31	0.93
ES42	Castilla La Mancha	511	0.31	0.65	0.46
ES43	Extramadura	27	0.00	-1.15	-0.81
ES51	Cataluna	700	0.08	0.76	0.53
ES52	Valenciana	501	0.36	0.71	0.50
ES53	Illes Balears	517	0.40	0.82	0.58
ES61	Andalucia	495	0.18	0.39	0.27
ES62	Murcia	217	0.25	-0.22	-0.16
FI1	Manner Suomi	360	0.06	-0.17	-0.12
FR1	Île De France	800	0.04	0.95	0.67
FR2	Bassin Parisien	694	0.07	0.72	0.51
FR3	Nord-Pas-De-Calais	441	0.11	0.13	0.09
FR4	Est	578	0.13	0.52	0.37

NUTS	Region	univF	univN	univAVR	univPC
FR5	Ouest	663	0.10	0.69	0.49
FR6	Sud-Ouest	771	0.07	0.92	0.65
FR7	Centre-Est	661	0.09	0.67	0.47
FR8	Mediterranee	711	0.30	1.16	0.82
GR1	Voreia Ellada	52	0.00	-1.08	-0.76
GR2	Kentriki Ellada	36	0.00	-1.12	-0.79
GR3	Attiki	163	1.08	1.05	0.74
GR4	Nisia	27	0.00	-1.15	-0.81
IE01	Border-Midland-Western	0	0.00	-1.22	-0.86
IE02	Southern-Eastern	408	0.03	-0.10	-0.07
ITC1	Piemonte	596	0.06	0.45	0.32
ITC2	Valle D Aosta	0	0.00	-1.22	-0.86
ITC3	Liguria	529	0.25	0.60	0.42
ITC4	Lombardia	639	0.09	0.61	0.43
ITD3	Veneto	778	0.09	0.98	0.69
ITD4	Friuli-Venezia-Giulia	62	0.00	-1.05	-0.74
ITD5	Emilia Romagna	800	0.19	1.20	0.85
ITE1	Toscana	754	0.22	1.13	0.80
ITE2	Umbria	692	0.19	0.92	0.65
ITE3	Marche	460	0.56	0.94	0.67
ITE4	Lazio	697	0.39	1.27	0.90
ITF1	Abruzzo	139	0.08	-0.72	-0.51
ITF2	Molise	18	0.00	-1.17	-0.83
ITF3	Campania	776	0.08	0.95	0.67
ITF4	Puglia	252	0.08	-0.42	-0.30
ITF5	Basilicata	19	0.00	-1.17	-0.82
ITF6	Calabria	32	0.00	-1.13	-0.80
ITG1	Sicilia	556	0.17	0.53	0.38
ITG2	Sardegna	394	0.34	0.39	0.28
NL1	Noord-Nederland	415	0.39	0.53	0.38
NL2	Oost Nederland	400	0.34	0.41	0.29
NL3	West-Nederland	425	0.22	0.27	0.19
NL4	Zuid-Nederland	82	0.00	-1.00	-0.71
PT11	Norte	89	0.00	-0.98	-0.69
PT15	Algarve	21	0.00	-1.16	-0.82
PT16	Centro	710	0.08	0.78	0.55
PT17	Lisboa	710	0.13	0.87	0.61
PT18	Alentejo	442	0.33	0.50	0.36
SE01	Stockholm	123	0.48	-0.08	-0.06
SE02	Ostra Mellansverige	523	0.15	0.41	0.29
SE03	Sydsverige	334	0.18	-0.03	-0.02
SE04	Norra Mellansverige	0	0.00	-1.22	-0.86
SE05	Mellersta A Norrland	0	0.00	-1.22	-0.86
SE06	Ovre Norrland	35	0.00	-1.12	-0.79
SE07	Smaland Med Oarna	0	0.00	-1.22	-0.86
SE08	Vastsverige	46	0.00	-1.10	-0.77
UKC	North East	343	0.29	0.18	0.12

