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Trust and Innovation in Europe: Causal, Spatial and Non-linear Forces

İ. Semih AKÇOMAK and Hanna MÜLLER-ZICK

TEKPOL | Science and Technology Policies Research Center
Middle East Technical University
Ankara 06531 Turkey
http://www.stps.metu.edu.tr

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İ. Semih Akçomak

Hanna Müller-Zick

Abstract

This paper investigates the effect of trust on innovation. In addition to generalised trust we use a range of other indicators that could measure trust and investigate which trust related variables could explain innovation in 20 European countries divided into 135 regions. We specifically look at causal, non-linear and spatial forces. Our findings indicate that only generalised trust and non-egoistic fairness have robust effects on innovation in Europe. Using historical data on the extent and existence of universities and an instrumental variable strategy we set up a causal relationship between trust and innovation. Even after controlling for causal, spatial and non-linear forces there is a significant direct impact of trust on innovation.

Key words: trust, social capital, innovation, EU
JEL codes: O1, O3, O52, Z13

[1] İ. Semih Akçomak, Science and Technology Policy Studies (TEKPOL), Middle East Technical University (METU), MM Binası Kat: 2 No: 220, 06800 Ankara/Turkey. Contact: akcomak@metu.edu.tr. This research partially drives from the Master thesis of Hanna Müller-Zick. Contact: Hanna Müller-Zick, H.MullerZick@alumni.maastrichtuniversity.nl. Research funded by the EU Commission FP7 project SEARCH, Sharing Knowledge Assets: Interregionally cohesive neighbourhoods

1. Introduction

There is a huge literature on the impact of social capital on economic and social outcomes. Researchers have associated social capital (trust) with economic growth (e.g., Knack and Keefer, 1997), innovation (e.g., Akçomak and ter Weel, 2009), education (e.g., Coleman, 1988), value creation by firms (e.g., Nahapiet and Ghoshal, 1997) and crime (e.g., Sampson, Raudenbusch and Earls, 1997) etc. In this paper we look at the relation betweeen trust and innovation by considering causal, non-linear and spatial forces.

The social capital can affect innovation via two main mechanisms. The impact of social networks on R&D and innovation has already been discussed extensively in the economics and economic geography literature (e.g., Maskell, 2001; Bottazzi and Peri, 2003; Dakhli and De Clercq, 2004; Doh and Acs, 2010; de Dominicis, Florax and de Groot, 2013). This literature shows that social networks are important in the diffusion of tacit as well as codified knowledge. For instance, Bottazzi and Peri (2003) argue that the externalities caused by localised spillovers in European regions might be a result of non-codified, tacit knowledge of persons who frequently interact and exchange. Social networks not only play role in the diffusion of information but also create social control among entrepreneurs and firms. In small worlds entrepreneurs and firms are sometimes forced to behave in a trustworthy manner in fear of loss of reputation. Most elements above are mainly utilised through information exchange within a network (or across networks).

On the other hand some researchers focus on the benefits of social networks in reducing transaction cost (search costs for instance, e.g., Zak and Knack, 2001; Akçomak and ter Weel, 2009) and solving moral hazard problems. This second channel is mostly attributed to generalised trust. Trust relations are either formed through personal contacts through time (i.e., dense social networks may form strong trust among actors in the network) or may be an indirect result of binding institutions in the past (Beugelsdijk, 2006; Akçomak and ter Weel, 2009; Tabellini, 2010). In both cases environments that are characterised by high trust levels are vibrant in creating and sharing knowledge. Thus, high trust environments are seedbeds for entrepreneurs and researchers to conduct innovative activities.

This paper looks at the trust-innovation link in European regions. We specifically look at whether (i) there is a causal relationship between trust and innovation, (ii) other forms of trust (e.g., general, personal etc.) are conducive to innovation, (iii) non-linearity of trust is a factor to consider, and (iv) spatial forces are important in the relation between trust and innovation. These issues have been tackled individually in the literature previously. However, this is the

first research that takes all these issues as a package.[2] We also provide a survey on the empirical literature specific to cross-country or regional regressions that use social capital and/or trust as independent and economic growth and/or innovation as dependent variable. There are quite a number of papers on this specific theme and method mix. However, the policy implications from this literature are weak and mostly indirect.

Our findings can be summarised as follows. Using an instrumental variable approach and using historical data from the state of universities in Europe we manage to identify a causal relationship between trust and innovation. Although there is evidence for non-linearity the effect is not significant. When spatial forces are taken into account the impact of general trust slightly falls. In general we find that a one standard deviation rise in general trust (a 12.5% rise in trust level) increases patents per million inhabitants on average by 2%.

Our data come from two main sources. Most of the innovation related data comes form eurostat. Trust related data is from the European Social Survey 2004 round. We specifically used the 2004 round beacause there are questions on generalised trust and moreover detailed questions on trust such as whether a person ever felt cheated by a plumber, financial broker etc. There are also questions on self experiences and own acts such as whether the interviewee ever cheated on taxes, claimed false insurance benefits etc. In total we analysed 21 indicators (other than the usual suspects such as generalised trust) that we think are related to trust and trustworthiness. The historical data regarding the universites in Europe comes from Akçomak and ter Weel (2009).

The paper proceeds as follows. The next section discusses the literature on social capital in general and trust and innovation link in particular. Section 3 presents information on the data and provides some descriptive statistics. In section 4 we discuss our empirical strategy. Section 5 discusses the main results and section 6 provides further robustness analysis. Section 7 concludes with a critical view of the empirical literature on social capital, trust and innovation with respect to policy implications.

2. Social capital, trust and innovation: Literature

Social capital is one of the most succesfully introduced concepts in the literature of economics, sociology and business in the last decades. On average 300-400 papers are included in the economics literature on social capital. This vast interest has its merits, but it

[2] For instance Echebarria and Barrutia (2011) find that social capital has and inverted U-shape relation with innovation. de Dominicis, Florax and de Groot (2013) investigate spatial forces in the relation between social capital and innovation. The causality issue is as old as the seminal Knack and Keefer (1997) paper.

also has its own problems. There are already many good review articles and books on social capital. Therefore, we summarise the most salient points regarding theory and empirics below (e.g., Woolcock, 1998; Portes, 1998; Paldam, 2000; Fine, 2001; Durlauf, 2002; Durlauf and Fafchamps, 2005; Akçomak, 2011).

The social capital literature emerged from the social capital-growth link (e.g., Knack and Keefer, 1997) however the exact mechanism of how social capital translates into growth is still an important and challenging question. One channel is innovation (see section 2.3). Another is financial development (e.g., Guiso, Sapienza and Zingales, 2004). The complex relation between social capital, trust, innovation and economic growth is discussed in earlier research (e.g., Akçomak and ter Weel, 2009). Researchers view trust as an integral part of social capital. Most empirical papers in the literature do not differentiate between social capital and trust and develop indicators for both but highligh the term "social capital". It is for this reason that this section discusses the social capital and innovation link in general including trust. But our empirical approach specifically focuses on the trust-innovation link both theoretically and empirically.

Thus, the aim of this section is just to sketch the link between social capital and innovation link and discuss possible channels of how social capital can induce innovation. We then specifically look at the empirical social capital and innovation link in the economics literature.

2.1. Theoretical Framework

The theoretical approaches stem from the simple assumption that social capital is an investable sum. Individuals and firms can actually invest in their relations and utilise them for productive means. This assumption gave social capital "capital"-like properties like physical and human capital (Robison, Allan and Siles, 2002). Most of the policy implications of the social capital literature derive from this simple assumption (see the policy section at the end of the paper).

Social capital can induce innovation (i) by reducing transaction costs, (ii) solving a moral hazard problem; (iii) providing various channels for information exchange and (iv) inducing change in individual behaviour. For instance Akçomak and ter Weel (2009) model the social capital and innovation link as a simple structure where research funds are allocated to best projects and entrepreneurs who are more likely to be successful in creating innovations. This structure necessitates a high social capital (or trust) environment. The venture capitalist has to trust the entrepreneur regarding the true quality of the project and how the funds are spent. This high social capital environment automatically addresses (i) and (ii) above (see also,

Fountain, 1998; Maskell, 2001; Zak and Knack, 2001; Cooke, Clifton and Oleaga, 2005; Hauser, Tappeiner and Walde, 2007; Rutten and Boekama, 2007; Ahlerup, Olsson and Yanagizawa, 2008). Social capital can also produce network effects in three ways. First, it creates many new channels for information exchange such as internet and the social media. More information exchange channels mean more information regarding funds, technical information, market watch, competitors etc. Second, using various channels the firm can validate information. As such social networks can be used to gather "quality" information that could be hard and for sure more expensive to obtain in the non-existence of such networks. These address (iii) above (see also Dakhli and De Clercq, 2004; Beugelsdijk and Van Schaik, 2005; Barrutia and Echebarria, 2010; Doh and Acs, 2010; Iyer, Kitson and Toh, 2005; Antoci, Sabatini and Sodini, 2011).[3] Third, social capital creates small worlds where reputation is of utmost importance. Especially, with the advent of internet and social media, bad reputation can travel in fast speed. This danger may force firms to act trustfully and thus, induces change in individual attitudes. This last point addresses (iv) above.

By reducing transaction costs, solving a moral hazard problem and creating network effects social capital can induce innovation. All of the cases above will shift the general equilibrium to a better point (in the pareto sense) and increase welfare.

2.2. Defining Social Capital

Since Jacobs (1961) and Loury (1977) coined the concept many different definitions have appeared (Akçomak, 2011). There is more or less a consensus on the three concepts that are associated with social capital: *(i)* generalised trust, *(ii)* social networks, (iii) civic norms. These three related forms of social capital date back to the original contribution of Coleman (1988). He studied social capital at the individual level and identified three main forms of social capital. The first form refers to obligations and trustworthiness of structures. Coleman illustrates the importance of reciprocity and adherence to obligations as a necessity to build trust among people. Secondly, information channels constitute another core form of social capital. They allow communication of information which is only transmitted via social contacts and therefore only to particular people, most often close friends or colleagues.

[3] This kind of research is actually dates back to times of Alfred Marshall and it is very much related to local spillovers that can be defined as positive externalities in the form of ideas that are "taken up by others and combined with suggestions of their own; and thus become the source of yet more new ideas" (Marshall, 1890, p.332). According to Audretsch and Feldman (1996), innovative activities concentrate and cluster in those areas and industries where knowledge *spillovers* are cornerstones. Botazzi and Peri (2003) in a similar manner show that localised spillovers are important for R&D and innovation.

Thirdly, social capital is defined as norms and effective sanctions, which facilitate the strengthening of social relationships.[4]

The definition in the management literature shows some similarities with the three forms above. For instance Nahapiet and Ghoshal (1997) talk about three different dimensions: the structural, the relational and the cognitive dimension. The first aspect includes social interaction meaning that a person can approach its contacts to access certain information (which is akin to the social network concept). The second aspect concerns social preferences which are embedded in social interactions, such as trust and trustworthiness. The last aspect is related to shared norms that alleviate the achievement of common goals within a group.

