

Trust and Innovation: New Evidence

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Summery. ---- This paper investigates the impact of trust on innovation. We classify trust into different types, according to social distance. We find both country level and individual level evidence that relative higher level of strong-tie trust facilitates innovation while relative higher level of weak-tie trust undermines innovation. The results are robust to various proxies, IVs and functional specifications. We propose an explanation based on social network theory. Dense clusters provide highly specialized labor division, which is necessary for modern R&D sector. Sparse links between clusters promotes diversified labor supply. Innovation level is higher in a society with relative higher level of strong-tie trust than weak-tie trust.

Long Abstract

This paper provides new evidence on the impact of trust on innovation. Existing research find an ambiguous relationship between trust and innovation. We demonstrate that this is due to opposite effects of different types of trust on innovation. We classify trust into different types, according to social distance. Then, we compute a relative index which is the ratio of one type trust to the sum of all types of trust. Strong-tie trust includes trust between family members, acquaintance and neighbors and weak-tie trust includes trust towards strangers, people of different religion and foreigners. Using data in 1994-2008 from 104 countries around the world, we find both country level and individual level evidence that relative higher level of strong-tie trust facilitates innovation while relative higher level of weak-tie trust undermines innovation. The results are robust to various proxies, IVs and functional specifications. We show that while the “strength of weak ties” works for individual decision, the “strength of strong ties” supports collective achievements. We propose an explanation based on social network theory. Strong links within a cluster form dense cluster. This provides highly specialized labor division, which is necessary for modern R&D sector. Sparse links between clusters promotes diversified labor supply, which sparks new ideas. Thus innovation level is higher in a society with relative higher level of strong-tie trust than weak-tie trust.

Key Words: Social Capital, Trust, Innovation, Growth

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1 INTRODUCTION

On the one hand, a large amount of evidence show that soft factors such as institutional environment and culture account for a large part of economic growth (Hall and Jones, 1999; Guiso, Sapienza, and Zingales, 2006; Gorodnichenko and Roland, 2011). In particular, starting from Loury (1977), a large literature study the relationship between social capital and economic development (Coleman, 1988; Putnam, 2000), financial market (Guiso, Sapienza, and Zingales, 2004), labor market participation (Tu and Bulte, 2010), education (Algan, Cahuc, and Shleifer, 2013), political accountability (Nannicini et al., 2013; Corbacho, Philipp and Ruiz-Vega, 2015).¹ On the other hand, endogenous growth theory proposed by Aghion and Howitt (1992) and Grossman and Helpman (1991) raised a discussion of growth and innovation. However, few researches studies how social capital and innovation interacts with each other.

Social capital refers to the networks that integrate people together, such as trust, regulation and social connections etc. Trust is a key dimension of social capital (Putnam, Leonardi and Nanetti, 1994). Knack and Keefer (1997) was the first to use trust to capture the effect of social capital on growth. They found a positive effect of trust on growth. This embarks a literature on what are the channels that linking trust and growth. Zak and Knack (2001) found that trust enhances productivity and growth by reducing transaction cost. D'Hernoncourt and Méon (2012) found that trust is negatively related to the size of shadow economy, and thus promotes economic growth. Beugelsdijk and Méon (2015) found that social trust improves the quality of economic-judicial institutions and thus promotes TFP and growth. Akcomak and Weel (2008, 2009), Akçomak and Müller-Zick (2015) suggested that trust affect growth through innovation. Using cross section data of several countries in Europe, they found that social capital enhances innovation and thus growth.²

In this paper, we study the relationship between two determinants of growth: innovation and trust, using data from World Values Survey (WVS), World Bank, Transparency International and ARDA in 1994-2008. Following the literature, we first examine the relationship between general trust, innovation and growth using 3SLS. We find the standard results that trust has a significant positive impact on growth. Innovation has a positive, but not very significant, effect on growth. For European countries, consistent with Akcomak and Weel (2009), we find that trust has a significant positive effect on innovation. Surprisingly, from the view of the whole world, the relationship between trust and innovation is negative.

We propose that this is mainly due to opposite impacts of trust on innovation. Trust could be divided into several types based on the social distance between people. We classify trust between family members, acquaintance and neighbors as strong-tie trust. Trust towards strangers, people of difference religion and foreigners are in the category of weak-tie trust. We estimate the impact of different types of trust on innovation at both macro (country) and micro (individual) level. On macro level, we estimate the relationship between relative degree of one type of trust and patent output across countries. We employ IVs and other proxies for robustness check. On micro level, we study the relationship between individual trust levels and their attitudes towards technology and new things. We employ Poisson model because trust levels and attitudes are in discrete units.

We find a positive relationship between strong-tie trust and innovation while a negative relationship between weak-tie trust and innovation, at both macro-level and micro-level. Results are significant for trust_acquaintance, trust_family and trust_stranger for all specifications. For most specification, trust_foreign is also significant at a lower level. On country level, the magnitude of the negative impact of weak-tie trust outweighs the positive impact of strong-tie trust by 33%³. In addition, in our dataset, European countries have a higher relative ratio of strong-tie trust than non-European countries. These findings could explain the puzzling fact that in general, the relationship between trust and innovation are positive for European countries but negative for non-European countries.

The rest of the paper is organized as follows. The next section provides theoretical foundations for impacts of different types of trust on innovation. Section 3 introduces the data set and empirical strategy, section 4 gives the results and section 5 concludes.

2 SOCIAL CAPITAL, TRUST AND INNOVATION

Trust is considered as a key dimension of social capital. Bourdieu (1986) was the first to give a clear definition to social capital. In his view, social capital is a collective of resources that are institutionalized by social network, such as trust, regulation and social connection. Based on rational action theory, Coleman (1988) gave a wider definition of social capital. Social capital is composed of different entities which promote the actions in social structure.

Nooteboom (2006) pointed out that social capital is too broad that may cause confusion. Social trust is a commonly used variable to measure the quality of social capital for its universalistic potential (Bouma et al., 2007; Torche and Valenzuela, 2011). Trust is the fundamental of corporation and social interaction (Blau,1964). It can reduce the uncertainty in trade, and thus the transaction cost (Nooteboom, 2000). High level of trust facilitates the accumulation of social capital. Reciprocal norms shape trust and trust spreads through social network (Putnam, 1995 and 2000).⁴ In this paper, we look at the trust level among people in a society using the commonly used index from WVS.

There is a large literature on the impact of social capital on economic and social development. However, only recently, a few of them looked at social capital/ trust and innovation. Kim and Kang (2014) found that both social norms and networks influence entrepreneurship. Akcomak and Weel (2009) found that innovation is a channel linking social capital and economic growth. Using data from 102 European regions, their result showed that trust has a positive effect on innovation. Akcomak and Müller-Zick (2015) used 20 European countries' data and confirmed that generalised trust have robust positive effects on innovation. Our work is different from Akcomak and Weel (2009) and Akcomak and Müller-Zick (2015) in the sense that we study the relationship between trust and innovation more maliciously. We divide trust into different types, according to the strength of the ties. 'trust_acquaintance', 'trust_family', 'trust_neighbor' are classified as strong-tie trust while 'trust_stranger', 'trust_religion' and 'trust_foreign' are in the category of weak-tie trust. We confirmed their finding that in general trust improves innovation for European countries. However, we find that different types of trust affect innovation differently. Only relative higher level of strong-tie trust

facilitates innovation. From innovation to trust, we find a positive but insignificant relationship between the two. The insignificance could be due to technology spillovers as shown in a lot of literature (Acs et al., 1994; Audretsch and Feldman, 1996; Beñat and Rodríguez-Pose, 2004).

The second related literature is about the significance difference between strong-tie and weak-tie social connections. Putnam (2000) divided social capital into bonding capital and bridging capital. Bonding capital exists in the relationship between relatives and friends while bridging capital lies in network among different social groups. Bonding capital enhances emotional contact within a group and provides social supports for group members (Bian, 1997). Bridging capital provides channels among groups to share information and resources (Lin et al., 1981). On the individual level, in the seminal work of Granovetter (1973), he divided relationship among people into strong ties and weak ties based on four dimensions, frequency of interaction, closeness between actors, intimacy of the relation and reciprocity of interaction. Granovetter found that weak ties play more important roles in getting jobs and career decision.

However, on the industry or country level, the “strength of weak tie” does not sustain. Gilsing and Nooteboom (2005) provides empirical evidence about network structure and innovation in the multimedia and pharmaceutical biotechnology industries in Dutch. In contrast with Granovetter (1973), they showed that the networks for exploration performs better with a dense structure of ties that are strong in most dimensions. Rosenkopf and Padula (2008) found that in order to maximize the rate of innovation, firms need to have a balance between cohesive and sparse alliances. Cohesive alliances provide a normative environment that guarantees the actual execution of knowledge process, while sparse alliances help firms to exchange information within a network conveniently. We enrich this literature by demonstrating the “strength of strong tie” for innovation at a country level. We show there is a difference between the “strength of weak ties” for individual decision and the “strength of strong ties” for collective achievements. Weak-tie trust results in adventure, amazing inventions or art works. However, the large uncertainty of adventures will not increase the total number of expected innovations for a society. For investment in technology and final innovation outcome, it is the “strength of strong ties” that facilitates the process.

The third literature strand is about the optimal level of trust in a society. Beugelsdijk and Smulders (2009) pointed that social capital is a two-side sword. Though trust can reduce rent-seeking or cheating, too high levels of social capital may reduce people’s working time and undermine economic growth. In a series of studies, Nooteboom (1999, 2001), Wuyts et al. (2005) and Nooteboom et al. (2007), they found an inverse-U shaped relation between value of learning and cognitive distance. The maximum of innovation is achieved with a medium level of difference among people. Lavie and Drori (2011) also found that there exists an optimal level of trust, beyond which the process of knowledge creation and application will be undermined. At individual level, Bulter et al (2009) found an inverted U-shaped relationship between individual income and trust. Too high level of trust results in being cheated while too low level leads to underperformance. We support this literature by investigating a quadratic form of specification and confirmed the inverted U-shape relation between trust and innovation.