NUTS	Region	univF	univN	univAVR	univPC
UKD	North West	120	0.03	-0.85	-0.60
UKE	Yorkshire-Humber	96	0.00	-0.96	-0.68
UKF	East Midlands	119	0.10	-0.73	-0.52
UKG	West Midlands	120	0.09	-0.75	-0.53
UKH	East Of England	790	0.05	0.94	0.66
UKI	Greater London	174	0.05	-0.67	-0.48
UKJ	South East	800	0.04	0.95	0.67
UKK	Sout West	91	0.00	-0.98	-0.69
UKL	Wales	107	0.09	-0.78	-0.55
UKM	Scotland	589	0.10	0.50	0.35
UKN	Northern Ireland	418	0.14	0.12	0.08

univF is defined as "*univF* = 2000 − the foundation date of the university".

univN is defined as "the number of universities per 100,000 population around 1850s".

univPC is the "first principal component of *univN* and *univF*".

univAVR is the "average of the standardized values of *univN* and *univF*".

Appendix 3: Further Analysis on the Stability

In this appendix we discuss in more detail the robustness analysis conducted in Section 4.3. 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 analyzes 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.[12] 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.[13] This suggests that these variables might be

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

[13]In almost all regressions *opinion* has a significant positive impact on growth. When only these regres-

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%

sions are considered, the coefficient of *trust* is significant in 223 cases and insignificant in 183 cases.

Table 1: Trust, innovation and education by countries

	trust	trust0	pat91	pat00	R&Dintns	educ
Austria	5.10		91.90	149.39	0.35	14.40
Belgium	4.68	0.30	62.69	148.98	0.48	15.47
Denmark	7.05	0.58	89.99	187.89	0.50	14.51
Finland	6.46		108.21	320.02	0.61	19.11
France	4.45	0.23	82.89	123.08	0.34	13.91
Germany	4.57	0.38	104.11	207.41	0.38	12.17
Greece	3.69		2.93	6.01	0.07	14.86
Ireland	5.47	0.48	18.48	74.10	0.29	11.53
Italy	4.57	0.32	30.01	58.37	0.12	14.55
Netherlands	5.69	0.53	105.75	225.12	0.35	14.03
Portugal	4.46	0.23	1.76	4.16	0.03	11.69
Spain	4.94	0.38	7.27	20.86	0.10	12.40
Sweden	6.06	0.67	125.92	282.57	0.47	11.91
UK	5.06	0.43	65.04	111.59	0.28	11.44
Total	4.88	0.39	58.29	116.10	0.25	13.08

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	1.16	0.68	0.06	3.53
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: Correlation between the instruments and trust

	trust	instPC	instAVR	univPC	univAVR	literacy
trust	1					
instPC	0.3744	1				
instAVR	0.3604	0.9964	1			
univPC	0.0151	-0.1662	-0.1596	1		
univAVR	0.0151	-0.1662	-0.1596	1	1	
literacy	0.4334	0.3091	0.3129	-0.0526	-0.0526	1

Table 4: Social capital and economic 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.

* 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 economic 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	0.04	-0.09	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.

* 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	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS
	pat91	pat00	trust	pat91	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.

* 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 trust	(2) 2SLS pat91	(3) 2SLS pat00	(4) OLS trust	(5) 2SLS pat91	(6) 2SLS pat00	(7) OLS trust	(8) 2SLS pat91	(9) 2SLS 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. * 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)	(4)	(5)
	growth	growth	growth	pat91	trust
gdppc90	-0.228	-0.285	-0.279		0.412
	[-1.046]	[-1.309]	[-1.280]		(0.096)***
	(0.022)***	(0.026)***	(0.027)***		
pat91	0.090	0.194	0.191		
	[0.413]	[0.890]	[0.876]		
	(0.024)***	(0.062)***	(0.063)***		
trust	0.016	0.034	0.025	0.724	
	[0.073]	[0.158]	[0.114]	(0.149)***	
	(0.014)	(0.052)	(0.053)		
educ	0.002	-0.019	-0.017	0.174	-0.098
	[0.007]	[-0.089]	[-0.079]	(0.062)***	(0.085)
	(0.014)	(0.017)	(0.018)		
urban	0.032	0.050	0.044		-0.143
	[0.148]	[0.229]	[0.202]		(0.048)***
	(0.011)***	(0.012)***	(0.012)***		
R&Dintns				0.228	-0.037
				(0.076)***	(0.088)
univPC					0.165
					(0.056)***
literacy					0.501
					(0.127)***
instPC					0.353
					(0.113)***
constant	0.374	0.513	0.519	-1.538	0.335
	[-0.596]	[0.435]	[0.075]	(0.637)	(0.435)
	(0.094)***	(0.064)***	(0.064)***		
N	102	102	102	102	102
R-squared	0.85	0.81	0.82	0.74	0.68