The empirical literature mostly focusses on the trust component (e.g., Knack and Keefer, 1997; Zak and Knack, 2001; Beugelsdijk, de Groot and van Schaik, 2004; Akçomak and ter Weel, 2009). Here social capital is associated with positive externalities which arise from social organisations and networks and lead to more trust;.trust in turn can be reinforced through social norms (Durlauf and Fafchamps, 2005). Thus, trust is a fundamental issue that can characterise a community. Another explanation for why the literature focusses on "generalised trust" is that the generalised trust question is the only available social capital indicator that is validated by the experimental economics literature (e.g., Holm and Danielson, 2005). Other forms of social capital such as associational activity (e.g., Iyer, Kitson and Toh, 2005), civic norms (e.g, Putnam, 1993), altruism (e.g., Guiso, Sapienza and Zingales, 2004) have also been used by researchers. Lastly we should mention that researchers also have widely used a latent construct approach where several different facets are merged into one social capital index (e.g., Beugelsdijk and van Schaik, 2005; Svendsen and Bjørnskov, 2007; Owen and Videras, 2009; Sabatini, 2009; Doh and Acs, 2010; Akçomak and ter Weel, 2012).

Durlauf and Fafchamps (2005) sum up the main idea on social capital as follows: social capital renders positive externalities for group members, these externalities are consequently achieved through shared trust, norms and values which in turn are generated by organisations based on social networks. In this paper we open up the black box and use a wide set of indicators (for robustness reasons) that most of the time fall under the trust component highlighted above. For this reason we follow a more general definition of social capital that

[4] In conceptual discussions there are several approaches that help to define social capital such as the individual (or micro) versus the aggregate view, or the bridging versus bonding social capital. We leave all these detailed discussions aside and refer the interested readers to the review articles cited in the beginning of section 2.

highlights the trust component and base our approach on two early definitions. Putnam (1993) defines social capital as "features of social organisation, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions (p.196)". According to Fukuyama (1995) "…social capital can be defined simply as an instantiated set of informal values or norms shared among members of a group that permits them to cooperate with one another. If members of the group come to expect that others will behave reliably and honestly, then they will come to trust one another. Trust acts like a lubricant that makes any group or organization run more efficiently (p.16)". These definitions also fit well with the economic approach to social capital as our major aim in this paper is to discuss and show that social capital and trust induce economic outcomes such as innovation.

2.3. Does social capital and trust lead to innovative activities?

There is by now well-developed literature on the link between social capital, trust (even culture) and the extent of innovation activities (e.g., Rodriguez-Pose, 1999; Dakhli and De Clercq, 2004; Akçomak and ter Weel, 2009; Doh and Acs, 2010; Miguelez, Moreno and Artis, 2011; de Dominicis, Florax and de Groot, 2011).[5] The main argument of this literature is that social capital creates an environment where local factors shape entrepreneurial and innovation activities of individuals and thus the whole region.

One of the first research that highlights the link between local factors and innovation is Rodriguez-Pose (1999). He investigated the existence of regional clubs that induce innovation using EU regional level data. Some regions are more prone to innovation as opposed to regions that are rather innovation-averse. The central factor that designates the phrase "innovation-prone" is local factors that can also be viewed as culture or social capital.[6] This idea pioneered many papers since then. The literature generally uses regional level data in different aggregations (or country level data) and tries to link social capital to innovation (see the policy section as well). For instance Dakhli and De Clercq (2004) investigate this relation using cross-section data for 59 countries. They used generalised trust and other social capital variables and show that social capital is conducive to innovation measured as patents. Doh and Acs (2010) also follow a similar methodology and reach similar conclusions for 53

[5] We focus on the empirical economics literature on social capital and trust. There is also a well-developed literature in management and business on the role of social capital and networks on firm level outcomes (e.g., Nahapiet and Ghoshal, 1998; Tsai, 1998; Adler and Kwon, 2002; Alcácer and Chung, 2007). However in this paper the focus is on the link between localised nature of knowledge production and innovation. Thus our focus is on regions rather than resources of firms (for example see the approach of Uzzi, 1997 or a more recent research Laursen, Masciarelli and Prencipe, 2012).

[6] For recent research on the role of social factors that many inhibit innovation (i.e., local social assets may act as a social filter) see D'Agostino and Scarlato (2012).

countries. They identify social networks and associational activity as the most important form of social capital that induces innovation. Akçomak and ter Weel (2008) use EU regional level data and show that physical funding in the form of EU structural funds induces innovation only in regions that are characterised by high human and social capital.[7] In the following study, Akçomak and ter Weel (2009) identify innovation as a channel that translates social capital into growth. In an empirical investigation of more than 100 EU regions in the 1990-2002 period they show that the direct impact of social capital on growth is not significant when its indirect impact through innovation is controlled for. Miguelez, Moreno and Artis (2011) used panel count data models and number of patents as dependent variable to assess the role of social capital on innovative activities in Spanish regions. They highlight the complementarity of social and human capital in spurring innovation.

More recent research highlights two other factors that are not taken into consideration *(i)* spatiality, *(ii)* limits of social capital. Regarding the first case de Dominicis, Florax and de Groot (2011) investigate the impact of social capital on innovation using NUTS 2 level disaggregated regional data from 11 EU countries (146 regions). They found that regions surrounded with regions that are rich in social and human capital are innovation prone. So it is not only the region's own social capital but the resources of their neighbours as well play role in regional innovation. Regarding the second case Echebarria and Barrutia (2011) show that social capital-innovation link is inverted U-shaped, that is to say that the impact of social capital on innovation is limited at higher levels of social capital.

A related literature looks at firm level outcomes using firm level data on innovation but regional level data on social and institutional factors. One of the earliest examples of such a methodology is Landry, Amara and Lamari (2002) who state that accumulation of social capital in markets and regions play a significant role in the acquisition of knowledge by firms. The interaction of researchers through social networks creates productive social capital. Landry et al. (2002) use transaction costs theories to show that firms that belong to regions where a larger stock of social capital exists are more competitive. They find that increases in the stock of social capital have a higher influence on the decision to innovate than other factors, such as the number of employees dedicated to R&D activities. Laursen, Masciarelli and Prencipe (2012) also follow a similar strategy and show that for a sample of about 2,400 firms in Italy geographically bounded social capital is an important determinant

[7] At the firm level Laursen, Masciarelli and Prencipe (2012) show that financial capital (firm's internal R&D investments) and regional social capital are complementary for product innovations.

of firm level product innovation. The authors assume social capital to be a key transmitter of knowledge spillovers and thus induce innovation.

3. Data and descriptive statistics

The data used in this paper compile a cross-section 135 regions (from 20 EU countries) which are defined according to the Nomenclature of Territorial Units for Statistics (NUTS). This regional classification is established by Eurostat, the Directorate-General of the European Commission, which is in charge of providing statistical information on European Union member states, candidate countries, and neighbouring countries of the European Union.

The dataset comprises NUTS1 and NUTS2 levels of identification.[8] Yet, for some regions no or not enough data were available, and therefore, the following regions and countries were excluded from the dataset: Cyprus (CY0), Canarias (ES7), Ciudad Autonoma de Ceuta (ES63), Ciudad Autonoma de Melilla (ES64), Aland (FI2), Départements d'Outre Mer (FR9), Hungary (HU10, HU21-23, HU31-33), Trentino-Alto Adige (ITD1/ ITD2), Norway (NO01-NO07), Região Autónoma dos Açores (PT20) and Região Autónoma da Madeira (PT30). For Austria, Belgium, Bulgaria, Germany, Greece, Finland, France, the Netherlands and the United Kingdom the paper uses NUTS1 and for the Czech Republic, Estonia, Denmark, Ireland, Italy, Poland, Portugal, Slovakia, Slovenia, Spain and Sweden NUTS2 level is employed. The study makes use of as many disaggregated regions as data availability allows. This permits to identify differences in social capital scores and number of innovations within relatively larger regions.

3.1 Trust indicators

Following Knack and Keefer (1997) and Zak and Knack (2001) and most other related research the general trust question on whether "most people can be trusted or you can't be too careful" provides a proxy for social capital (based on Fukuyama's and Putnam's definition of social capital). In societies where trust is high people are cooperative and interact with each other in organisations and networks.

Data for the general trust question are retrieved from the 2004 round of the European Social Survey (ESS). The database covers 30 European countries and is divided into regions. Original data are adjusted by population weights to avoid overrepresentation of some countries. To measure generalised trust respondents were asked to indicate on a 0-10 scale

[8] Nuts levels are hierarchical, meaning that NUTS 1 is a larger region than a NUTS 2 region.

whether "most people can be trusted or you can't be too careful" (0 means "you can't be too careful" and 10 indicates "most people can be trusted", with nine levels in between). We label this variable as "*TRUST*". The micro data for this measure is recoded such that (1) means low, (2) medium and (3) high trust because we wanted to construct same scale for all 24 trust related indicators. These categories have then been aggregated and were clustered to make comparisons between countries easier and to detect outliers. Interestingly, in contrast to the data with the 1-10 scale, the association becomes stronger with the new categories. This is because people from different countries and therefore cultures rank for example high trust differently. The individual regional scores for *TRUST* range from 1.46 (Italy, ITF6) to 2.59 (Denmark, DK0), with an average (std. dev.) of 1.93 (0.24) for all 135 regions. The summary statistics are provided in Table 1. Data on European regions also suggest large heterogeneity in previous studies (e.g. Beugelsdijk and van Schaik, 2005; Akçomak and ter Weel, 2009).

Table 1: Summary statistics of the main variables

Variable	Mean	Std. Dev.	Min	Max
TRUST	1.93	0.24	1.46	2.59
HELP	1.85	0.27	1.33	2.39
FAIR	2.11	0.23	1.52	2.70
PATENT	87.33	109.38	0.45	581.45
RD BUS	0.81	0.78	0.02	3.53
RD PUB	0.19	0.18	0.00	1.12
EDUC	23.20	8.09	6.80	42.20

Notes: The values are non-standardised. *TRUST, FAIR* and *HELP* are measured on a scale from 1-3 (year 2004). Patents are defined as the number of patent applications to the European Patent Office (EPO) by year per million inhabitants (basis year 2006). R&D expenditures are defined as % of GDP (mean of years 2005-2008). Tertiary education represents the % of population with tertiary education aged between 25 and 64 years in 2008.