We propose an explanation based on social network theory. Young (2011) provide a theoretical model of the dynamics of social innovation as a coordination game played on a network. Individuals experiment with innovation that would increase their welfare provided that it is also adopted by their neighbors. Their model predicts that local clustering greatly enhances social innovations spread speed. In a society with high level of strong-tie trust relative to weak-tie trust, productive corporations tend to occur among people with small social distance. Relationship between people with large social distance results in adventure and new ideas featuring uncertainty. This results in a social network with several dense clusters. The connections within clusters are intense while links between clusters are sparse. Modern innovation requires highly specialized labor division in R&D sector. This could only be achieved within dense clusters. Moreover, the sparse link between clusters promotes diversified labor supply, which sparks new ideas. Thus innovation level is higher in a society with relative high level of strong-tie trust than weak-tie trust.

3 DATA AND EMPIRICAL STRATEGY

(a) Data Resources

We use database of WVS, the World Bank, ARDA and Transparency International. Data for trust indicator is from the 1994-1999, 1999-2004, 2005-2008 waves of World Values Survey (WVS). WVS is an international social survey consisting five released waves, the 1981-1984 wave, the 1989-1993 wave, the 1994-1999 wave, the 1999-2004 wave, and the 2005-2008 wave. We exclude the earlier waves because there is a change in patent registration. The recently released 2005-2008 wave provides indicators of different types of trust according to social distances, namely trust in family, trust in neighborhood, trust in people known personally, trust in strangers, trust in people of another religion and trust in people of another nationality.

Data for total patent applications, the percentage of urban population, school enrollment of tertiary students, the percentage of R&D expenditure of GDP and GDP per capita are from World Bank, Statistics on Patents World Intellectual Property Indicators and database of uis.unesco in 1994- 2008. Data about people's religion is from ARDA. Transparency International publishes annually the Corruption Perceptions Index (CPI) that generally defines corruption as "the misuse of public power for private benefit. It is determined by expert assessments and opinion surveys. We use it as the proxy for the political situation. Using these data we can estimate the empirical relationship between trust and innovation at a maximum of 104 countries. For the relationship between different types of trust and innovation, we have a sample of at a maximum of 47 countries. ⁵

(b) Measuring Trust

Trust is the key variable in our paper. Most papers chose survey results as a way to measure trust. ⁶There are mainly four databases. The most widely-used one is WVS, as in Knack and Keefer (1997), Zak and Knack (2001), Aghion et al. (2010). Since it can be obtained online for free, we used it as well. Other three databases are EVS, as in Beugelsdijk and Schaik (2005), ESS, as in Akcomak and Weel (2009) and GSS, as in Algan and Cahuc(2010). All the

surveys have the same question regarding trust. That is ‘Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?’. But they differ in respondents and answer options. WVS is a worldwide survey conducted in 87 societies, totaling more than 256,000 interviews. The answer options of different waves varies from ‘can be trusted’ and ‘should be careful’ to ‘can be trusted’, ‘don’t know’ and ‘should be careful’. EVS is conducted in only OECD countries and has the same options as WVS. ESS focuses on European countries. Its answer options are values from 1 to 10 so it’s more discernable. GSS is a survey in U.S.A. with answer options from 1 to 3. Based on existing research, we also construct a variable ‘trust’ to represent the general feeling of trust. Following Knack and Keefer (1997), Zak and Knack (2001), Aghion et al. (2010), we calculate it as the percentage of people who choose “Most people can be trusted” for the question that “Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?”

Many researches argue that the question regarding trust is too general. Aharonovitz et al. (2009) mentioned that respondents will define trust on their own understanding. Knack and Keefer (2001) pointed out that when answering the question, some people will consider government regulation while others won’t. This can be avoided if we use clearer question that specifies whom to trust. More and more researches were based on more specific questions regarding whom to trust. Aghion et al. (2010) investigated trust among people and trust toward organizations (firms, labor market, legal system and political system). Corbacho, Philipp and Ruiz-Vega (2015) studied trust in the local police and trust in the judiciary system. In addition to the classification of personal trust and institutional trust, we could divide trust based on social distance. Putnam (2000) pointed out that trust can be classified into strong-tie trust and weak-tie trust. The former refers to trust toward people who have small social distances with you, like families. The later refers to trust toward people who have large social distances with you, like strangers. Alesina and Ferrara (2002) found that we will trust people who are more similar to us. This implies dividing trust into different categories according to social distance is better than using a single general indicator for trust.

Trust is classified into six groups in WVS 2005-2008. We divided trust into six types: ‘trust_acquaintance’, ‘trust_family’, ‘trust_neighbor’, ‘trust_stranger’, ‘trust_religion’ and ‘trust_foreigner’ based on the following six questions. “Could you tell me whether you trust your family completely, somewhat, not very much or not at all?”, “Could you tell me whether you trust your neighborhood completely, somewhat, not very much or not at all?”, “Could you tell me whether you trust people you know personally completely, somewhat, not very much or not at all?”, “Could you tell me whether you trust people you meet for the first time completely, somewhat, not very much or not at all?”, “Could you tell me whether you trust people of another religion completely, somewhat, not very much or not at all?”, “Could you tell me whether you trust people of another nationality completely, somewhat, not very much or not at all? ” There are four answer options: 1 for trust totally, 2 for trust somewhat, 3 for don’t trust and 4 for don’t trust at all. Based on Putnam (2000), strong-tie trust includes ‘trust_acquaintance’, ‘trust_family’, ‘trust_neighbor’ and weak-tie trust includes ‘trust_stranger’, ‘trust_religion’ and ‘trust_foreigner’. These questions can give us a better understanding of trust and innovation. We use these new classified data to explain why trust

may have a negative effect on innovation, which hasn't been done before.

We study different types of trust on both country level (macro level) and individual level (micro level). On macro level, we constructed a relative ratio index for each type of trust. It measures how important each type of trust accounts for the general level of trust in a country. It is more reasonable to look at relative weight of each type of trust for two reasons. First, countries differ in the level of aggregate trust. Some countries have higher level of both weak-tie and strong-tie trust than others. So if we use the gross index for each types of trust, we cannot disentangle the effects of strong-tie trust relative to weak-tie trust from general trust. Second, in a given country, people can either choose continue investing in the existing project or turning to a stranger's projects. It is the relative ratio of different types of trust that influences people's decision, not the gross level.⁷

We construct the relative trust index in two steps. First, we calculated the weighted average of trust level for each type of trust. Second, we calculate the relative ratio of this type's value to the sum of all types' values.

Take 'trust_acquaintance_macro' for example. First, the weighted average index is calculated as the following.

$$trustacq = 4 * trustacqa + 3 * trustacqb + 2 * trustacqc + 1 * trustacqd$$

1 to 4 is the trust level people choose as answers, standing for not at all, not very much, somewhat and completely respectively.⁸ The bigger the number, the higher the feeling of trust is. 'trustacqa' to 'trustacqd' are the percentage of people who choose answer '1' to '4' in a given country.

Second, we calculate the relative ratio as,

$$\frac{trust_acquaintance_macro}{trustacq} = \frac{trustacq}{trustfam + trustnei + trustacq + truststr + trustrel + trustfor}$$

On Micro level, we use individual's response as an indicator for her trust level.

(c) Measuring Innovation

We use standard indexes of innovation output and input. As summarized by Akcomak and Weel, (2009), patents are an imperfect proxy for regional innovativeness but are the only well-established source reflecting innovative output. There are six indicators for patents, including patre (patent applications by residents), pat (total patent applications), patnon (patent applications by nonresidents) and the per capita counterpart patrepc, parpc, patnonpc. For innovation input, there are six indicators as well: rdexp (Research and development expenditure (% of GDP)), gerd (gross domestic expenditure on R&D), gerdpc (gross domestic expenditure per capita on R&D), rdperson (research staff in R&D, per million people), researchers (researchers in R&D, per million people) and technicians (technicians in R&D, per million people). We calculate the correlation between trust indexes and innovation to compare these indicators.⁹

For innovation output, all the indicators are highly correlated, except for ‘patnonpc’. The two indicators of patent applications by nonresidents are less correlated with other indicator. This implies that patent applications by residents and total patent applications are more suitable indicators for a country’s innovation output. We use the yearly percentage change in ‘pat’ (total patent applications) ‘*lnpat*’ as the proxy for innovation output. To avoid yearly fluctuations, we use the average of a five-year interval. For innovation input, all six indicators are highly correlated to each other, except for ‘gerd’. For correlations between innovation input indicators and patent indicators, there is little between ‘technicians’ and patent indicators while ‘gerd’ has strong positive correlation with patent indicators. Correlation between other innovation input indicators and patent indicators are moderate. So we use ‘*lngerd*’ as indicator for R&D intensity. Similarly, we use the average of a five-year interval to avoid year fluctuations.

(d) Empirical strategies

We first study the whole picture of trust, innovation and growth to show the need of a deep investigation. We follow previous researches to use instrument variables to get unbiased estimation. For example, Knack and Keefer (1997) used number of graduates from law school as an instrumental variable. Religion variables are the most prevailing chosen instrumental variables. La porta et al (1997) used hierarchical-religion. Culture heterogeneity should be highly correlated with trust. For example, Knack and Keefer (2001) based their model on social distance. Alesina and Ferrara (2002) found that personal characteristic (education background, income and recent experience), whether are in discrimination group present or in the past, movability and social variety are all determinants of trust. However, they are not the key determinants of innovation. Using historical data as instrumental variables is another good method because historical data is usually unrelated to current dependent variable. Akcomak and Weel (2009) used university situation, political situation and illiteracy in 1850. Tabellini (2010) used past political institutions. Considering existing methods and data availability, we use religion heterogeneity and historical political state as instrumental variables for trust. We control for a country’s developing level using urban degree, initial income per capita and education level.¹⁰

To explore how trust affects innovation, we build upon Akcomak and Weel (2009). As standard in the literature, we control for R&D expenditure as a proportion of GDP and education.¹¹ They argue there is little culture difference among European countries. However, as we study the problem from a world prospective, we control for culture difference by Buddhists, Christian and Muslims in addition to their specification.¹² We employed panel data regression, using fixed/ random country effect. We also did alternative regressions for robustness check. To estimate the full model of growth, innovation and trust, we used 3SLS to account for simultaneity.