Standard errors in parentheses. Standardized coefficients in brackets.

* 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.

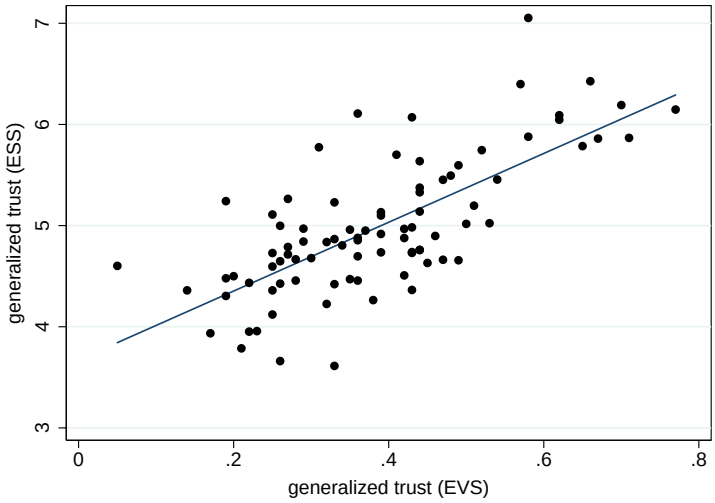

Figure 1: Generalized trust scores, EVS vs. ESS

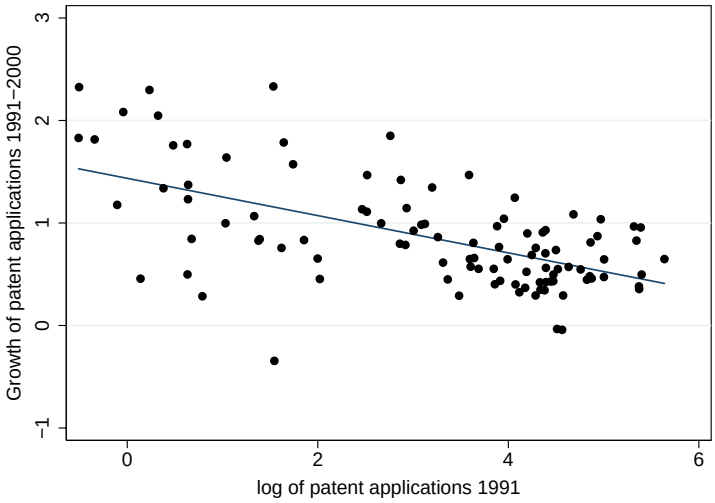

Figure 2: Growth of patents 1991-2000