Besides interest in general trust, this paper looks at two more proxies for social capital. Both proxies stem from the ESS 2004 round. Answers on these two social capital questions were also received by asking people to indicate on a 0-10 scale whether (*FAIR*): "most people would try to take advantage of me or most people would try to be fair" and (*HELP*): "people mostly look out for themselves or people mostly try to be helpful". For the first question (0) measures "most people would try to take advantage of me" and (10) means "most people would try to be fair"; the second question is constructed similarly indicating (0) for "people mostly look out for themselves" and (10) "people mostly try to be helpful", with nine levels in between. The variables were respectively labelled "*FAIR*" and "*HELP*". The micro data for these measures have also been constructed in low, medium and high categories as described above. Regional scores for *FAIR* range from 1.52 (Italy, ITF6) to 2.70 (Denmark, DK0), with

an average (std. dev) of 2.11 (0.23) for all regions. The scores for *HELP* display a similar pattern ranging from 1.33 (Italy, ITF6) to 2.39 (Sweden, SE08), with an average (std. dev.) of 1.85 (0.27). All three indicators underline large differences between and within countries. Aggregating the data to countries shows that Greece and eastern European countries, such as Bulgaria have the lowest social capital score whereas Scandinavian countries depict generally high social capital levels as can be seen in columns (1) - (3) in Table 2.

Table 2: Means for trust and innovation variables across countries

Country	TRUST (1)	HELP (2)	FAIR (3)	PATENT (4)	RDBUS (5)	RDPUB (6)	EDUC (7)
Austria	2.08	2.10	2.25	203.46	1.88	0.14	17.63
Belgium	1.95	1.77	2.21	128.38	1.14	0.27	34.33
Bulgaria	1.56	1.51	1.87	3.56	0.11	0.25	22.85
Czech	1.81	1.73	2.08	14.63	0.94	0.15	14.29
Denmark	2.59	2.35	2.70	225.74	1.90	0.08	32.10
Estonia	2.10	1.90	2.18	15.78	0.40	0.09	12.10
Finland	2.52	2.26	2.62	230.19	2.57	0.34	36.60
France	1.87	1.85	2.24	123.97	1.19	0.25	26.96
Germany	1.92	1.96	2.25	206.74	1.22	0.45	25.86
Greece	1.67	1.49	1.64	7.71	0.12	0.12	21.10
Ireland	2.21	2.36	2.34	68.62	0.89	0.10	32.95
Italy	1.86	1.66	1.89	67.95	0.42	0.15	14.15
Netherlands	2.29	2.14	2.45	225.63	1.02	0.34	30.40
Poland	1.67	1.53	1.91	3.35	0.13	0.13	18.53
Portugal	1.69	1.64	1.96	8.78	0.41	0.08	14.00
Slovakia	1.85	1.79	1.95	10.26	0.23	0.17	17.66
Slovenia	1.78	1.85	1.97	50.18	0.92	0.33	23.00
Spain	2.01	1.81	2.11	27.92	0.57	0.16	29.39
Sweden	2.39	2.34	2.53	234.87	1.94	0.14	30.29
UK	2.11	2.21	2.23	81.04	1.08	0.15	30.82
Overall	1.93	1.85	2.11	87.33	0.81	0.19	23.20

Note: The values are non-standardised.

3.2 Innovation indicators and education

The data for innovation output and input as well as education are retrieved from Eurostat's regional database. Since data for some observations are missing, the final variables are constructed by replacing missing observations with data from other years.[9]

As innovation output the paper uses patent data. The problems related with using patents as proxy for innovation are well-known (de Dominicis, Florax, & de Groot, 2011). One major pitfall is that not all new ideas are patented and not all patents contribute equally to new knowledge. According to Bottazzi and Peri (2003), it can be argued that patents are good

[9] To fill missing points in the data the paper uses linear interpolation, a method for estimating an unknown value of a function between two known values of that function.

proxies for innovation. Ideas are only patented if they fulfil certain standards of "novelty, originality and potential use" (Bottazzi & Peri, 2003, p.692).

The patent data stem from the patent applications to the European Patent Office (EPO) by year per million inhabitants. We used data from 2006 for data availability reasons. Whenever there is a missing observation, it is replaced by the mean of the years 2004 and 2007. Our patent indicator (*PATENT*) is the logarithm of patent applications per million inhabitants. *PATENT* indicate very large differences between regions, ranging from 0.45 patent applications (Poland, PL34) to 581.45 patent applications (Germany, DE1), with an overall mean (std. dev.) of 87.33 (109.38) patent applications. Moreover, one can see the geographic divide in column (4) of Table 2: Germany, the Netherlands and the Scandinavian countries have the highest patent applications in contrast to southern and eastern countries which have the lowest numbers.

As proxy variables for innovation input several variables are employed: R&D intensity in the business and public sector, respectively defined as percentage of GDP. In order to construct one summary variable for each of the variables, the mean values of 2005, 2006, 2007 and 2008 is calculated to form *RDBUS* and *RDPUB*. The data range from 0 % (Poland, PL43, PL61) to 1.12 % (Germany, DE3), with a mean (std. dev.) of 0.19 % (0.18) for *RDPUB*. Berlin (DE3) is the region spending most for research activities in the public sector. For *RDBUS*, the data range from 0.02 % (Poland, PL42) to high levels of 3.53 % (Sweden, SE04), with a mean (std. dev.) 0.81 % (0.78). When comparing the numbers in column (5) and (6) to column (4) in Table 2 the findings suggest that *PATENT*, *RDBUS* and *RDPUB* is correlated.

Finally, another potential factor which influences innovative activities in a region is the stock of human capital (Bottazzi & Peri, 2003). As proxy for education the percentage of population with tertiary education aged 25-64 years in 2008 is used. This measure is abbreviated as *EDUC*. The highest levels of tertiary education are to be found in a Scandinavian country, Finland, and the lowest ones in an eastern European country, Estonia (Table 2).

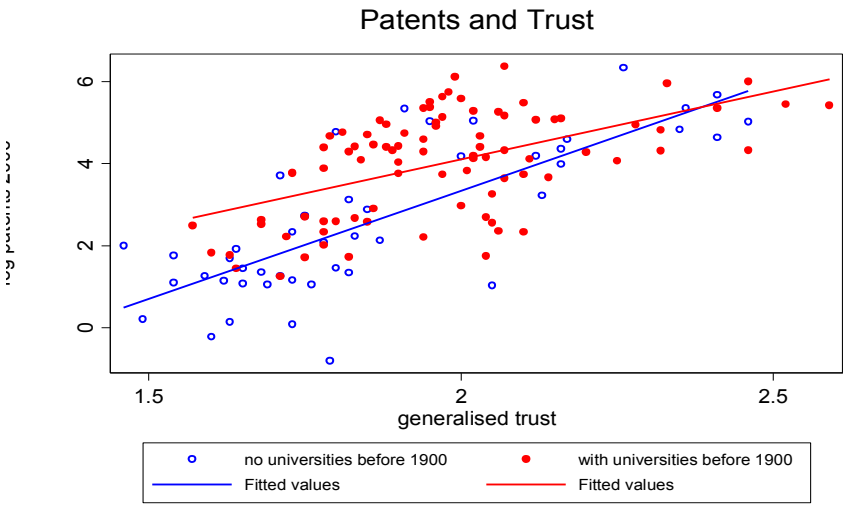
3.3 Instrumental variable: universities in history

Any research that investigates the link between social capital and innovation should address the causality issue and at least offer a solution. All research reviewed in section 2 assumes that social capital induces innovation. But it could be the case that advances in ICT offers new way of networking and induce social capital or that more exogenously induced innovation in a region may force entrepreneurs to share ideas. There could be many other

channels that question the causality. To control for possible endogeneity we apply an IV methodology where historical information on the extent of universities is used as an instrument (barrowed from Akçomak and ter Weel, 2009).

Following Readings (1996), it can be argued that universities contributed in particular to the creation of national culture and identity since they lay the basis for national liberation movements. Moreover, university graduates are commonly considered as being educated with a "common world view in the same cultural tradition and norms" and contribute to the shaping of their respective region as they are integrated into social structures. The instrument could also be defended by referring to the complementarities of human and social capital (e.g., Coleman, 1988; Goldin and Katz, 1999; Gradstein and Justman, 2000). But in this research the complementarities are between the extent of universities in the past and current social capital. We assume that past extent of universities influence current social capital but not current innovation attempts.

Figure 1: Patents and Trust in regions with and without Universities



We use an index made out of three indicators: *EXIST*: (2000 - foundation date of university in a region) measures the period of existence of universities in regions already exist, taking the foundation date of the oldest university into account. *DENSITY1900* and *DENSITY2000* capture the density of universities per 100,000 inhabitants before 1900 and in 2000, respectively. The first principal component of these three indicators is employed as an

instrument and labelled as *UNIV*.[10] Figure 1 depicts the trust-innovation relation in regions with and without universities before 1900.

3.4 Summary Statistics

Table 3 presents correlations between all social capital measures, innovation variables and the instrument. All indicators are standardised such that mean equals zero and variance equals one for comparability reasons between indicators. Innovation output measure *PATENT* is positively correlated with the main social capital indicators *TRUST, HELP* and *FAIR* as well as the control variables *RDBUS* and *EDUC*. Among the indicators only *RDPUB* display low correlations to all variables. Especially there is no correlation between social capital indicators and *RDPUB*. This could mean that social capital is less important for research in the public sector. This finding is not that surprising as the economic approach to social capital links trust to innovative and entrepreneurial activities of individuals and firms. There may not be such a relation among public R&D and trust as our results report.

Table 3: Pairwise correlations between variables

	TRUST	HELP	FAIR	PATENT	RDBUS	RDPUB	EDUC	UNIV
TRUST	1.000							
HELP	0.840***	1.000						
FAIR	0.852***	0.854***	1.000					
PATENT	0.673***	0.689***	0.707***	1.000				
RDBUS	0.561***	0.567***	0.614***	0.717***	1.000			
RDPUB	0.098	0.148	0.254***	0.337***	0.239***	1.000		
EDUC	0.566***	0.565***	0.588***	0.502***	0.436***	0.388***	1.000	
UNIV	0.314***	0.187**	0.230***	0.379***	0.186**	0.189**	0.269***	1.000