Then, we study different types of trust and innovation on both country level (macro level) and individual level (micro level). For country level evidence, the regression set is specified as follows:

$$lnpat_i = a_0 + a_1 trust_k_i + a_2 lngerd_i + a_3 x_i + \epsilon_i$$

Where dependent variable $lnpat_i$ is the proxy for innovation output. Independent variable $trust_{k_i}$ contains ‘trust_family_macro’, ‘trust_neighbo_macro’, ‘trust_acquaintance_macro’, ‘trust_stranger_macro’ and ‘trust_religion_macro’, which have been described above in details. $lngerd_i$ is the proxy for innovation input. x_i stands for controls. We use the Corruption Perceptions Index (CPI) from Transparency International to control for political environment. Buddhism, Christian and Muslim are the three main religions. Thus we use ‘buddhist’, ‘christian’ and ‘muslims’ (the percentage of people in a country who believe in Buddhism, Christian and Muslim respectively) to control for culture differences. The data is from ARDA National Profiles. The variable ‘education’ (school enrollment of tertiary students) controls for education level in each country. Each variable is the average of 2003-2007 to avoid yearly fluctuations.

On individual level, both the dependent variables and independent variables are count data (only taking on nonnegative integer values), so we employ the Poisson regressions. The regression set is specified as follows:

$$attitude_{k_i} = b_0 + b_1 trust_{k_i} + b_2 x_i + \epsilon_i$$

Where dependent variable $attitude_{k_i}$ contains ‘technology’, ‘adventure’ and ‘tradition’. We choose them as to capture people’s attitude towards technology investment and adventure. The variables are based on the following questions: “Please tell me for more emphasis on the development of technology, if it were to happen, whether you think it would be a good thing, a bad thing, or don't you mind?” “Adventure and taking risks are important to this person; to have an exciting life”; “Tradition is important to this person; to follow the customs handed down by one’s religion or family”. ‘technology’ characterizes people’s view of technology investment while the other two represent their personality regarding adventure. The answer options of them are numerical values representing different levels.

Independent variable $trust_{k_i}$ contains ‘trust_family_micro’, ‘trust_neighbor_micro’, ‘trust_acquaintance_micro’, ‘trust_stranger_micro’, ‘trust_religion_micro’ and ‘trust_micro’. Here they are the answer value for each individual (different from the country index we discussed above). x_i stands for controls. A person’s attitude toward technology investment is also affected by his/her personal background and values. So we control for personal background (including country, gender, age, education, employment, profession job nature, family saving income level, ethnic, mother immigrant, father immigrant, language and marry) and values (including science_general, environment, book, democracy, fight_war, life_thinking and friends) .

4 EMPIRICAL RESULTS

It is well accepted that culture factors such as trust account for the differences across countries. We give summery statistics of trust and innovation by regions in Table A.4 in Appendix. Generally speaking, the level of trust is higher in developed countries (with an average level of 0.413) than in developing countries (with an average level of 0.161). However, the standard error of developed countries (0.167) is also bigger than that of developing countries (within 0.01 except for Asian). Northern European countries, including

Norway, Sweden, Finland, and Switzerland are of the highest level of trust. Norway is the highest with 0.742. Among developing countries, Asian countries have the highest level of trust (with an average level of 0.358), especially for China, Vietnam, Indonesia, Thailand. China and Vietnam are listed as the fourth and fifth highest around the world in the level of trust in the 2005-2008 Wave of WVS. This seemingly counter intuitive fact may in fact due to the activeness of informal economy in those areas. A large amount of business is built upon personal relationship instead of strict contract. Long run interactions call for trust and cultivate a corporation environment.¹³ It is also possible that people in different country take the absolute value of the answer options differently. In China and Vietnam, people have more optimistic believes about personal relationship and they give higher value to the same degree of trust than people in other countries.¹⁴

It's more interesting to look into different types of trust. Countries differ in relative degree of strong tie trust to weak tie trust. Both development level and culture accounts for the difference. Moreover, different types of trust have significant different correlation with innovation. Figure 1 and Figure 2 show the correlation between relative trust in acquaintances/ trust in strangers and patent applications per capita respectively. Other country characteristics, like education level, political institutions and religion factors are controlled.¹⁵ Red points represent developing countries and blue points represent developed countries. The developed and developing country criteria are according to IMF standards.

People in developed countries trust acquaintances more and this is beneficial to develop new technology. UK, Finland, Sweden, Switzerland and France are typical countries with relative high level of strong trusts and high level of innovation. The relationship is not one to one. For example, France is the highest relative trust in acquaintances, but it only has a moderate level of innovation among European countries. People in developing countries have a higher relative trust in strangers. This accounts for their low level of innovation. The benefit of strong ties is more robust than the drawbacks of weak ties. However, there are exceptions such as Italy, Spain and Netherland, who is more similar to developing countries than to developed countries. This is not surprising as there are long-standing arguments that relate Italy and Netherland more close to Eastern Countries in culture.

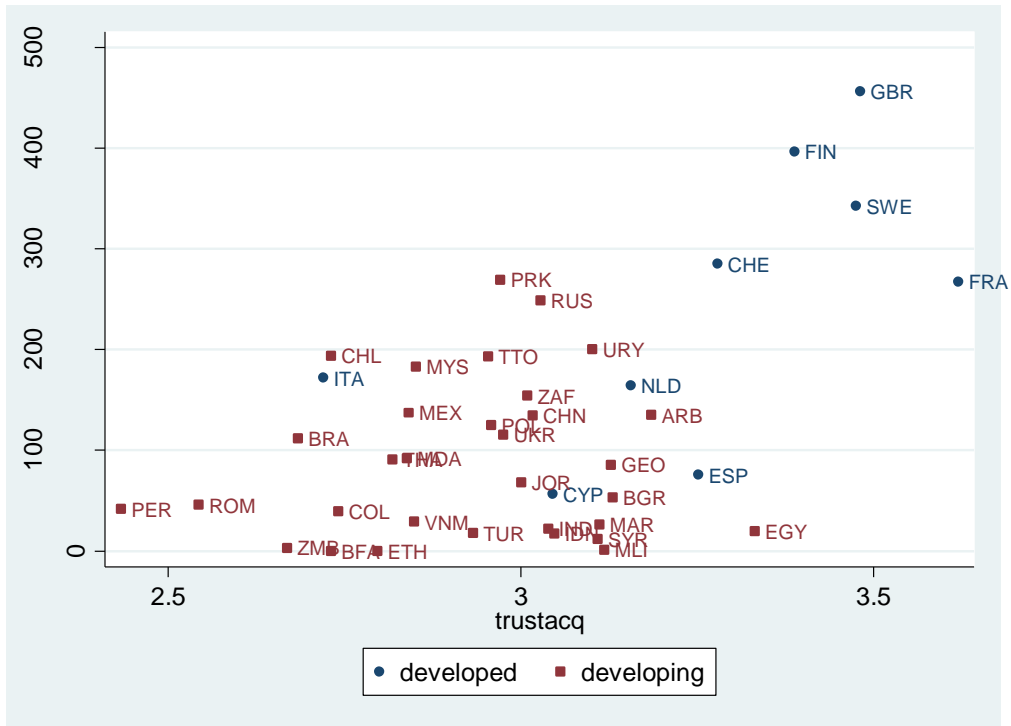


FIGURE 1

Relative Trust in acquaintances and Patent Applications per capita
 Source: World Bank and WVS.

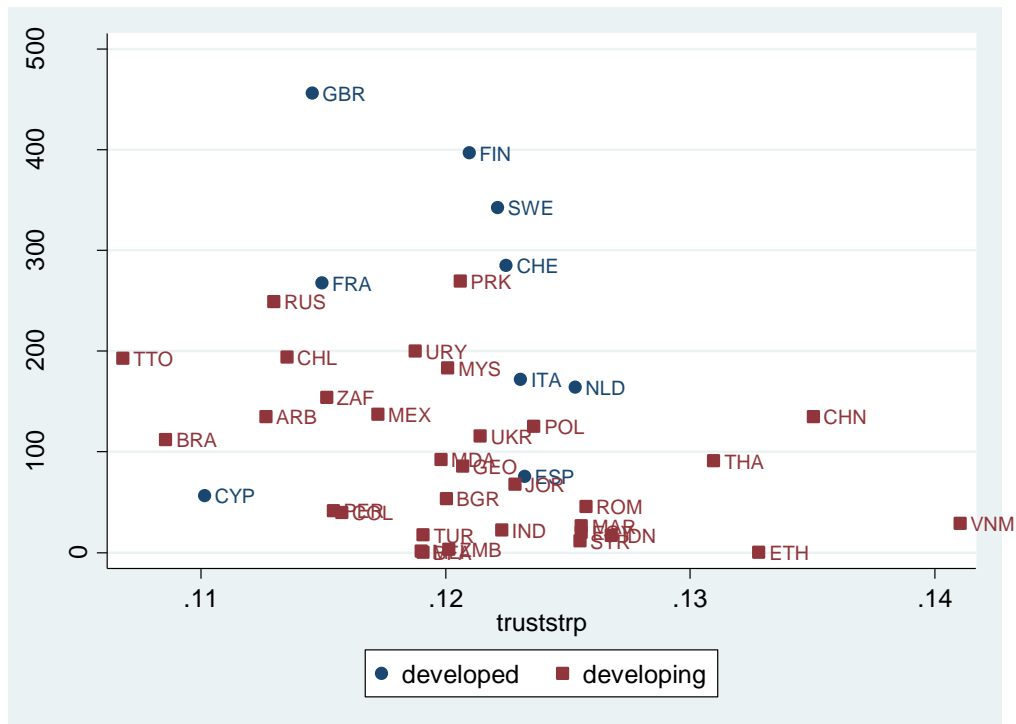


FIGURE 2

Relative Trust in strangers and Patent Applications per capita
 Source: World Bank and WVS.