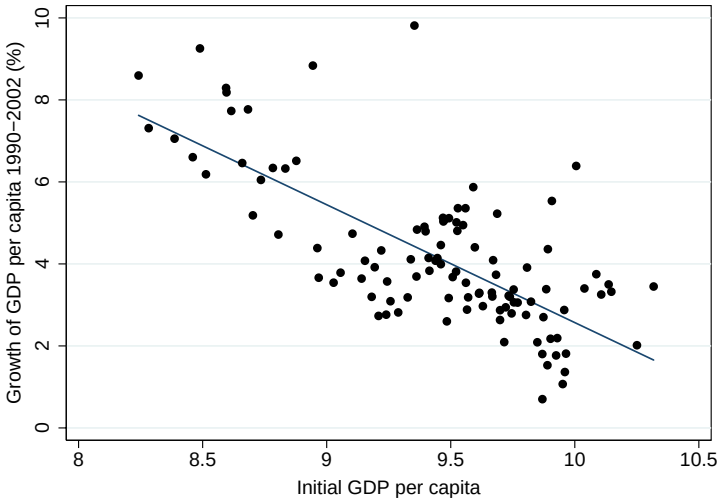

Figure 3: Growth of per capita GDP 1990-2002

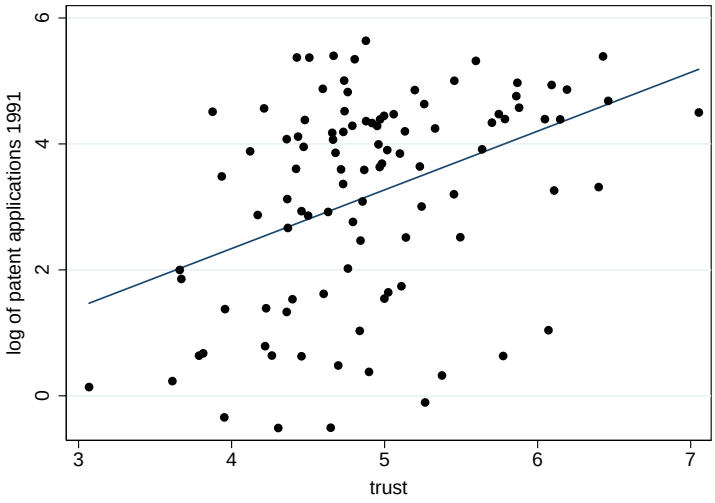

Figure 4: Patent applications 1991 and trust

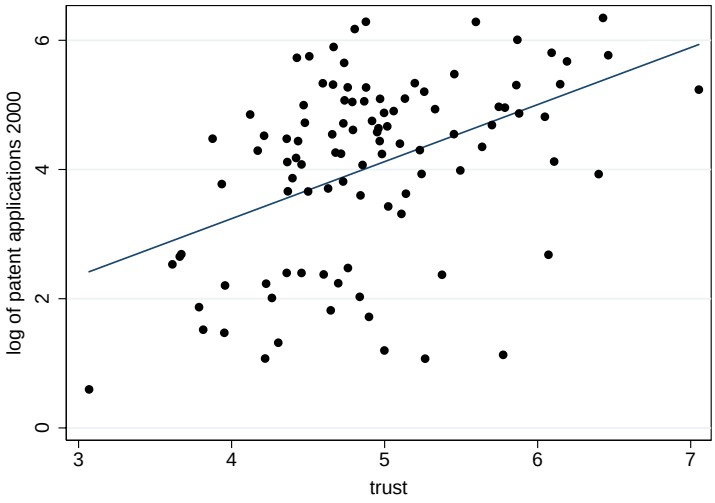

Figure 5: Patent applications 2000 and trust

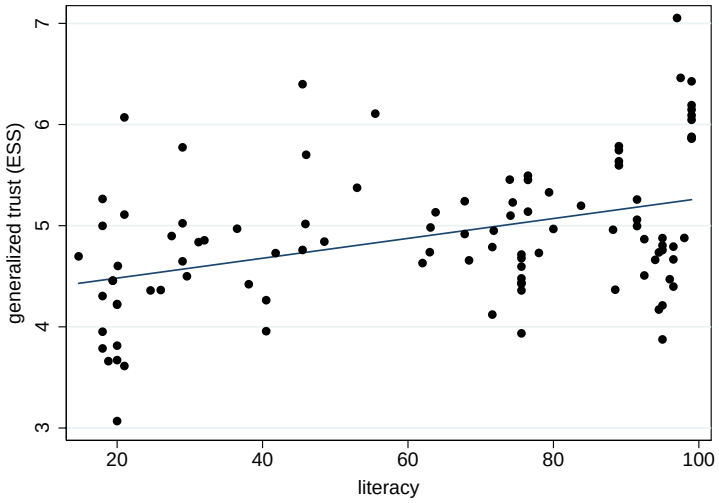