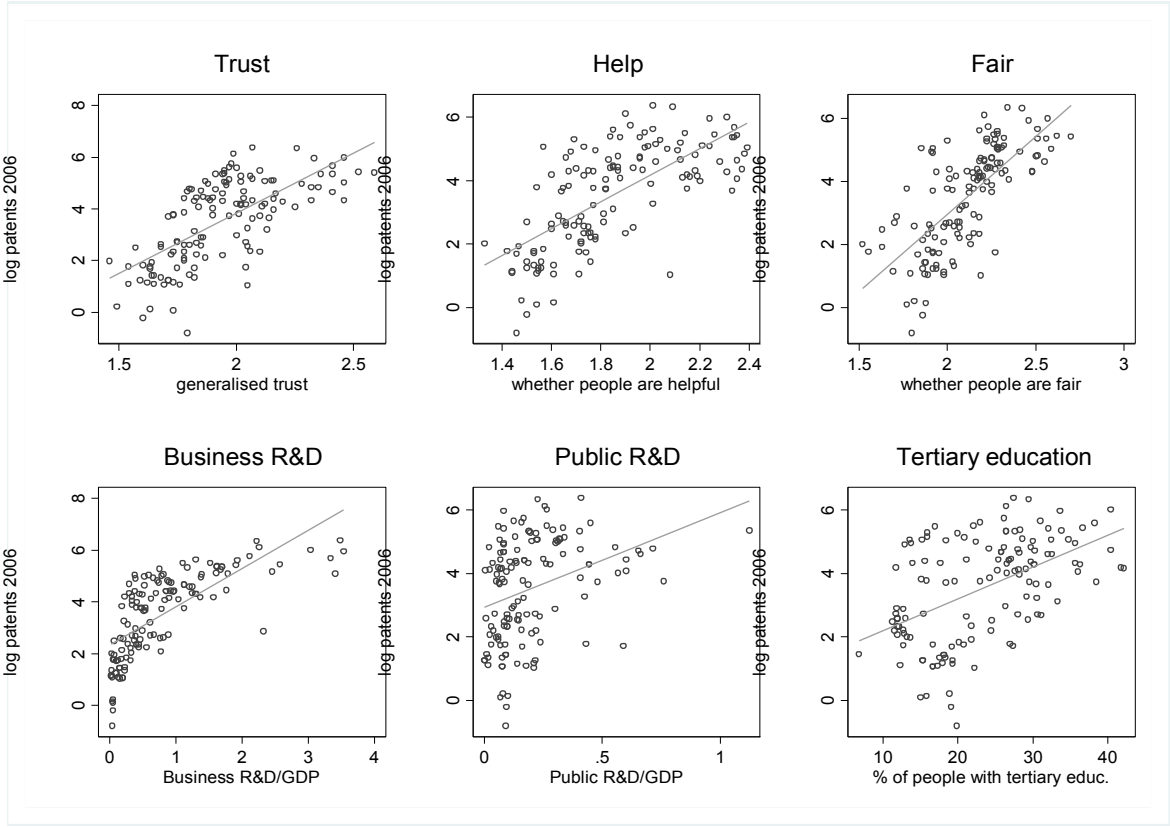
Notes: Indicators are standardised. *** is significant at the 1 %, ** at 5 % and * at 10 %.

Figure 2 depicts scatter plot to better view these correlations. Our main objective is to spot the outliers if any and search for any interesting pattern among variables. There are several observations to be made. First, the scatter plot between *RDPUB* and *PATENT* shows some outliers. The very right data point in the scatter plot is the German region Berlin. It invests apparently a lot in public R&D (but not as much in business R&D). Apart from this there seems to be no outlier that may drive the econometric results in section 5. Second, the correlations between *RDBUS* and *PATENT* show a nonlinear pattern. The Scandinavian

[10] Collecting these data special attention was paid to possible pitfalls such as foundation and possible re-foundation dates. It could also be that universities did not exist at a later time anymore and universities could have merged at a later stage. Shifts of borders had also to be taken into account when matching the cities to the correspondent regions. For details please see Akçomak and ter Weel (2009).

regions, the Netherlands and some southern German regions such as Baden-Wuerttemberg invest more in business R&D (points above 2% of business R&D to GDP ratio). It seems that there is a threshold of about 2% of Business R&D to GDP. After this threshold the relation between *RDBUS* and *PATENT* breaks down. A similar anomaly can be put forward with very low values of *RDBUS* as well. Finally, though not strong, there seems also to be a non-linearity between *TRUST* and *PATENTS*. *TRUST* levels beyond 2.2 (graph first row, first column) the relation between generalised trust and patents seem to blur.

Figure 2: Scatter plots of social capital and innovation variables



4. Empirical strategy

In order to test for the impact of trust on innovation we follow a three stage strategy. i) a factor analysis to see whether there are different components of trust, ii) the regression analysis to see the impact of trust on innovation using OLS and instrumental variable (IV) estimators, and iii) robustness analysis.

First we employ a factor analysis to see whether different forms of trust and trustworthiness are related to innovation. Research is either concentrated on the generalised

trust question (e.g., Zak and Knack, 2001) or composite social capital indices (e.g., Beugelsdijk and van Schaik, 2005). However, looking at different trust related indicators gives a more complete overview on which components of trust (if any) are good for innovation. The second round of ESS allows us to use a wide set of trust related questions such as trust in financial institutions, or judgment on how wrong actions are such as bribing etc. Specifically, 21 questions from the ESS are taken to create indices with variables that measure conceptually similar subcomponents of social capital. A list with all trust-related questions for the factor analyses is provided in Appendix B.

Secondly, this paper tests the impact of trust on innovation by estimating the following equation using OLS

$$\begin{aligned} PATENT = \quad & \beta_0 + \beta_{1i}TRUST + \beta_{2i}TRUST^2 + \beta_{3i}RDBUS + \beta_{4i}RDPUB + \\ & \beta_{5i}EDUC + \beta_{6i}TRUST * RDBUS + \beta_{7i}TRUST * RDPUB + \\ & \beta_{8i}TRUST * EDUC + c_i + \varepsilon \end{aligned} \quad (1)$$

Equation (1) shows the full set of explanatory variables. We first estimate an OLS regression using *TRUST, HELP, FAIR* and country-fixed effects. Then we add *RDBUS, RDPUB* and *EDUC* as control variables. In the next step we add interaction terms. Finally to analyse the non-linearity of the correlation between trust and innovation we add a squared term of *TRUST*.

In equation (1) we assume that the causality runs from trust to innovation. The OLS estimations might be biased because it is likely that current trust levels may be influenced by innovative activities. Hence, the correlations between social capital and innovation cannot be interpreted in a causal way. For instance, McElroy, Jorna and van Engelen (2006) argue that knowledge and innovation are important determinants of social capital. Thus there might well be reverse causality problem. Previous research have addressed this issue by using instruments that are correlated with the endogenous *TRUST* but not with the error term (e.g., Knack and Keefer, 1997; Akçomak and ter Weel, 2009). To estimate causal relationships and avoid reverse causality a two-stage instrumental variables (IV) regression approach is employed (Wooldridge, 2004). The first stage tests whether the instrument *UNIV* correlates with *TRUST* when the impact of other independent variables is controlled for. Then we use the predicted values of *TRUST* and include in the *PATENT* regression.

In any IV regression the instrument must not be correlated with the error term. This second condition is not testable due to the fact that we cannot measure the unobserved variables. One indication that the instrument *UNIV* is not related to *PATENT* is to include *UNIV* as a regressor in equation (1) with *TRUST, RDBUS, RDPUB* and *EDUC* and country dummies as other independent variables. In such a regression the coefficient for *UNIV* is not significant (coefficient: 0.058, std. dev.: 0.053). In addition, the regressions based on equation (1) are also controlled for the recent number of university graduates (*EDUC*) to increase the validity of the instrument. It might be possible that universities before 1900 affect the present number of university graduates, and through this channel they could affect the number of patents. Such doubts can be refuted on the grounds that historical information on universities such as density before 1900 is unlikely to lead to more patents today due to the large time period in between.

Thirdly, we employ two robustness tests addressing two questions: *(i)* do spatiality affect the results? (*ii)* are the estimations robust to the inclusion of other trust related indicators? Spatial autocorrelation is taken into account and the *Moran's I* statistic is calculated. In order to test this, first an OLS regression without country-fixed effects and without interaction terms is estimated. The spatial diagnostics report the estimates for the simple LM test for error dependence (LMerr), the simple LM test for a missing spatially lagged dependent variable (LMlag), as well as the robust variants.

To analyse the robustness of the findings for inclusion of other relevant indicators we benefited from the seminal paper of Sala-I-Martin (1997). For our purposes we first estimate a base regression where the dependent variable is *PATENT* with *TRUST, RDBUS, RDPUB* and *EDUC* as independent variables then include a set of other relevant trust related indicators. In total we use 21 indicators as described in Appendix B. We compute five tests in total as described and used in previous studies (Beugelsdijk, de Groot and van Schaik, 2004; Akçomak and ter Weel, 2009).

5. Results

5.1 Factor analysis

The factor analysis on 21 trust related indicators yields six factors. Appendix C shows the result and the factor loadings. The first factor is called "*BRIBE*" because questions in this factor are mainly about whether someone was asked a favour for a service or offered a favour to a government official. The second factor is about questions that ask how much someone

trusts in private business such as financial companies and therefore is labelled as "TRUST IN BUSINESS". The next factor is "*JUDGEMENT*" because it clusters questions on how wrong it is to do something like paying cash without receipt to avoid paying the tax. The fourth factor summarises questions on own experience regarding the honesty of others and is labelled "*HONESTY*". The last two factors are called "*SERIOUS ACT*" and "*NON-SERIOUS ACT*". The former encompasses questions on for example false insurance claims, whereas the latter clusters around questions that for example ask how often a person has kept change from shop assistants when too much money was given back.

Table 4: Pairwise correlations between trust indicators

	TRUST	HELP	FAIR
TRUST	1.000		
HELP	0.840***	1.000	
FAIR	0.852***	0.854***	1.000
F1: BRIBE	0.411***	0.409***	0.433***
F2: TRUST IN BUSINESS	0.249***	0.249***	0.388***
F3: JUDGEMENT	0.172**	-0.036	-0.010
F4: HONESTY	-0.183**	-0.231***	-0.303***
F5: SERIOUS ACTS	0.015	0.001	-0.025
F6: NON-SERIOUS ACTS	-0.346***	-0.395***	-0.403***

Notes: The indicators are standardised. *** is significant at the 1%, ** at 5% and * at 10% significance level

Correlations between the different trust indicators are shown in Table 4. We omit correlations between factors as by definition there is no correlation among factors. *TRUST, HELP* and *FAIR* are positively and significantly correlated with the first and second factor indicating that these factors might display a similar character in the patent regressions. Hence, assuming that social capital has a positive relationship with patents, less bribe and high trust in business interactions is likely to stimulate an innovative environment. The other factors surprisingly, display either no relation or negative correlation with trust. There may be two definitions for this. First, the question may not be measuring the aspect of trust that it aims to measure. People could hesitate answering a question on whether he/she has ever offered bribed or cheated on taxes. Thus, the answers could be biased. When compared to such questions answering a question whether the person has ever felt like a plumber or a financial analyst asked more money for the services is much easier and yet more reliable. Second related with the first issue the correlations might be plagued by outliers. For a further analysis we sketched the relations using scatter plots (Figure 3).