(a) Trust, Innovation and Growth

In this subsection, we rediscover evidence on trust, innovation and growth. We find consistent evidence on trust and growth as in existing findings. However, we find that the relationship between trust and innovation requires more detailed studies.

We first study the relationship between trust and growth. Results are omitted here but available upon request. One percentage increase in trust among people increases regional per capita income growth by 9%. This result is consistent with the estimates presented in Knack and Keefer (1997) for a cross-section of countries over the period 1980–1992. We use politics and religion as instrumental variables. After controlling the endogenous problem, the impact of trust on per capita income growth becomes stronger and more significant. This result is consistent with the finding of Akcomak and Weel (2009) about European countries. Adding patent as a control doesn't change the results.

Second, we explore how trust affects innovation. We find the same positive relationship for European countries as in Akcomak and Weel (2009). However, when we look at other countries around the world, we come to different results. Table 1a reports the panel data regression results. Column (1)-(3) report the results of the whole world, of European countries and of non-European countries respectively. In Column (2), when the sample is restricted to European countries, one percentage increase in trust among people increases regional innovation output by 0.12%. The result is significant at the 1% level. This is consistent with Akcomak and Weel (2009). However, from a worldwide view, as shown in Column (1), one percentage increase in trust among people decreases regional innovation output by 0.11%, with a significance level of 1%. We did robustness check by doing pooled OLS regression and using politics and religion as IVs. Results are available upon request. The difference between European and Non-European countries and the negative relationship between trust and innovation for the whole world remains robust. Florida, Cushing and Cates (2002) also found a negative relationship between innovation and trust. Using data of many metropolitan areas in the United States, they found that areas with low levels of innovation - such as Bismarck, North Dakota; Birmingham, Alabama; and Cleveland - scored high on social capital. Conversely, areas that did well on innovation - Seattle; Boulder, Colorado; and the San Francisco Bay area - tended to have below-average levels of social capital. However, they only offered an argument based on the “strength of weak ties” but no further evidence. In contrast, we provide evidence that this puzzling negative relationship is due to the “strength of strong ties” on a country level.¹⁶

Table 1a Innovation and Trust (Panel Data)

	(1)World patent	(2)Euro patent	(3)Non Euro patent
trust	-0.105*** (0.0337)	0.123*** (0.0420)	-0.0417 (0.0437)
r_d	2.680*** (0.655)	-0.490 (0.678)	5.917*** (0.912)
educ	0.142***	0.0159	0.0996***

	(0.0321)	(0.0271)	(0.0366)
Buddhist	14.38 ^{***} (3.544)	147.6 (215.8)	13.73 ^{***} (3.209)
Chastain	-5.639 ^{**} (2.669)	-92.99 ^{**} (45.00)	2.911 (3.188)
Muslims	-3.972 (2.694)	-93.24 ^{**} (44.40)	2.559 (2.867)
constant	219.5 (239.6)	9127.9 ^{**} (4445.9)	-559.9 [*] (291.4)
<i>N</i>	104	39	65
<i>R</i> ²	0.676	0.678	0.826
<i>Wald chi2</i>		59.64 (0.0000)	268.82 (0.0000)

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

column 1 panel data with whole world;

column 2 panel data within European countries;

column 3 panel data non-European countries.

Since the p-value of Hausman test for column 1 is 0.0340, we choose fixed effect model. The p-value of Hausman test for column 2 is 0.0896, we choose random effect model. The p-value of Hausman test for column 3 is 0.4914, we choose random effect model.

Table 1b Innovation and Trust (Panel Data, Quadratic)

	(1)World patent	(2)Euro patent	(3)Non Euro patent
trust	6.742 [*] (4.044)	13.57 (13.39)	-3.524 (5.088)
trustsq	-0.163 ^{**} (0.0685)	-0.114 (0.151)	0.0284 (0.0955)
r_d	261.3 ^{***} (57.92)	41.27 (84.62)	318.3 ^{***} (73.97)
educ	-0.219 (1.279)	-2.334 (1.886)	2.471 (1.890)
buddhist	892.3 (571.3)	6271.0 (27842.8)	948.0 (593.0)

chstian	-453.1 (384.8)	-9592.9 (6454.8)	-223.0 (452.9)
muslims	-679.9 (433.0)	-9844.0 (6419.1)	-463.8 (467.5)
constant	509.3 (372.5)	9633.3 (6445.0)	332.5 (403.7)
N	104	36	68
R^2			

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

column 1 panel data with whole world;

column 2 panel data within European countries;

column 3 panel data non-European countries.

We choose Random Effect Model as an specification.

Following the recent discussion on the optimal amount of trust, we studied a quadratic specification of trust and innovation. Consistent with Butler et al (2012), we find there is an inverted-U shape relationship between trust and innovation for the whole world and European countries, though the result is significant only for the whole world. Figure 3 shows this inverted-U shape relationship for the whole world sample. The optimal level of trust in this case is 20.63, with a sample mean of trust as 26.78. 58 countries are above this threshold.

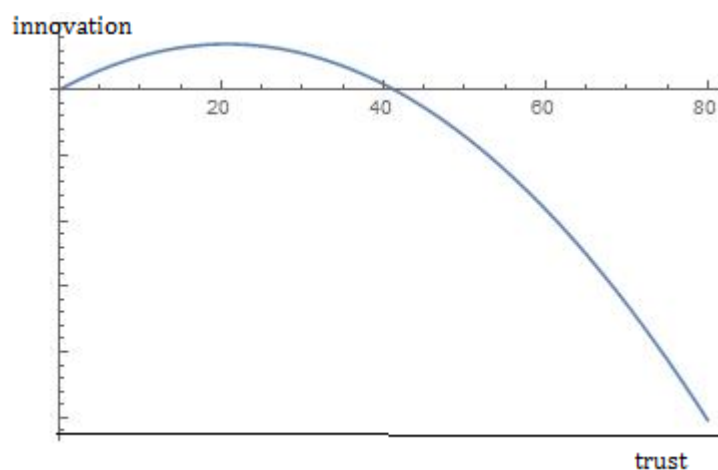


FIGURE 3

Non-linear relationship between trust and innovation, including 104 countries in total.

Finally, we study the full model of growth, innovation and trust. To address the issue of simultaneity, we use 3SLS estimation. Table 2 reports the results. Column (1)-(3) reports the

estimates of the first stage and column (4)-(6) reports the estimates of the second stage. Trust has a very significant positive effect on growth while a very significant negative effect on innovation. This is consistent with the findings above. As to the question whether innovation is the channel from trust to growth, our findings is inconclusive. From a world view, trust has a negative effect on innovation in general and innovation has an insignificant positive effect on growth. So innovation may not explain the significant positive relationship between trust and growth. As we are going to show below, relative high strong-tie trust facilitate innovation while relative high weak-tie trust undermines innovation, it is possible that the strong-tie dimension of trust serves as the connection between trust and growth.

Table 2 Growth, Innovation and Trust

	(1) 1st Growth	(2) 1st patent	(3) 1st trust	(4)3SLS growth	(5)3SLS patent	(6)3SLS trust
gdppc	-4.959* (2.519)	0.0147 (0.0571)	0.680*** (0.150)	-12.53*** (2.739)		
patent				2.597 (4.173)		
trust				9.989*** (3.204)	-0.178*** (0.0591)	
educ	4.169*** (1.434)	0.104*** (0.0325)	0.190** (0.0856)	1.464 (1.406)	0.150*** (0.0322)	
urban	-3.179** (1.339)	0.0690** (0.0304)	-0.142* (0.0799)	-2.097 (1.346)		
r_d	12.01 (55.94)	-0.834 (1.269)	-0.182 (3.339)		2.915*** (0.690)	
Buddhist	-18.69 (56.21)	-2.075 (1.275)	-7.675** (3.355)		13.59*** (3.408)	
Chastain	-29.22 (37.39)	0.821 (0.848)	2.503 (2.232)		-6.712** (2.613)	
Muslims	-412.5* (217.1)	7.063 (4.926)	7.680 (12.96)		-4.918* (2.610)	
politics	-452.5** (188.0)	-13.45*** (4.266)	-0.0510 (11.22)			0.684 (0.627)

						0.174
religion	-457.3** (185.6)	-11.28*** (4.211)	4.334 (11.08)			(0.109)
year2000	-15.18 (9.183)	0.509** (0.208)	-1.892*** (0.548)	19.09 (52.34)	-0.930 (1.215)	2.300 (4.147)
year2005	-0.419 (2.260)	-0.122** (0.0513)	0.348** (0.135)	70.95 (54.75)	-3.027*** (1.153)	2.051 (3.822)
constant	894.9*** (203.9)	5.054 (4.625)	25.75** (12.17)	200.9* (114.0)	6.393** (2.666)	21.98*** (4.064)
<i>N</i>	104	104	104	104		
<i>R</i> ²	0.369	0.698	0.550	0.185		

Standard errors in parentheses, robust standard errors in blankets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (robust)

(b) Country Level Evidence

In this subsection, we provide country level evidence. We discuss the relationship between different types of trust and innovation. Table 3 gives the OLS regression results. Controls are omitted¹⁷. We have a positive relationship between strong-tie trust and innovation while a negative relationship between weak-tie trust and innovation. However, only typical forms of strong-tie/ weak-tie trust are significantly related to innovation. ‘trust_acquaintance’, ‘trust_family’ and ‘trust_stranger’ are significant at 5%. ‘trust_foreign’ is significant at 10%. Others are insignificant. For numerical value, ‘trust_acquaintance’ and ‘trust_stranger’ are higher than other types of trusts in a large degree. One percentage increase in ‘trust_acquaintance’ (‘trust_stranger’) increases (decreases) innovation by 41.22% (56.05%). Figure 4 gives an illustration of the opposite effects of different types of trust.