Figure 6: Literacy and trust

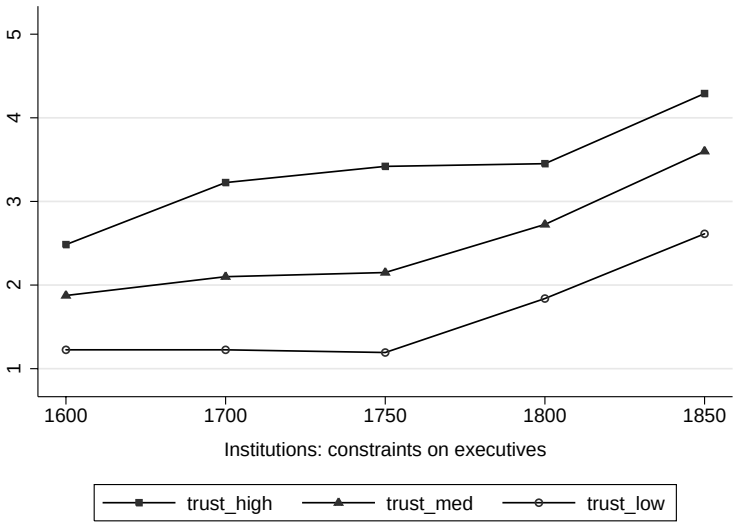

Figure 7: Institutions 1600-1850 and trust

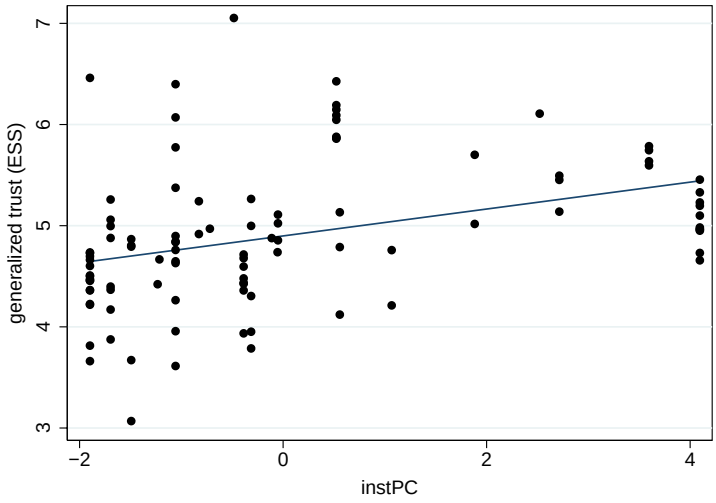

Figure 8: Institutions and trust

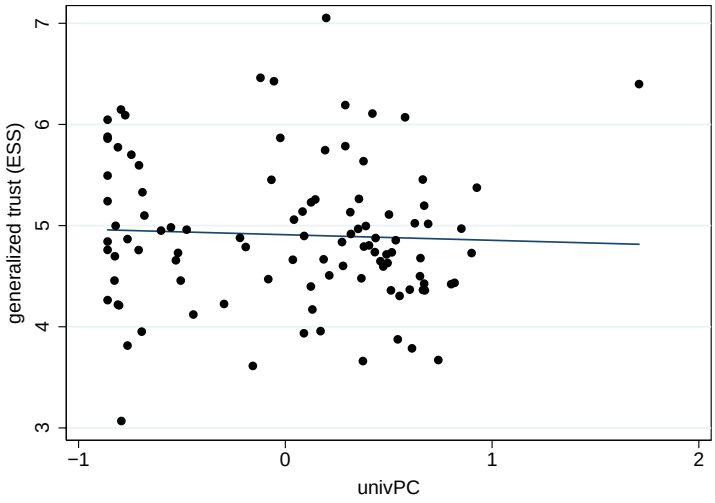

Figure 9: Universities and trust

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