Figure 3: Scatter plots of trust related indicators

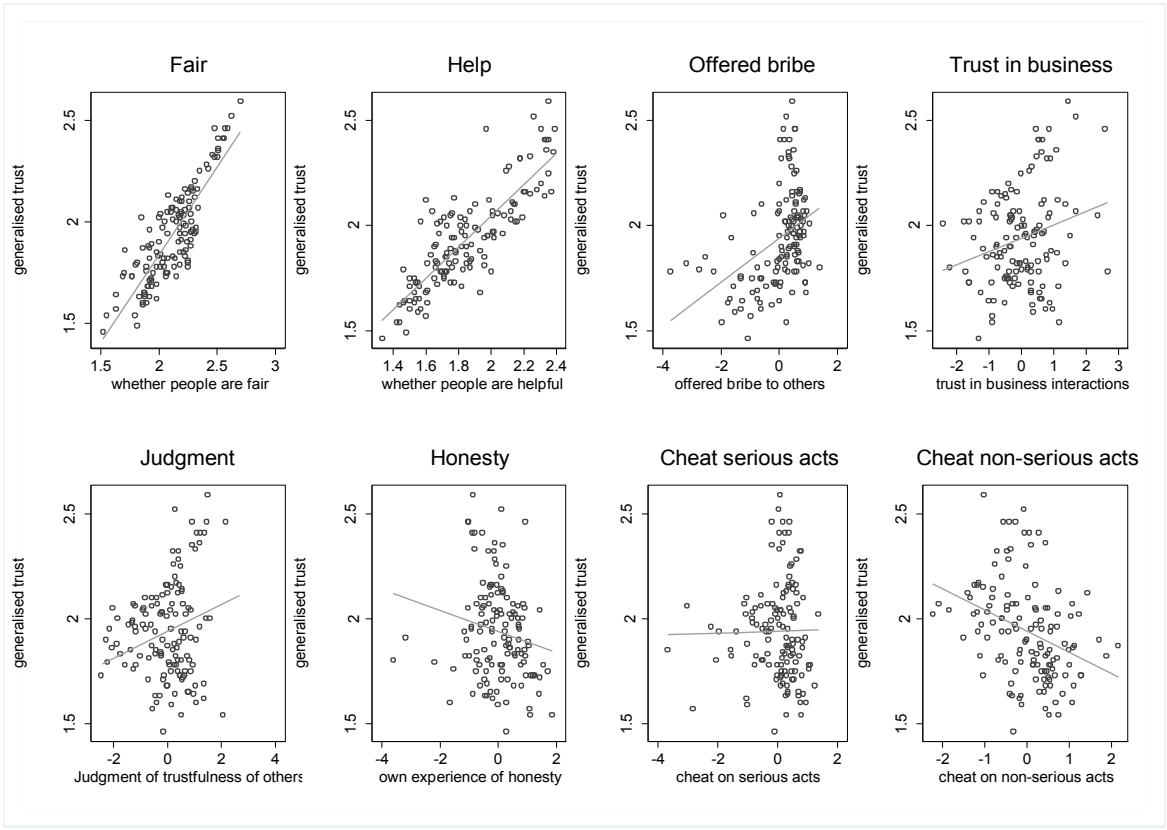


Figure 3 displays scatter plots between *TRUST, HELP, FAIR* and the six factors. Several observations can be made. First, the scatter plots show that the correlations should be interpreted in caution especially in the case of *JUDGEMENT, HONESTY* and *SERIOUS ACT*. It seems that there is no pattern or that the pattern is driven by outliers. One reason could be the question itself as we discussed. Another reason may the number of "not applicable" and "never" answers to the question. For instance factor 5 measures the serious trust issues such as reporting false insurance claims. As apparent from the scatter plot the values are centred on zero. Another interesting pattern to observe is that even though the northern countries display very high general trust levels they do not display high scores on questions based on recent experience (such as *HONESTY* and *NON-SERIOUS ACT*). East European countries display just an opposite pattern: low on general trust and high on personal experiences on trust, trustworthiness and honesty. One possible explanation is that general trust is a stock variable that takes long time to form and has a history behind; whereas questions on own experience on trust and honesty measures the current state of interpersonal trust. This finding also supports the use of an historical variable *UNIV* as an instrument to *TRUST*.

5.2 The impact of trust on innovation

Table 5 presents the estimates of the impact of trust on innovation using equation (1). The correlation between *TRUST* and *PATENT* is statistically significant across 135 European regions. The country dummies are included in order to avoid an omitted variable bias due to different national cultures or institutions. Estimating regressions without country dummies in column (1) returns a R^2 of 0.6, but including the dummies returns an R^2 of 0.9 which means that one third of the variation in *PATENT* is explained by country fixed effects. The estimates suggest that a one standard deviation increase in *TRUST* (12.5%) leads to a rise in *PATENT* of between a quarter and half a standard deviation. In terms of the number of patents, this implies between 1.5 and 2.3 more patents. This means that if general trust increases by about 12.5% patents per million inhabitants increase on average by 2%. This relationship remains stable when other control variables are included. Adding *RDBUS* bus to the model reduces the coefficient of *TRUST* which seems plausible because some of the direct of *RDBUS* on *PATENT* is captured by *TRUST*. If R&D activities (business and public) increase by one standard deviation (1%), patents increase on average by 2%.

In column (5), estimates are reported when interaction terms that capture possible complementary effects between innovation inputs and *TRUST* are included in the regression. The estimated coefficient of *TRUST* is reduced slightly, but remains significant. The coefficients of the interaction terms are negative but never significant, which suggests that there are no statistically significant interaction effects.

Other trust related indicators demonstrate mixed results. For *FAIR*, the results are comparable to *TRUST*. A one standard deviation increase in *FAIR* (10%) leads to a rise in innovation of between one-fifth and half a standard deviation. In terms of the number of patents, this implies between 1.4 and 2.3 more patents. Including interaction terms between the control variables and *FAIR* in column (5) reduces the coefficient, but remains significant. This result seems consistent with the definition of the two indicators. People are inclined to answer in similar ways to whether people can be trusted (*TRUST*) and whether most people would try to be fair (*FAIR*) since the two questions seem to be a paraphrase of the other.

In contrast, the indicator *HELP* does not return significant coefficient. It is only significant once at the 10 percent level when all control variables, except the interaction terms, are included. These results are in line with Dakhli and de Clercq (2004) and Kaasa (2009). They argue that norms of being a good citizen are rather contradictory to creativity and thinking differently. Our results could be interpreted as the fact that it is rather "actual

behaviour that matters, and not the norms, whereas the norms may but need not guide the actual behaviour" (Kaasa, 2009, p.27).

Table 5: The OLS results for the impact of trust on innovation

Dependent variable: PATENT (log of patents)

	(1)	(2)	(3)	(4)	(5)
TRUST	0.516	0.382	0.376	0.338	0.253
	(0.085)***	(0.080)***	(0.079)***	(0.086)***	(0.085)***
HELP	0.308	0.273	0.262	0.281	0.121
	(0.213)	(0.179)	(0.178)	(0.158)*	(0.146)
FAIR	0.502	0.412	0.405	0.393	0.204
	(0.100)***	(0.086)***	(0.085)***	(0.085)***	(0.525)***
F1: BRIBE	0.156	0.143	0.141	0.128	0.053
	(0.083)*	(0.074)*	(0.075)*	(0.076)*	(0.082)
F2: TRUST IN BUSINESS	-0.008	-0.001	0.008	0.115	-0.004
	(0.081)	(0.683)	(0.073)	(0.065)	(0.059)
F3: JUDGEMENT	0.123	0.117	0.114	0.094	0.081
	(0.089)	(0.068)	(0.069)	(0.059)	(0.065)
F4: HONESTY	-0.067	-0.052	-0.042	-0.042	0.005
	(0.088)	(0.075)	(0.078)	(0.078)	(0.091)
F5: SERIOUS ACTS	-0.002	0.028	0.028	0.013	-0.021
	(0.056)	(0.048)	(0.049)	(0.045)	(0.039)
F6: NON-SERIOUS ACTS	-0.125	-0.066	-0.069	-0.053	-0.011
	(0.072)*	(0.064)	(0.065)	(0.061)	(0.063)
n	135	135	135	135	135
Controls	Country dummies	Country dummies	Country dummies	Country dummies	Country dummies
		RDBUS	RDBUS	RDBUS	RDBUS
			RDPUB	RDPUB	RDPUB
				EDUC	EDUC
					Interaction terms

Note: All coefficients in each cell are the result of separate regressions with a different independent variable set. Robust standard errors are reported in parentheses. The variables are defined in more detail in the Appendix. *** is significant at the 1%, ** at 5% and * at 10% significance level.

A final result showed in Table 5 is that the first factor *BRIBE* correlates positively and significantly with innovation, although only at the 10 percent level. A one standard deviation increase in this factor leads to a rise in innovation of between one and three twentieth standard deviation. None of the other factors discusses in section 5.1 return significant coefficient. This result may be due to the fact that it is general trust that matters, not other forms of trust. However, we may have reached these results because the questions might not measure the right aspect of trust so that people do not answer the questions in the right way.

Table 6: Non-linearity in the relationship between trust and innovation

Dependent variable: PATENT (log of patents)

	(1)	(2)	(3)	(4)	(6)
TRUST	0.505	0.372	0.367	0.326	0.260
	(0.083)***	(0.076)***	(0.075)***	(0.079)***	(0.083)**
HELP	0.181	0.205	0.190	0.208	0.084
	(0.196)	(0.173)	(0.172)	(0.142)	(0.146)
FAIR	0.402	0.312	0.305	0.296	0.184
	(0.127)**	(0.097)**	(0.097)**	(0.079)***	(0.067)***
F1: BRIBE	0.180	0.116	0.119	0.022	0.078
	(0.137)	(0.121)	(0.074)	(0.069)	(0.102)
F2: TRUST IN BUSINESS	0.006	0.009	0.019	0.022	0.013
	(0.079)	(0.069)	(0.074)	(0.069)	(0.063)
F3: JUDGEMENT	0.126	0.124	0.120	0.100	0.086
	(0.092)	(0.067)	(0.069)	(0.056)	(0.062)
F4: HONESTY	-0.184	-0.139	-0.129	-0.124	-0.088
	(0.120)	(0.105)	(0.107)	(0.105)	(0.088)
F5: SERIOUS ACTS	0.034	0.036	0.029	0.039	0.025
	(0.087)	(0.075)	(0.076)	(0.073)	(0.071)
F6: NON-SERIOUS ACTS	-0.125	-0.066	-0.070	-0.053	-0.010
	(0.074)*	(0.066)	(0.067)	(0.063)	(0.064)
n	135	135	135	135	135
Controls	Country dummies	Country dummies	Country dummies	Country dummies	Country dummies
	TRUST SQR	TRUST SQR	TRUST SQR	TRUST SQR	TRUST SQR
		RDBUS	RDBUS	RDBUS	RDBUS
			RDPUB	RDPUB	RDPUB
				EDUC	EDUC
					Interaction terms

Note: All coefficients in each cell are the result of separate regressions with a different independent variable set. Robust standard errors are reported in parentheses. The variables are defined in more detail in the Appendix. *** is significant at the 1%, ** at 5% and * at 10% significance level.

5.3 Accounting for non-linearity in the relationship between trust and innovation

In Table 5, it is assumed that the correlation between trust and innovation is linear. However this does not need to be the case. The fact that the level of social capital is maximised in the surveys could be one explanation. Considering a trust scale from 1 to 10 a move from 3-4 is different than a move from 9-10. From a certain point onwards on this scale the difference between the levels becomes almost imperceptible. Moreover, too much trust could be detrimental to innovation because it prevents new ideas to flourish and creativity might be diminished. Hence, this may suggest diminishing returns to social capital. To examine the curvature of the correlation across different regions squared trust terms are included to the estimations displayed in Table 5. The results are presented in Table 6. The coefficients of *TRUST* and *FAIR* remain similar in terms of magnitude and significance. The squared terms, which are not shown in the table, never return significant but always negative estimates. This

indicates that the correlation between social capital and innovation is likely to be concave, although a linear curvature cannot be rejected.