Table 3 Effects of Different Types of Trust on Macro Level

	(1)OLS lnpat	(2)OLS lnpat	(3)OLS lnpat	(4)OLS lnpat	(5)OLS lnpat	(6)OLS lnpat
trust_ acquaintance _macro	41.22** (15.61) [20.10]					
trust_ family _macro		15.01** (9.147) [8.497]				
trust_ _macro			9.185			

neighbor		(16.06)				
_macro		[19.50]				
trust_						
stranger				-56.05**		
_macro				(32.25)		
				[31.77]		
trust_						
religion					-5.668	
_macro					(4.779)	
					[5.101]	
trust_						
foreigner						-35.41*
_macro						(25.16)
						[22.26]
<i>N</i>	41	41	41	41	41	41
<i>R</i> ²	0.851	0.833	0.821	0.835	0.827	0.830

Robust standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

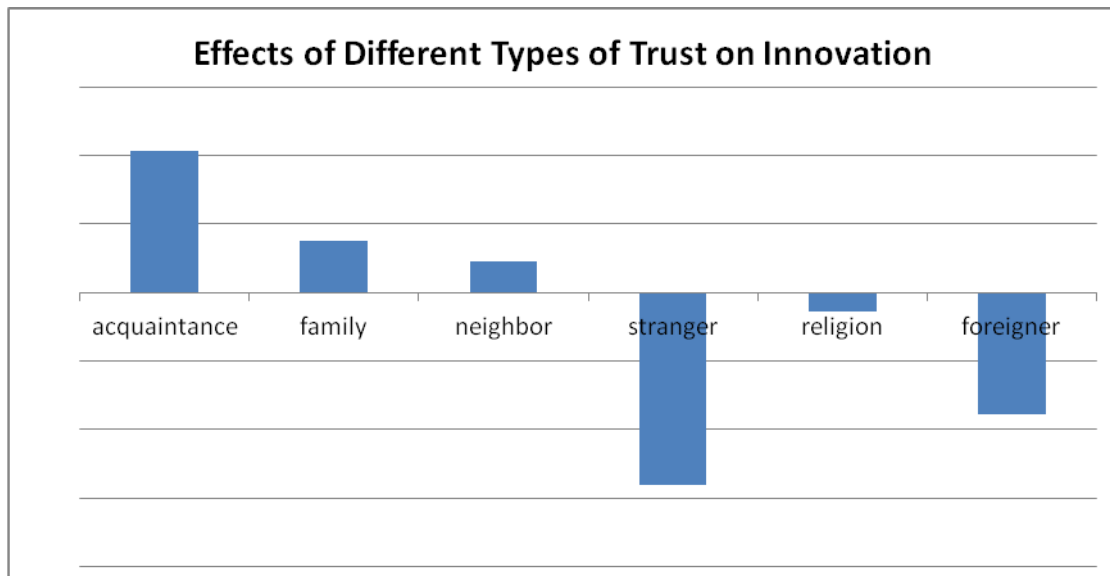


FIGURE 4: Different Trust affects Innovation Differently

(c) Individual Level Evidence

In this subsection, we look at whether the impact of trust on innovation would differ from an individual aspect. We look at the relationship between a person's feeling of trust and her attitudes towards technology, adventure and tradition on the individual level. We use the full sample of the 2005-2008 wave of WVS. Sample size of each regression varies from 17540 to 24449 depending on the number of missing values.

Table 4a and 4b report the marginal effect of Poisson models.¹⁸ We choose different dependent variables to represent attitudes toward innovation and include different sets of

controls for different specifications¹⁹. These results confirm our prediction that strong-tie trust will facilitate innovation while weak-tie trust may turn out to be ‘credulity’ in innovation business. Generally speaking, trust is significantly negatively related to attitudes towards technology investment. The higher the level of trust, the less likely people think technology investment is good. All specifications have a significance level of 0.1%. This might be surprising, but it can be explained when we look at different types of trust separately. One possible explanation is that when people are asked about the general question, they tend to put more weights on trust as ‘trust towards strangers’ or other weak-tie trust. So, the effect of general trust is the same with the effect of weak-tie trust, which turned out to be negative.

Strong-tie trust is significantly positively related to attitudes towards technology investment. ‘trust_family’ has more significant effect both statistically and numerically than the other two types of strong-tie trust. The results of ‘trust_family’ are also more robust to various specifications. ‘trust_family’ is significant at a level of 0.1% for all specifications while ‘trust_acquaintance’ is significant at a level of 0.1% in one specification but at a level of 5% in the other two specifications. ‘trust_neighbor’ becomes insignificant in two specifications. For numerical value, ‘trust_family’ is about four times larger than ‘trust_acquaintance’. The effect of weak-tie trust is significantly negative. ‘trust_stranger’ has more significant effect both statistically and numerically than the other two types of weak-tie trust. ‘trust_stranger’ is significant at a level of 0.1% in two specifications while ‘trust_foreign’ is significant at a level of 1% in those two specifications. Numerically, ‘trust_stranger’ is almost twice larger than ‘trust_foreign’. ‘trust_religion’ is insignificant for all specifications.

When we look at the relationship between different types of trust and people’s tendency to try new things, we recover evidence for the “strength of weak ties”²⁰. In general, trust is negatively related to ‘adventure’ and positively related to ‘tradition’ at a significance level of 0.1%. By decomposing trust, we see clearly the opposite impacts of strong-tie trust and weak-tie trust. Strong-tie trust is negatively related to people’s tendency to adventure while weak-tie trust is a positively related to it. ‘trust_family’, ‘trust_neighbor’, ‘trust_stranger’, and ‘trust_foreign’ are significant at a level of 0.1%. ‘trust_acquaintance’ is significant at a level of 1% for adventure and a level of 5% for tradition. Numerically, ‘trust_family’ is much larger than other trust, about twice larger for adventure and four times larger for tradition .

Table 4a investment on technology (Poisson model)

dep.v. technology	(1)	(2)	(3)
trust_micro	-52.58354*** (10.159)	-73.5298*** (10.142)	-69.11538*** (10.794)
<i>N</i>	21165	20454	17736
<i>R</i> ²	0.0235	0.0567	0.0575
trust_acquaintance_micro	15.95944*** (6.0164)	10.39859* (6.02826)	11.90343* (6.49703)
<i>N</i>	21606	20864	18042
<i>R</i> ²	0.0220	0.0546	0.0555
trust_family_micro	54.09633***	43.04474***	46.24513***

	(10.009)	(10.072)	(11.069)
<i>N</i>	21691	20943	18096
<i>R</i> ²	0.0225	0.0546	0.0557
trust_neighbor_micro	16.35574***	1.001174	-0.089772
	(5.75419)	(5.79854)	(6.29384)
<i>N</i>	21578	20838	18015
<i>R</i> ²	0.0217	0.0541	0.0549
trust_stranger_micro	-8.438735	-18.24756***	-22.80528***
	(5.69009)	(5.70725)	(6.29699)
<i>N</i>	21454	20720	17924
<i>R</i> ²	0.0223	0.0547	0.0559
trust_religion_micro	1.261484	-4.468956	-8.838766
	(5.5452)	(5.55252)	(6.06657)
<i>N</i>	20972	20265	17566
<i>R</i> ²	0.0223	0.0539	0.0547
trust_foreigner_micro	-7.485016	-11.65956**	-12.67331**
	(5.64627)	(5.65345)	(6.18123)
<i>N</i>	20928	20232	17540
<i>R</i> ²	0.0222	0.0543	0.0547

Robust standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001²¹

Table 4b propensity to adventure (Poisson model)

dep.v.	adventure	tradition
	(2)	(3)
trust_micro	-8.875315***	10.24708***
	(2.1529)	(1.90674)
<i>N</i>	23643	23774
<i>R</i> ²	0.0648	0.0341
trust_acquaintance_micro	-3.349785*	4.215733**
	(1.46023)	(1.29371)
<i>N</i>	24199	24334
<i>R</i> ²	0.0642	0.0332
trust_family_micro	-17.30181***	24.60085***
	(2.04904)	(1.88831)
<i>N</i>	24308	24449
<i>R</i> ²	0.0663	0.0392
trust_neighbor_micro	-5.196027***	11.05277***
	(1.33871)	(1.20297)
<i>N</i>	24160	24302
<i>R</i> ²	0.0643	0.0361
trust_stranger_micro	9.011163***	-4.296244***
	(1.31872)	(1.18393)
<i>N</i>	23969	24090

R^2	0.0658	0.0331
trust_religion_micro	9.836483*** (1.33916)	-2.272223 (1.18175)
N	23022	23134
R^2	0.0631	0.0329
trust_foreigner_micro	10.78112*** (1.32138)	-5.880327*** (1.17172)
N	22916	23033
R^2	0.0635	0.0342

Robust standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ ²²

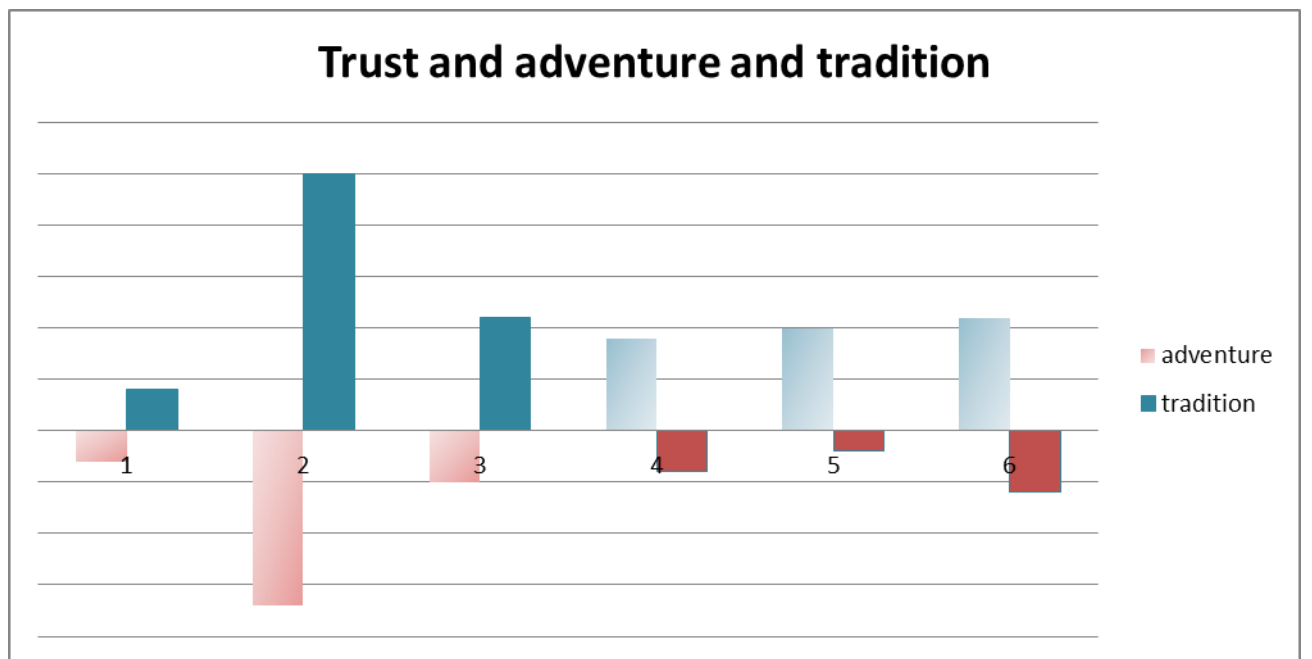
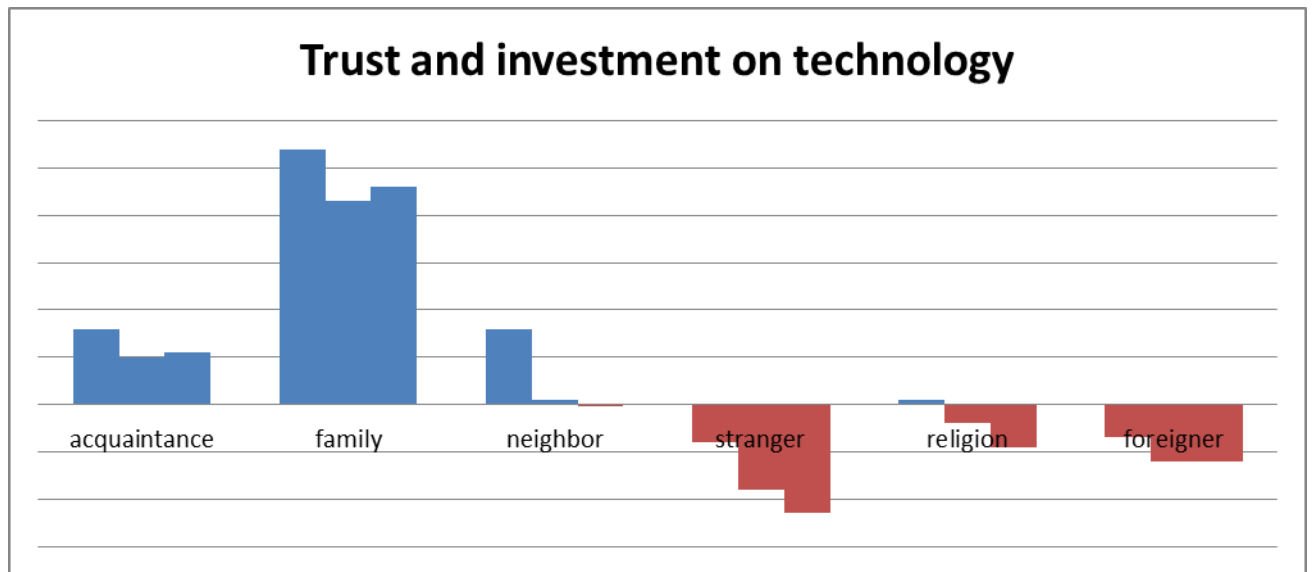


FIGURE 5: Different Trust affects People's attitudes Differently

To recap, strong-tie trust and weak-tie trust have opposite relationship with peoples' attitudes towards technology investment and adventure. The higher the level of strong-tie trust, the more important people consider technology investment and the less important they see adventure. The results for weak-tie trust are the opposite.

The above results show the difference between the "strength of weak ties" for individual decision and the "strength of strong ties" for collective achievements. More emphasis on adventure and less emphasis on tradition could sparks amazing inventions or art works. However, the large uncertainty of adventures will not increase the total number of expected innovations for a society. For investment in technology and final aggregate innovation outcomes, it is the "strength of strong ties" that facilitates the process. The "strength of weak ties" works for individual adventure but doesn't sustain for aggregate innovation level in a society. These results also show that 'trust_family' is the typical indicator for strong-tie trust while 'trust_stranger' is the typical indicator for weak-tie trust. 'trust_acquaintance' and 'trust_foreign' are also strong indicators. However, for spreading role, like emphasized in the "strength of weak ties", 'trust_neighbor' is more significant than 'trust_acquaintance'. For corporation role, as we emphasize in the "strength of strong ties", 'trust_acquaintance' is more significant than 'trust_neighbor'.

(d) Robustness Tests

In this subsection, we provide a summary of robustness tests. Table 5 shows the robustness checks of three parts of evidence respectively.

For the effects of general trust, we did robustness checks by considering pooled OLS, using politics and religion as IVs, and excluding Buddhist, Christian and Muslims. The difference between pooled OLS and panel data is very small. By using IV, the negative sign remains. However, the coefficient becomes twice larger while the significance level drops. The puzzling negative impact of trust on innovation is robust, though the size of the impact requires future investigation.

The second part of Table 5 shows the country level evidence for the opposite impacts of strong-tie and weak-tie trusts on innovation. We did two robustness checks. First, we use 'network' as a proxy for strong-tie trust. Beugelsdijk and Smulders (2003) argued that network serves as a productive social capital in the economy. Their reasoning follows from game theory. 'Repeated interactions among group members prevent opportunistic behavior and cheating in prisoners' dilemma kind of situations.' So we use 'network' (participation level of voluntary associations) as a proxy for strong-tie trust. In this case, we still find a positive relationship with significance level of 5%. More intense network enhances innovation activities. Second, we use Gini Index as an IV for 'trust_stranger_macro'. Gini Index is the most commonly used measure of inequality. Trust among strangers also captures differences between people, so they are probability related. In more equalized country, people

tend to trust strangers more. However, innovation is related to the gross economy level, not inequality. So Gini Index could serve as a nice IV. This improves the significance level of ‘trust_stranger’. The coefficient changes from -56.1 to -174.7 and the significance level changes from 5% to 1%.

For Individual Level Evidence, we did robustness check by using OLS model. The statistical significance and values are quite similar, especially for key variables, trust_family, trust_acquaintance, trust_stranger, and trust_foreign. The third part of Table 5 gives the maximum, minimum and average percentage changes of the six types of trust’s impact for different specifications. The first to fourth rows show the statistics of trust’s relationship with investment on technology²³. For significant specifications, the percentage changes are reasonable. The averages are from 8.33% to 11.09%. There is still difference between Poisson model and OLS model. The last two rows show the results for trust’s impact on adventure and tradition. The percentage changes are very small, with an average of 1.29% and 2.01%. The difference between using Poisson model and OLS is small.

Table 5 Robustness Tests

(1)World: trust and innovation		(2) Country Level		(3) Individual Level			
					max	min	avg
Panel Data	-0.105*** (0.0337)	trust_	41.22** (15.61)	Min_	-17.27%	0.00%	-3.51%
		acquaintance	[20.10]	invest			
		macro		Max	306.35%	2.49%	51.30%
Pooled OLS	-0.105*** (0.0338)	proxy	0.483** (0.294)	invest			
	[0.0523]	network	[0.268]	Min_sig_	-17.27%	0.02%	-8.33%
				invest			
IV	-0.301** (0.107)	trust_	-56.05** (32.25)	Max_sig_	11.80%	-1.45%	-11.09%
	[0.129]	strangers	[31.77]	invest			
		_macro		adventure	-3.56%	0.08%	-1.29%
without religion	-0.0662 (0.0426)	IV	-174.7*** (75.28)	tradition	-5.27%	-0.84%	-2.01%
	[0.0493]		[60.80]				

Robust standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

5 CONCLUSIONS

In this paper, we have studied social capital and economic development from an important yet under investigated view: the relationship between trust and innovation. By using detailed information about different types of trust in a cross section of 104 countries worldwide in 2005-2008, we provide new evidence on this question. We found that strong-tie trust (trust among people who have small social distance with each other) is positively related to innovation while weak-tie trust (trust among people who have large social distance with each other) has a negative relationship with innovation. The relationship is robust. We used instrument variables to address endogeneity issues, tried different specifications and study this relationship from both country and individual level. The opposite impacts of strong-tie trust and weak-tie trust remain. Moreover, trust towards families and trust towards strangers appear

to be the most representative indicators for strong-tie trust and weak-tie trust respectively. The general trust in previous studies based on value surveys, such as EVS, WVS may mainly demonstrates the impact of trust towards strangers.

The seminal work of Granovatter (1973) showed the “strength of weak tie” for individual decision and success. However, this may not sustain on an industry or country level. Due to data limitation, existing researches that distinguish between strong-tie trust’s and weak-tie trust’s impacts are limited to a specific industry or a region. Our paper takes countries around the world as research objects. It shows that industry level evidence of opposite effects of strong-tie trust and weak-tie trust can be extended to worldwide country level. We showed that on a society level, the corporation between familiar people, i.e., the “strength of strong tie” promotes aggregate innovation. In addition, we also did a first step investigation on individual’s opinion on technology and their level of different types of trust. Further study could focus on more detailed individual level studies. For example, if we have data on individual job choice (scientists, entrepreneur, technology development position), their actual spending on innovation related investment and their consumption patterns etc., we could seek out one’s trust type and actual behavior type about innovation (instead of the opinion type regarding innovation in our study).