5.4 Estimating causal relationships between trust and innovation

To investigate the causality of the correlation between trust and innovation we apply a 2SLS strategy. The instrument is the first principal component of three variables: the number of years of existence of universities and density of universities before year 1900 and around 2000 (number of universities per 100.000 inhabitants). The first-stage is estimated including all independent variables but excluding the interaction terms. Table 7 shows the results. The instrument *UNIV* is always positively and significantly correlated with the *TRUST* and *FAIR* which suggests that the instrument is suitable. In order to test the strength and relevance of the instrument Table 7 reports the F-test for the instrument. Staiger and Stock (1997) suggested a critical value of 10; if the F-test exceeds this measure the instrument is reliable. The F-tests are above the critical level except for *HELP*. However as we have discussed in section 5.1 the *HELP* does not produce significant coefficients in patent regressions.

As a sensitivity test, the correlation between the instrument and trust indicators is tested once the regions without universities are taken out of the estimation, and the results remains stable. The sample is then reduced to 87 regions. With these 87 regions the F-tests for *HELP* are around 10, but for *TRUST* and *FAIR* they are higher (about 28 and 26 for *TRUST* and *FAIR* respectively).

Table 7: First-stage results of the IV estimation

Dependent variable: TRUST, HELP, FAIR

	TRUST	TRUST	HELP	HELP	FAIR	FAIR
	(1)	(2)	(3)	(4)	(5)	(6)
UNIV	0.217 (0.047)***	0.185 (0.049)***	0.094 (0.344)***	0.102 (0.037)***	0.186 (0.043)***	0.178 (0.046)***
F-test	21.67***	13.84***	7.42***	7.48***	18.79***	14.77***
n	135	135	135	135	135	135
Controls	Country dummies	Country dummies	Country dummies	Country dummies	Country dummies	Country dummies
		RDBUS		RDBUS		RDBUS
		RDPUB		RDPUB		RDPUB
		EDUC		EDUC		EDUC

Note: All coefficients in each cell are the result of separate regressions with two different models, one with country fixed effects but without any controls (columns 1, 3, 5) and one with including the controls (columns 2, 4, 6). Robust standard errors are reported in parentheses. The variables are defined in more detail in the Appendix. *** is significant at the 1%, ** at 5% and * at 10% significance level.

The results of the second-stage are presented in Table 8. The coefficients are significant and the size of the coefficients is generally larger. For *TRUST* it has almost twice the magnitude of the coefficient of the OLS regression. This means that if for example *TRUST* increases by

about 12.5% (one std. dev.) *PATENT* increase on average by 3%, which indicates a stronger effect than in the OLS regressions. The IV estimates might be larger because the OLS estimates are biased and only the 2SLS regressions establish a causal effect. Moreover, the 2SLS regressions establish the causal link for the sub-sample of regions whose *TRUST* levels are determined by the historical state of an important influencer of social capital which is higher education. As Angrist and Pischke (2009) argue, the OLS estimates give the so-called average treatment effect (ATE), whereas the 2SLS estimates can be interpreted as the local average treatment effect (LATE). As a sensitivity test we also estimated the regressions with the set of regions without universities (87 regions). The estimates are reduced by almost a half and are therefore similar to the OLS estimates for the whole set.

Table 8: Second-stage results of the IV estimation

Dependent variable: PATENT (log of patents)

	(1)	(2)	(3)	(4)	(5)	(6)
TRUST	0.958 (0.385)***	0.616 (0.333)*				
HELP			2.218 (1.248)*	1.114 (0.662)*		
FAIR					1.121 (0.440)**	0.640 (0.329)*
n	135	135	135	135	135	135
Controls	Country dummies	Country dummies	Country dummies	Country dummies	Country dummies	Country dummies
		RDBUS		RDBUS		RDBUS
		RDPUB		RDPUB		RDPUB
		EDUC		EDUC		EDUC

Note: All coefficients in each cell are the result of separate regressions with two different models, one with country fixed effects but without any controls (columns 1, 3, 5) and one with including the controls (columns 2, 4, 6). Robust standard errors are reported in parentheses. The variables are defined in more detail in the Appendix. *** is significant at the 1%, ** at 5% and * at 10% significance level.

6. Robustness analyses

6.1 Spatial autocorrelation

This section investigates the spatial distribution of trust and innovation for 135 EU regions using Exploratory Spatial Data Analysis (ESDA). ESDA analyses whether spatial autocorrelation between observations exists. In order to test for spatial autocorrelation "location similarity" needs to be established. This can be expressed in spatial weight matrices. Such matrices can be defined in different ways, such as simple contiguity (i.e., a common border) or inverse distance (to account for distance-decay effects). Inverse distance suggests that data points should be influenced most by nearby points and less by more distant

points. The spatial weight matrix in this paper is based on the inverse of the squared distance between pairs of locations. As has been argued elsewhere this approach is useful for European regions (e.g., Bottazzi and Peri, 2003).

To test for the presence of spatial autocorrelation the *Moran's I* statistic is calculated (Moran, 1950). The null hypothesis of absence of spatial autocorrelation is rejected if values of I are larger than the expected value $E(I) = -1/(n-1)$. This measure is the global approach to measuring spatial autocorrelation, in which the overall pattern of dependence is summarised into a single indicator (de Dominicis, Florax & de Groot, 2011, p.10). Table 9 presents the *Moran's I* statistic and the associated z- and p-values for six variables. In all six cases the z-values for *Moran's I* are positive and statistically significant, suggesting the presence of positive spatial autocorrelation. *RDBUS* and *PATENT* indicate the highest level of spatial autocorrelation. The result that the Moran's I for *RDBUS* is larger than for *RDPUB* is in line with the findings of de Dominicis, Florax and de Groot (2011) and appears to be reasonable because "firms tend to cluster in space, taking advantage of the presence of localisation economies" (p.11).

Table 9: Moran's I measure of spatial autocorrelation for main variables

Variable	Moran's I	z-value	p-value
RDBUS	0.200	7.113	0.000
PATENT	0.191	19.006	0.000
FAIR	0.188	17.954	0.000
EDUC	0.177	16.938	0.000
TRUST	0.145	14.075	0.000
RDPUB	0.055	5.844	0.000

Spatial dependence of the data can occur either, because innovation in one region is likely to depend on creativity in neighbouring regions. This situation is referred to in the literature as a spatial lag model, which is defined by Anselin, Le Gallo and Jayet (2008) as "the formal specification for the equilibrium outcome of a spatial or social interaction process, in which the value of the dependent variable for one agent is jointly determined with that of the neighbouring agents" (in de Dominicis, Florax & de Groot, 2011, p.5). In contrast, situations, where the error terms of the innovation production function are spatially autocorrelated, are referred to as spatial error models.

To find out which situation is present for our case, spatial diagnostics are tested and presented in columns (1) - (3) of Tables 10 and 11, after running OLS regressions according to equation (1). The *Moran's I* test on the residuals is positive and significant. Empirical

literature (e.g. Anselin, 1988) that use spatial econometric techniques analyse the results of the Lagrange Multiplier tests (LM) on the estimated OLS residuals to determine whether the data suggest a spatial lag or spatial error model. Following this approach, the data indicate a spatial lag model because both the LM (lag) and Robust LM (lag) test are statistically significant and of larger magnitude than the corresponding LM tests for the spatial error model.

The spatially lagged model coefficients for *TRUST* and *FAIR* are somewhat lower than the OLS estimates but remain significant at the 1 percent level. This supports the conjecture that innovation in one region is related to large extent with new ideas in other regions. Comparing the measures of the overall fit for the spatially lagged model in columns (4) - (6) in Tables 10 and 11 to earlier findings we find that the spatially lagged model fits the data better. Rho is always positive and significant, reflecting the spatial dependence of the regions in our sample. In addition, the null hypothesis of the LM test that rho is 0, meaning no spatial dependence, is always rejected. Hence, running the spatially lagged model did not lead to a model without spatial autocorrelation effects. Spatial autocorrelation seems to be an integral component of the trust and innovation in European regions.

Table 10: Spatial Autocorrelation for the case of TRUST

Dependent variable: PATENT (log of patents)

	OLS (1)	OLS (2)	OLS (3)	LAG (4)	LAG (5)	LAG (6)
TRUST	0.673 (0.052)***	0.401 (0.062)***	0.386 (0.075)***	0.539 (0.045)***	0.302 (0.049)***	0.290 (0.061)***
n	135	135	135	135	135	135
Controls		RDBUS	RDBUS		RDBUS	RDBUS
		RDPUB	RDPUB		RDPUB	RDPUB
		EDUC	EDUC		EDUC	EDUC
			Interaction terms			Interaction terms
Spatial diagnostics						
Moran's I (residuals)	14.060***	14.182***	10.998***			
LM (error)	84.985***	74.108***	38.419***			
Robust LM (error)	5.144**	3.953**	1.602			
LM (lag)	98.488***	112.761***	73.380***			
Robust LM (lag)	18.647***	42.606***	36.563***			
rho				0.953***	0.961***	0.948***
LM test of rho=0				98.488***	112.761***	73.380***

Note: Robust standard errors are in parentheses. The variables are defined in more detail in the Appendix.
*** is significant at the 1%, ** at 5% and * at 10% significance level.

Table 11: Spatial Autocorrelation for the case of FAIR

Dependent variable: PATENT (log of patents)

	OLS (1)	OLS (2)	OLS (3)	LAG (4)	LAG (5)	LAG (6)
FAIR	0.706 (0.061)***	0.387 (0.65)***	0.237 (0.073)***	0.555 (0.055)***	0.255 (0.057)***	0.142 (0.059)**
n	135	135	135	135	135	135
Controls		RDBUS	RDBUS		RDBUS	RDBUS
		RDPUB	RDPUB		RDPUB	RDPUB
		EDUC	EDUC		EDUC	EDUC
			Interaction terms			Interaction terms
Spatial diagnostics						
Moran's I (residuals)	13.379***	15.655***	13.778***			
LM (error)	75.071***	90.368***	61.415***			
Robust LM (error)	8.638***	9.420***	8.116***			
LM (lag)	76.824***	106.558***	74.501***			
Robust LM (lag)	10.391***	25.610***	21.202***			
rho				0.943***	0.957***	0.945***
LM test of rho=0				76.824***	106.558***	74.501***

Note: Robust standard errors are in parentheses. The variables are defined in more detail in the Appendix.
*** is significant at the 1%, ** at 5% and * at 10% significance level.