Our new evidence suggests that innovation could be the channel linking strong-tie trust and growth, but not between weak-tie trust and growth. This is complementary to the view that institutional environment serves as the channel between trust and growth (productivity), such as in Beugelsdijk and M^on (2015). They found that the effect of social trust on TFP runs through economic-judicial institutions. On the one hand, our results suggested that strong-tie trust improves innovation and thus growth. On the other hand, weak-tie trust enhances growth through improving institutional environment. The opposite effects come from the different guiding roles of strong-tie trust and weak-tie trust in allocating social resources. Relative high level of strong-tie trust creates dense clusters, which provide highly specialized labor division for modern R&D sector. Relative low level of weak-tie trust foster sparse links between clusters and thus diversified labor supply. Thus innovation level is higher in a society with high level of relative to weak-tie trust. This finding reminds us the complexity of trust, which requires more detailed studies.

Notes

1 Morrone, Tontoranelli and Ranuzzi (2009) conducted a detailed investigation on the role of trust on economic performance in modern society. The paper compares different trust indicators and estimates the impact of trust on various dimensions of economic and social well-being.

2 Algan and Cahuc (2013) has a detailed survey on the relationship between trust and growth. They reviewed the empirical methods used to identify the causal impact of trust on economic

performance. Existing researches employ two methods. First is to use historical events, such as past education and past political institutions in Tabellini (2010) and the past history of independence of certain cities in Guiso et al. (2008). Second is using time-varying instruments, such as inherited values in Algan and Cahuc (2010). However, the economic or social channels linking trust and growth are still unclear.

3 We obtain this number by calculating the difference of the sum of three types of weak-tie trust and the sum of three types of strong-tie trust. If we only include significant results, the difference increases to 35%.

4 The seminal work by Adler and Kwon (2002) provides a deep survey on the concept of social capital, including researches in sociology, political science, economics, and organizational theories. They argue that the core intuition guiding social capital research is that the goodwill that others have toward us, like sympathy, trust, and forgiveness, is a valuable resource.

5 The list of the countries is in appendix. The sample of countries changes slightly depending on the proxies for innovation input and output we use. For different types of trust and innovation, we have a large reduction in the number of countries because the new released wave doesn't survey different types of trust for all countries.

6 There is a debate about whether survey value based measurement is accurate, like in Sapienza, Toldra-Simats and Zingales (2013). However, as concluded in their paper, neither the results from WVS-question nor the outcome in a trust game is a perfect indicator of trust as defined by Gambetta (2000). The sender's behavior in a trust game composes both beliefs and preferences while WVS-like measures capture mostly the belief component.

7 We controlled for politic situations, so in a country with relative high level of strong-tie trust, people will invest more in current project than turn to a stranger. Because the stranger's project features high uncertainty, even without agency problem, on the country level, frequent switches to new project of strangers undermines innovation. With agency problem, this could be even worse. If the entrepreneur expects frequent switches of investor, she will have no incentive to put effort in current period. This results from the long time period feature of innovation.

8 We changed the order of answer options in the original survey so that a higher value means higher trust level.

9 TableA.3 in Appendix A illustrates the correlation between them.

10 Urban is the proportion of people living in major cities. Initial income per capita is GDP per capita, PPP (constant 2005 international \$) unit: thousands dollars. Education is represented by School Enrollment, tertiary (% gross). Data for the three variables is from World Bank.

11 As in the above footnote, data is from the World Bank. R&D expenditure is measured as Research and development expenditure (% of GDP). Education is measured as School Enrollment, tertiary (% gross).

12 As to be said below, we choose Buddhism, Christian and Muslim because they are the three main religions. We use the percentage of people in a country who believe in Buddhism, Christian and Muslim to represent 'buddhist', 'christian' and 'muslims' respectively.

13 From a game theory perspective, many factors can account for cooperation in the long run. For example, there is the “folk theorem” that one can support cooperation in repeated prisoners’ dilemma, and other “non-one-stage“ equilibrium outcomes in infinitely-repeated games with sufficiently high discount factors, like in Fudenberg and Maskin (1986). Besides, when we consider reputation effects due to informational asymmetries, we can support cooperative behavior in finitely-repeated games, likes in Kreps and Wilson (1982) and Milgrom and Roberts (1981). More recently, there is a huge debate on how does social preference, like altruism, fairness and vindictiveness, affect equilibrium results, including Rabin, 1993; Levine, 1998; Fehr and Gaechter, 2000; Falk et al., 2005; Dreber-Almenberg et al., 2014.

14 This implies that using the absolute value of trust as the indicators might involves measurement error. To avoid this, we use relative ratio of one type of trust. This could effectively eliminate the difference coming from people’s different interpretation of the values in answer options in different countries.

15 The figures doesn’t capture the pure correlation between different types of trust and innovation. Instead, they capture the regression results, after controlling R&D expenditure, education, political environment and religion.

16 They argue that relationships can get so strong that the community becomes complacent and insulated from outside information and challenges. Strong ties can also promote the sort of conformity that undermines innovation. Weak ties, on the other hand, allow a basic level of information sharing and collaboration while permitting newcomers with different ideas to be accepted quickly into the social network. Thus, social groups with weak ties could be expected to encourage innovative thinking. However, they didn’t provide evidence about which kind of social capital is higher in the low-innovation-high-trust cities.

17 Controls include lngerd, patpc, corruption, Buddhist, christian, muslims, education. The first four controls have a significant level of 1% for most regressions, while the others are insignificant. We employed OLS not panel regression because of data limitation.

18 We changed the order of answer options’ values if necessary so that the bigger the number the more tendency a person has to support technology, take an adventure or consider tradition important.

19 We have did 5 groups of regressions, including controls science_general; science_general, life_thinking, fight_war, expectation; science_general, life_thinking, fight_war, democracy; science_general, life_thinking, fight_war, democracy, book and science_general, life_thinking, fight_war, democracy, book, environment in addition to basic background controls. We only report the first, fourth and fifth group because the results of other three groups are similar.

20 We also studied the relationship between ‘new_ideas’ and different types of trust. However, in this case all trusts are positively related to ‘new_ideas’.

21 controls of column 1: country, gender, age, education, employment, job_nature, family_saving, income_level, ethnic, father_immigrant, language, marry, environment.
controls of column 2: country, gender, age, education, employment, job_nature, family_saving, income_level, ethnic, father_immigrant, language, marry, science_general, environment.
controls of column 3: country, gender, age, education, employment, job_nature, family_saving, income_level, ethnic, father_immigrant, language, marry, science_general, book, democracy, fight_war, life_thinking, environment.

For each dependent variable, different types of trust are not put into regression as a whole, but separately for 7 regressions.

22 Controls: country, gender, age, education, profession, family_saving, income_level, ethnic, language, marry, friends.

For each dependent variable, different types of trust are not put into regression as a whole, but separately for 7 regressions.

23 For trust's relationship with investment on technology, we have three specifications containing different controls, as in Table 4a. We compute the minimum, the maximum, the minimum for at least 5% significant results and the maximum for at least 5% significant results for the three specifications.

References

- [1] Acs, Zoltan J, Audretsch, David B and Feldman, Maryann P, 1994. "R&D Spillovers and Recipient Firm Size," *The Review of Economics and Statistics*, MIT Press, vol. 76(2), pages 336-40, May. DOI: 10.2307/2109888
- [2] Adler Paul S. and Seok-Woo Kwon, 2002, "Social Capital: Prospects for a New Concept," *The Academy of Management Review*, :Academy of Management, vol. 27(1). pages 17-40. January. DOI: 10.5465/AMR.2002.5922314
- [3] Aghion Philippe, Yann Algan, Pierre Cahuc and Andrei Shleifer, 2010. "Regulation and Distrust," *The Quarterly Journal of Economics*, Oxford University Press, vol. 125(3), pages 1015-1049. DOI: 10.1162/qjec.2010.125.3.1015
- [4] Aghion, Philippe and Howitt, Peter, 1992. "A Model of Growth through Creative Destruction," *Econometrica*, Econometric Society, vol. 60(2), pages 323-51, March. DOI: 10.2307/2951599
- [5] Aharonovitz Gilad D., Nathan Skuza and Faysal Fahs, 2009. "Can Integrity Replace Institutions? Theory and Evidence," *CESifo Working Paper Series 2730*, CESifo Group Munich.
- [6] Akcomak, I. Semih and ter Weel, B., 2008. "How do social capital and government support affect innovation and growth? Evidence from the EU regional support programmes". In: Nauwelaers, C., Wintjes, R. (Eds.), *Innovation Policy in Europe, Measurement and Strategy*. Edward Elgar, Cheltenham, pages. 106–136. ISBN 9781845427597.
- [7] Akçomak, I. Semih and ter Weel, Bas, 2009. "Social capital, innovation and growth: Evidence from Europe," *European Economic Review*, Elsevier, vol. 53(5), pages 544-567, July. DOI:10.1016/j.eurocorev.2008.10.001
- [8] Akçomak, I. Semih and Hanna Müller-Zick, 2015. "Trust and inventive activity in Europe: causal, spatial and nonlinear forces," *The Annals of Regional Science*. vol. Special Issue, pages 1-40. DOI: 10.1007/s00168-015-0729-2
- [9] Alesina, Alberto & La Ferrara, Eliana, 2002. "Who trusts others?," *Journal of Public Economics*, Elsevier, vol. 85(2), pages 207-234, August. DOI: 10.1016/S0047-2727(01)00084-6
- [10] Algan Yann and Pierre Cahuc, 2010. "Inherited Trust and Growth," *American Economic Review*, American Economic Association, vol. 100(5), pages 2060-92, December. DOI: 10.1257/aer.100.5.2060
- [11] Algan Yann and Pierre Cahuc. 2013, "Trust and Growth", *Annual Review of Economics*, Vol. 5. Pages: 521-549. May. DOI: 10.1146/annurev-economics-081412-102108
- [12] Algan, Yann, Pierre Cahuc, and Andrei Shleifer. 2013. "Teaching Practices and Social Capital," *American Economic Journal: Applied Economics*, American Economic