6.2 Extreme Bound Analysis and strong and weak sign tests

This section tests the robustness of findings with respect to inclusion of other relevant variables. The theory behind EBA is that a changing set of conditioning variables *C* has potentially different effects of trust on innovation. We have a set of 21 conditioning variables that are further explained in Appendix B. The robustness procedure estimates a regression with fixed indicators and then starts introducing indicators from set *C*, individually, in groups of two and three until all possibilities are consumed. This process estimates many regressions and we are interested in the coefficient of *TRUST* (*FAIR*). In total we have five tests:

(i) TEST 1: The strong sign test is passed if all coefficients for the independent variables have the same sign,

(ii) TEST 2: The weak sign test is passed if 95% of the coefficients for the independent variables have the same sign,

(iii) TEST 3: The relationship between the dependent variable and independent variable is robust if all estimated coefficients for the independent variable have the same sign and are statistically significant at the same time (Leamer & Leonard, 1983)

(iv) TEST 4: The relationship between the dependent variable and independent variable is robust if 95% of the estimated coefficients for the independent variable have the same sign and are significant at the same time (Sala-i Martin, 1997)

(v) TEST 5: 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 95% of the estimated coefficients for the independent variable have the same sign and are significant at the same time.

Tables 12.A and 12.B present the results of the robustness tests and highlight that the relationship between *TRUST (FAIR), RDBUS, RDPUB, EDUC* and *PATENT* is robust to the inclusion of other variables. Except RDPUB all variables pass all five tests. *RDPUB* and three of the indicators from the 21 conditioning variable set from ESS only pass the strong and weak sign tests. The three indicators are i) How often, if ever, have each of these things happened to you in the last five years? A public official asked you for a favor or a bribe in return for a service, ii) How wrong, if at all, do you consider the following ways of behaving to be? Someone selling something second-hand and concealing some or all of its faults, iii) How often, if ever, have you done each of these things in the last five years? Sold something second-hand and concealed some or all of its faults. Except these variables none of the other 21 indicators have any influence on the regression estimates of section 5.2. Thus we can safely argue that general trust question is robust to the inclusion of other indicators.

Table 12.A: Stability of the PATENT regressions (TRUST as an indicator)

Variable	No. of regress. appeared	Mean value	Left confid. interval	Right confid. interval	Fraction of (+) values	Fraction of (-) values	Fraction of signf. (+) values	Fraction of signif. (-) values	Test 1	Test 2	Test 3	Test 4	Test 5
TRUST	1561	0.336	0.329	0.343	1.000	0.000	1.000	0.000	Yes	Yes	Yes	Yes	Yes
RDBUS	1561	0.278	0.276	0.279	1.000	0.000	1.000	0.000	Yes	Yes	Yes	Yes	Yes
RDPUB	1561	-0.057	-0.060	-0.055	0.000	1.000	0.000	0.000	Yes	Yes	No	No	No
EDUCATION	1561	0.231	0.226	0.235	1.000	0.000	1.000	0.000	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable in all regression is *PATENT* and the variable of interest is *TRUST*. The fixed independent variables are *RDBUS, RDPUB, EDUC* and country dummies. There are 21 conditioning variables (see Appendix B). 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?).

Table 12.B: Stability of the PATENT regressions (FAIR as an indicator)

Variable	No. of regress. appeared	Mean value	Left confid. interval	Right confid. interval	Fraction of (+) values	Fraction of (-) values	Fraction of signf. (+) values	Fraction of signif. (-) values	Test 1	Test 2	Test 3	Test 4	Test 5
TRUST	1561	0.394	0.386	0.402	1.000	0.000	1.000	0.000	Yes	Yes	Yes	Yes	Yes
RDBUS	1561	0.294	0.292	0.296	1.000	0.000	1.000	0.000	Yes	Yes	Yes	Yes	Yes
RDPUB	1561	-0.078	-0.081	-0.075	0.000	1.000	0.000	0.040	Yes	Yes	No	No	No
EDUCATION	1561	0.267	0.263	0.271	1.000	0.000	1.000	0.000	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable in all regression is *PATENT* and the variable of interest is *FAIR*. The fixed independent variables are *RDBUS, RDPUB, EDUC* and country dummies. There are 21 conditioning variables (see Appendix B). 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?).

Table 13: Trust, social capital and innovation. What policy conclusions?

Article	Methodology	Social capital variable	Outcome variable	Conclusion / Policy	number of appearances of the word "policy"
Knack and Keefer (1997)	Cross-country growth regression (29 countries)	general trust and civic engagement	GDP growth 1980-1992	The effect of trust is more in poor countries with undeveloped institutions. Policy conclusion: if it is difficult to foster interpersonal trust, foster institutions; foster education; but not horizontal networking.	17 in total / 8 in effective terms
Zak and Knack (2001)	General equilibrium growth model and cross-country growth regression (41 countries)	general trust	GDP growth 1970-1992	When formal and informal institutions are weak cheating increase as institutions are not binding. Also social distance and social heterogeneity increases cheating thus reduces trust.	4 in total / zero in effective terms
Dakhli and De Clercq (2004)	Cross-country regression (59 countries)	general trust + some other SC variables	innovation measured by patents, R&D expenditures	Social capital is conducive to innovation but not as strong as human capital. No specific policy conclusions.	2 in total / zero in effective terms
Beugelsdijk and Van Schaik (2005)	Regional growth regresssion (54 Western EU regions)	social capital index made of trust and civic engagement	GDP growth 1950-1998	Social capital is conducive to growth. No policy implications. For policy to emerge we have to understand the mechanism how social capital translates into growth.	10 in total / 4 in effective terms
Iyer, Kitson and Toh (2005)	40 US states. Determinants of social capital rather than SC growth link.	Various questions on social capital, civic engagement and trust.	different form of social capital	Education is complementary to all forms of SC. Ethnic diversity is negatively related to SC. Specific "policy implications" section.	6 in total / 6 in effective terms

Table 13: Trust, social capital and innovation. What policy conclusions? (continued)

Article	Methodology	Social capital variable	Outcome variable	Conclusion / Policy	number of appearances of the word "policy"
Cooke, Clifton and Oleaga (2005)	Correlations and correspondence analysis (12 UK regions)	social capital index and trust	SME performance metrics and innovation (introduction of new goods and services)	Innovative firms tend to make greater use of collaboration and information exchange, be involved in higher trust relationships, and make greater use of non-local networks. Policy conclusion: support firms in less-favoured regions by learning social networks.	13 in total / 8 in effective terms
Hauser, Tappeiner and Walde (2007)	Factor analysis with social capital indicators integrated into a knowledge production function (51 European regions)	social capital measured as trust, social networking etc.	Innovation measured as patent applications	The impact of social capital on innovation is comparable to human capital. 'Associational Activity' represents the strongest driving force for patenting activity. No significant effect of trust on innovation.	1 in total / zero in effective terms
Ahlerup, Olsson and Yanagizawa (2008)	theoretical investment game and cross-country growth regression (46/61 countries)	general trust	GDP growth 1995-2005	Generalised trust is more effective when institutions are not binding. No specific policy conclusions.	Zero in total / zero in effective terms
Akçomak and ter Weel (2009)	Regional growth regresssion (102 EU regions)	general trust + some other SC variables	GDP growth 1990-2002 and innovation measured by patents	Trust is conducive to innovation and growth. Innovation is a channel that how social capital turns in to growth. Policy conclusion: regions with poor SC should better invest in education as SC is a stock variable that takes long time to form.	2 in total / 1 in effective terms

Table 13: Trust, social capital and innovation. What policy conclusions? (continued)

Article	Methodology	Social capital variable	Outcome variable	Conclusion / Policy	number of appearances of the word "policy"
Tabellini (2010)	Regional growth, 69 EU regions	trust and questions on culture	Growth in gross value added 1995-2000.	History matters. Cultural traits such as social capital form in long period of time and could explain current outcomes.	3 in total / zero in effective terms
Doh and Acs (2010)	Cross-country regression (53 countries)	social capital index (trust, civic engagement, associations etc.)	Innovation measured by patents	Social capital is conducive to innovation but the most important element is associational activity. Policy conclusion: foster networking.	Zero in total / zero in effective terms
Miguelez, Moreno and Artis (2011)	Spanish regions. Negative binomial panel regression.	social capital is measured using a model than behaves SC as an investable sum.	Innovation measured by patents	Complementarity of social capital and human capital. Social capital supports innovation and knowledge diffusion. Complementarities are strong in richer regions. Policy conclusions are too general.	5 in total / 2 in effective terms
Echebarria and Barrutia (2011)	Non-linear dynamics in a linear model (54 European regions)	social capital index (trust, active and passive group membership)	Patents per million inhabitants	Social capital–innovation relationship has an inverted 'U'-shape.	1 in total / zero in effective terms
de Dominicis, Florax and de Groot (2011)	Regional EU data (146 EU regions); spatial regression	social capital and trust (PCA analysis of several variables)	Innovation measured by patents	Regions surrounded with regions that are rich in social and human capital are innovation prone. Emphasis on networks of firms. No specific policy implications.	2 in total / zero in effective terms

7. Conclusion and policy implications

This paper investigates some recent issues regarding the social capital / trust and innovation link. We specifically focused on three forces that could affect the trust-innovation link: causality, non-linearity and spatiality. The roles of these forces have been investigated by using data from 135 EU regions.

Our findings show that trust is an important determinant of innovation measured by patent applications per million inhabitants. Of all other 21 trust related indicators from the ESS we showed that the only two robust indicators are *TRUST* and *FAIR*. This result is a strong finding regarding the robustness of the general trust question used in various surveys like the ESS or European Values Survey. After we set up a link between trust and innovation we looked at some issues in a more detailed way. First, we dealt with causality issue using historical state of universities in European regions and estimated IV regressions. The IV approach is commonly used in the literature to address causality issue between social capital /trust and outcome variables such innovation and economic growth (e.g., Akcomak and ter Weel, 2009; Tabellini, 2010). Our findings show that with an IV estimation we can capture the exogenous general trust element and show that it is conducive to innovation. However as with most other papers in the literature the coefficient of *TRUST* is somewhat higher in IV regression compared to OLS estimates.

Second, we look at non-linearity. It could be the case that at very high trust levels the trust-innovation link breaks down or even turns into negative. For instance closed networks or family networks have very high social capital but generally prove to be bad for personal outcomes. To investigate the existence of such forces we included squared terms of *TRUST* and *FAIR* into the regression. The squared terms turn out to be negative but not significant. While we report signs of non-linearity we cannot report statistically significant findings like Echebarria and Barrutia (2011). Third, we investigate the impact of spatial forces. It could be tha case that just as R&D, innovation and human capital of neighbouring regions could have effects on regional factors, trust of the surrounding regions could affect economic outcomes. Our estimates using spatial lag models confirm previous studies that spatiality is an important force (de Dominicis, Florax & de Groot, 2013).

Various investigations were conducted on the impact of social capital and/or trust on outcome indicators since the seminal paper of Knack and Keefer (1997). Using cross-country and regional data the literature show that social capital/trust and innovation/growth link is statistically significant. However, the literature is generally silent on one aspect: what policy? Table 13 summarizes about 15 papers that investigate the link between social capital and

economic outcomes that use similar methodology (growth or patent regression that use data at the country or regional level). The main message out of this table is that policy implications that come out of this literature are generally weak and mostly indirect.

The literature generally makes statements but does not really provide in-depth policy implications. If we find that trust is conducive to innovation we have to think about what this finding actually means. We cannot tell people or firms to trust others more because this is important for innovation. At this stage the literature turns into more indirect policy implications by looking at the factors that create social capital and trust. From Table 13 two observation stands out. First, the literature is developed in many different aspects but not on the policy aspect. A detailed analysis shows that the literature could not really develop the original policy conclusions of the seminal Knack and Keefer (1997) paper. In most cases the word "policy" appears several times but not in effective terms (i.e., a real policy implication suggested by the authors). Disturbing as it sounds the Knack and Keefer (1997) paper is one of the best in the literature in terms of policy implications despite many papers on this specific topic (social capital-economic outcome link).

Second, there are two types of policy conclusion. If indicators that represent associational activity and participation to networks are used as independent variables and their effects are positive then the policy conclusion is obvious: social networks are good for economic outcomes so the government should enhance participation in networks. The EU framework projects are good examples because most applications require a consortium. In this way professional and social links are established throughout the continent (and sometimes outside the continent) which in the long run is very important for diffusion of knowledge. Through this channel social capital can be tied to innovation. So fostering (especially vertical) networks is a policy outcome (e.g., Cooke, Clifton and Oleaga 2005; Hauser, Tappeiner and Walde, 2007; Doh and Acs, 2010). If the general trust or social capital index is used as an indicator then the literature either benefits from complementarity effects to argue that governments should invest in human capital as education has great socialising element (e.g., Knack and Keefer, 1997; Iyer, Kitson and Toh, 2005; Akçomak and ter Weel, 2009) or looks at the variables that form social capital/trust in the long run (e.g., Akçomak and ter Weel, 2009; Tabellini, 2010). If the research has a long run view then establishing formal institutions as well as education would create good social capital in the future (e.g., Zak and Knack, 2001).

This paper is about the trust-innovation link so our policy implications are akin to the second observation (i.e., the complementarities and institutions as first best solutions). But in

general current EU policies that support forming networks (e.g., framework project), fostering education (e.g., lifelong learning) and reducing heterogeneity (e.g., policies on social inclusion, inclusive growth) can foster trust in an indirect way. The new Horizon 2020 set up is also conducive to social capital and trust since interdisciplinarity is a strong aspect of the program. Interdisciplinary character of the Horizon 2020 directly addresses the benefits of social capital that drives from vertical relations in social networks between and within regions.

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Appendix A: Variable definitions

TRUST	Generalised 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. Source: European Social Surveys (ESS) second round in 2004
HELP	Question on how helpful other people are using the answer to the following question: “Would you say that most of the time people try to be helpful or that they are mostly looking out for themselves?” The answer category ranges from (0) ‘‘people mostly look out for themselves’’ to (10) ‘‘most people try to be helpful’’, with nine levels in between. Source: European Social Surveys (ESS) second round in 2004
FAIR	Do you think that most people would try to take advantage of you if they got the chance, or would they try to be fair?” The answer category ranges from (0) ‘‘most would try to take advantage of me’’ to (10) ‘‘most people would try to be fair’’, with nine levels in between. Source: European Social Surveys (ESS) second round in 2004
BRIBE	Factor constructed out of the answers to the questions: “How often, if ever, have each of these things happened to you in the last five years?” 4th option: You were sold something second-hand that quickly proved to be faulty. 5th option: A public official asked you for a favour or a bribe in return for a service. Additionally, the factor contains the answers to the question: “How often, if ever, have you offered a favour or bribe to a public official in return for their services?” The answer category ranges from (1) ‘‘never’’ to (5) ‘‘5 times and more’’, with three levels in between. Source: European Social Surveys (ESS) second round in 2004
TRUST IN BUSINESS	Factor constructed out of the answers to the questions: “How much would you trust the following groups to deal honestly with people like you?” 1st option: Plumbers, builders, car mechanics and other repair-people. 2nd option: Financial companies such as banks or insurers. 3rd option: Public officials. The answer category ranges from (1) ‘‘Distrust a lot” to (5) ‘‘Trust a lot’’, with four levels in between. Additionally, this factor contains the answers to the question: “How often, if ever, have each of these things happened to you in the last five years?” 1st option: A plumber, builder, car mechanic or other repair person overcharged you or did unnecessary work. The answer category ranges from (1) ‘‘Never” to (5) ‘‘5 times or more”, with three levels in between. Source: European Social Surveys (ESS) second round in 2004
JUDGEMENT	Factor constructed out of the answers to the questions: “How wrong is someone paying cash with no receipt so as to avoid paying VAT or other taxes?”, “How wrong is someone selling something second-hand and concealing some or all of its faults?”, “How wrong is someone making an exaggerated or false insurance claim?”, “How wrong is a public official asking someone for a favour or bribe in return for their services?” The answer category ranges from (1) ‘‘Not wrong at all” to (4) ‘‘Seriously wrong”, with two levels in between. Source: European Social Surveys (ESS) second round in 2004
HONESTY	Factor constructed out of the answers to the questions: “How often, if ever, have each of these things happened to you in the last five years?” 2nd option: You were sold food that was packed to conceal the worse bits. 3rd option: A bank or insurance company failed to offer you the best deal you were entitled to. The answer category ranges from (1) ‘‘Never” to (5) ‘‘5 times or more”, with three levels in between. Source: European Social Surveys (ESS) second round in 2004
SERIOUS ACT	Factor constructed out of the answers to the questions: “How often, if ever, have you done each of these things in the last five years?” 4th option: misused or altered a card or document to pretend you were eligible for something you were not. 5th option: made an exaggerated or false insurance claim. 7th option: over-claimed or falsely claimed government benefits such as social security or other benefits. The answer category ranges from (1) ‘‘Never” to (5) ‘‘5 times or more”, with three levels in between. Source: European Social Surveys (ESS) second round in 2004

NON-SERIOUS ACT	Factor constructed out of the answers to the questions: "How wrong is someone paying cash with no receipt so as to avoid paying VAT or other taxes?" The answer category ranges from (1) ''Not wrong at all" to (4) ''Seriously wrong", with two levels in between. Additionally, this factor contains the answers to the question: "How often, if ever, have you done each of these things in the last five years?" 1st option: kept the change from a shop assistant or waiter knowing they had given you too much? The answer category ranges from (1) ''Never" to (5) ''5 times or more", with three levels in between. Source: European Social Surveys (ESS) second round in 2004
PATENT	Patent applications per million inhabitants centered around 2006. 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
RDBUS	R&D intensity in the business sector defined as percentage of GDP centered around 2006/2007 (average of 2005-2008). Source: Eurostat
RDPUB	R&D intensity in the public sector defined as percentage of GDP centered around 2006/2007 (average of 2005-2008). Source: Eurostat
EDUC	Proxy for education defined as the percentage of population with tertiary education aged 25-64 years in 2008. Source: Eurostat
EXISTENCE	Existence of the university defined as year 2000 - the foundation date of the university. Source: Ridder-Symoens (1996) and Jilek (1984)
DENSITY1900	Density of the universities in a particular region defined as the number of universities per 100.000 inhabitants before 1900. Source: Ridder-Symoens (1996) and Jilek (1984). Source for population data: http://www.library.uu.nl/wesp/populstat/ populhome.html.
DENSITY2000	Density of the universities in a particular region defined as the number of universities per 100.000 inhabitants before 2000. Source: Ridder-Symoens (1996) and Jilek (1984). Source for population data: http://www.library.uu.nl/wesp/populstat/ populhome.html.
UNIV	principal component of univ_1 and univ_4
LATITUDE	Latitude of the respective region. Source: google maps
LONGITUDE	Longitude of the respective region. Source: google maps

Note: All answers for the trust related questions for the factors were redefined so that a lower number means less trust and the highest number high trust.

Appendix B: Variables that are used in the factor analysis and as conditioning variables in the robustness test

Question	Abbreviation
How much would you trust the following groups to deal honestly with people like you?	
a. Plumbers, builders, car mechanics and other repair people	Trustplumber
b. Financial companies such as banks and insurers	Trustbank
c. Public officials	Trustofficials
How often, if ever, have each of these things happened to you in the last five years?	
a. A plumber, builder, car mechanic or other repair person overcharged you or did unnecessary work	Overcharge
b. You were sold food that was packed to conceal the worse bits	Weresoldfoodworsebits
c. A bank or insurance company failed to offer you the best deal you were entitled to	Failbestoffer
d. You were sold something second-hand that quickly proved to be faulty	Weresoldfaulty
e. A public official asked you for a favor or a bribe in return for a service	Wereaskedforbribe
We have just asked you about experiences of being treated dishonestly over the past five years. How worried are you that things like this will happen to you?	Experience
How wrong, if at all, do you consider the following ways of behaving to be?	
a. someone paying cash with no receipt so as to avoid paying VAT or other taxes	Payingcashwrong
b. someone selling something second-hand and concealing some or all of its faults	Selling2ndhandwrong
c. someone making an exaggerated or false insurance claim	Falseinsuranceclaimwrong
d. a public official asking someone for a favor or bribe in return for their services	Bribewrong
How much do you agree or disagree with this statement about how people see rules or laws? If you want to make money, you can't always act honestly.	Moneynohonesty
How often, if ever, have you done each of these things in the last five years?	
a. kept change from a shop assistant or waiter knowing they had given you too much	Keptchange
b. paid cash with no receipt so as to avoid paying VAT or other taxes	Paidcash
c. sold something second-hand and concealed some or all of its faults	Sold2ndhandfaulty
d. misused or altered a card or document to pretend you were eligible for something you were not	Misuse
e made an exaggerated or false insurance claim	Falseinsuranceclaim
f. offered a favor or bribe to a public official in return for their services	Offeredbribe
g. over-claimed or falsely claimed government benefits such as social security or other benefits	Falseclaimbenefits

Appendix C: Factor loadings

Indicator	Factors					
	1	**2**	**3**	**4**	**5**	**6**
Trustplumber		0.741				
Trustbank		0.682				
Trustofficials		0.764				
Overcharge		0.502				
Weresoldfoodworsebits				0.783		
Failbestoffer				0.465		
Weresoldfaulty	0.596			0.553		
Wereaskedforbribe	0.862					
Experience						
Payingcashwrong			0.590			0.406
Selling2ndhandwrong			0.859			
Falseinsuranceclaimwrong			0.881			
Bribewrong			0.540			
Moneynohonesty						
Keptchange						0.728
Paidcash						
Sold2ndhandfaulty						
Misuse					0.515	
Falseinsuranceclaim					0.678	
Offeredbribe	0.787					
Falseclaimbenefits					0.553	