- Association, vol. 5(3), pages 189-210, July. DOI: 10.1257/app.5.3.189
- [13] Audretsch, David B and Maryann P Feldman, 1996. "R&D Spillovers and the Geography of Innovation and Production," *American Economic Review*, American Economic Association, vol. 86(3), pages 630-40, June. DOI: 10.1.1.684.3300
- [14] Beñat, Bilbao-Osorio and Andrés Rodríguez-Pose, 2004. "From R&D to Innovation and Economic Growth in the EU," *Growth and Change*, Wiley Blackwell, vol. 35(4), pages 434-455. DOI: <http://dx.doi.org/10.1111/j.1468-2257.2004.00256.x>
- [15] Beugelsdijk, Sjoerd, Henri L.F. de Groot and Anton B.T.M. van Schaik, 2004. "Trust and economic growth: a robustness analysis," *Oxford Economic Papers*, Oxford University Press, vol. 56(1), pages 118-134, January. DOI: 10.1093/oep/56.1.118
- [16] Beugelsdijk Sjoerd and Ton Van Schaik, 2005. "Differences in social capital between 54 Western European regions," *Regional Studies*, Taylor & Francis Journals, vol. 39(8), pages 1053-1064. DOI:10.1080/00343400500328040
- [17] Beugelsdijk, Sjoerd and Smulders, Sjak, 2009. "Bonding and Bridging Social Capital and Economic Growth", *CentER Discussion Paper Series No. 2009-27*. Available <http://dx.doi.org/10.2139/ssrn.1402697>
- [18] Bian, Yanjie, 1997. "Bringing strong ties back in: Indirect ties, network bridges, and job searches in China." *American Sociological Review*, American Sociological Association, vol. 62(3), pages 366-385. June. DOI: 10.2307/2657311
- [19] Bjørnskov, Christian and M éon, Pierre-Guillaume, 2015. "The Productivity of Trust," *World Development*, Elsevier, vol. 70(C), pages 317-331. DOI:10.1016/j.worlddev.2015.01.015
- [20] Blau, Peter M., 1964, *Exchange and power in social life*. Transaction Publishers. ISBN: 9780887386282
- [21] Bouma, Jetske, Daan van Soest and Erwin Bulte, 2007. "How sustainable is participatory watershed development in India?," *Agricultural Economics*, International Association of Agricultural Economists, vol. 36(1), pages 13-22, 01. January. DOI: 10.1111/j.1574-0862.2007.00173.x
- [22] Bourdieu, Pierre. 1986., *The forms of capital*. In J. Richardson (Ed.) *Handbook of Theory and Research for the Sociology of Education* (New York, Greenwood), 241-258. ISBN-13: 978-0313235290
- [23] Butler Jeffrey, Paola Giuliano, Luigi Guiso, 2009. "The Right Amount of Trust," *NBER Working Papers 15344*, National Bureau of Economic Research, Inc. DOI: 10.3386/w15344
- [24] Coleman, James. S., 1988. "Social capital in the creation of human capital". *American journal of sociology*, University of Chicago Press, vol. 94, Supplement: Organizations and Institutions: Sociological and Economic Approaches to the Analysis of Social Structure, pages 95-120, DOI: 10.1086/228943

- [25] Corbacho, Ana , Philipp, Julia and Ruiz-Vega, Mauricio, 2015. "Crime and Erosion of Trust: Evidence for Latin America," *World Development*, Elsevier, vol. 70(C), pages 400-415. doi:10.1016/j.worlddev.2014.04.013
- [26] D'Hernoncourt, Johanna and Pierre-Guillaume Méon, 2012. "The not so dark side of trust: Does trust increase the size of the shadow economy?" *Journal of Economic Behavior and Organization*, Elsevier, vol. 81(1), pages 97–121, January. DOI:10.1016/j.jebo.2011.09.010
- [27] Dreber-Almenberg, Anna, Drew Fudenberg and David G. Rand , 2014. "Who cooperates in repeated games: The role of altruism, inequity aversion, and demographics," *Journal of Economic Behavior & Organization*, Elsevier, vol. 98(C), pages 41-55. DOI:10.1016/j.jebo.2013.12.007
- [28] Falk Armin, Fehr Ernst and Fischbacher Urs, 2005. "Driving Forces Behind Informal Sanctions," *Econometrica*, Econometric Society, vol. 73(6), pages 2017-2030, November. DOI: 10.1111/j.1468-0262.2005.00644.x
- [29] Fehr, Ernst, and Simon Gächter. 2000. "Cooperation and Punishment in Public Goods Experiments." *American Economic Review*, 90(4): 980-994. DOI: 10.1257/aer.90.4.980
- [30] Florida Richard, Robert Cushing and Gary Gates, 2002, "When social capital stifles innovation" *Harvard Business Review*, vol 80(8), August.
- [31] Fudenberg, Drew and Eric Maskin, 1986. "The Folk Theorem in Repeated Games with Discounting or with Incomplete Information," *Econometrica*, Econometric Society, vol. 54(3), pages 533-54, May. DOI: 10.2307/1911307
- [32] Gambetta, Diego (2000) 'Can We Trust Trust?', in Gambetta, Diego (ed.) *Trust: Making and Breaking Cooperative Relations*, electronic edition, Department of Sociology, University of Oxford, chapter 13, pp. 213-237. ISBN-13: 978-0631175872
- [33] Gilsing, Victor and Bart Nooteboom, 2005, "Density and strength of ties in innovation networks: an analysis of multimedia and biotechnology" *European Management Review*, vol. 2(3), pages 179–197. DOI: 10.1057/palgrave.emr.1500041
- [34] Gorodnichenko, Yuriy and Gerard Roland, 2011. "Which Dimensions of Culture Matter for Long-Run Growth?," *American Economic Review*, American Economic Association, vol. 101(3), pages 492-98, May. DOI: 10.1257/aer.101.3.492
- [35] Granovetter, Mark S. 1973. "The Strength of Weak Ties." *American Journal of Sociology*, The University of Chicago Press, vol. 78(6), pages 1360-1380. DOI: 10.1086/225469
- [36] Grossman, Gene M. & Elhanan Helpman, 1991. "Quality Ladders in the Theory of Growth," *Review of Economic Studies*, Oxford University Press, vol. 58(1), pages 43-61. doi: 10.2307/2298044
- [37] Guiso, Luigi, Paola Sapienza, and Luigi Zingales. 2004. "The Role of Social Capital in Financial Development," *American Economic Review*, American Economic Association, vol. 94(3), pages 526-556, June. DOI: 10.1257/0002828041464498

- [38] Guiso, Luigi, Paola Sapienza, and Luigi Zingales. 2006. "Does Culture Affect Economic Outcomes?," *Journal of Economic Perspectives*, American Economic Association, vol. 20(2), pages 23-48, Spring. DOI : 10.1257/jep.20.2.23
- [39] Guiso L, Sapienza P, Zingales L. 2008. Long term persistence. NBER Work. Pap. 14278
DOI: 10.3386/w14278
- [40] Hall, Robert E. and Charles I. Jones, 1999, "Why Do Some Countries Produce So Much More Output per Worker than Others?" *The Quarterly Journal of Economics*, Oxford University Press, vol. 114(1), pages 83-116. DOI:10.1162/003355399555954
- [41] Kim, Byung-Yeon and Youngho Kang, 2014. "Social capital and entrepreneurial activity: A pseudo-panel approach," *Journal of Economic Behavior & Organization*, Elsevier, vol. 97(C), pages 47-60. DOI:10.1016/j.jebo.2013.10.003
- [42] Knack, Stephen and Philip Keefer, 1997. "Does social capital have an economic payoff? A cross-country investigation." *Quarterly Journal of Economics*, Oxford University Press, vol. 112 (4), pages 1251–1288, Nov. DOI:10.1162/003355300555475
- [43] Kreps, David M. and Robert Wilson , 1982. "Reputation and imperfect information," *Journal of Economic Theory*, Elsevier, vol. 27(2), pages 253-279, August. DOI:10.1016/0022-0531(82)90030-8
- [44] La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer and Robert W. Vishny , 1997. "Trust in Large Organizations," *American Economic Review*, American Economic Association, vol. 87(2), pages 333-38, May.
- [45] Lavie, Dovev and Israel Drori , 2012, "Collaborating for Knowledge Creation and Application: The Case of Nanotechnology Research Programs." *Organization Science*, vol.23(3), pages 704-724. <http://dx.doi.org/10.1287/orsc.1110.0656>
- [46] Levine, David K., 1998. "Modeling Altruism and Spitefulness in Experiment," *Review of Economic Dynamics*, Elsevier for the Society for Economic Dynamics, vol. 1(3), pages 593-622, July. DOI:10.1006/redo.1998.0023
- [47] Lin Nan, Walter M. Ensel and John C. Vaughn. 1981, "Social resources and strength of ties: Structural factors in occupational status attainment." *American Sociological Review*, American Sociological Association , vol. 46(4), pages 393-405. August. DOI: 10.2307/2095260
- [48] Loury, Glenn C, 1977,"A dynamic theory of racial income differences." In P. Wallace and A. LaMond (Ed.) *Women, Minorities and Employment Discrimination*. Lexington: Lexington Books. ISBN: 9780669012828
- [49] Milgrom, Paul and John Roberts, 1982. "Predation, reputation, and entry deterrence," *Journal of Economic Theory*, Elsevier, vol. 27(2), pages 280-312, August. DOI:10.1016/0022-0531(82)90031-X
- [50] Morrone, A., N. Tontoranelli and G. Ranuzzi (2009), "How Good is Trust? Measuring Trust and its Role for the Progress of Societies" , OECD Statistics Working Paper, OECD

Publishing, Paris. DOI: 10.1257/pol.5.2.222

- [51] Nannicini, Tommaso, Andrea Stella, Guido Tabellini, and Ugo Troiano. 2013. "Social Capital and Political Accountability," *American Economic Journal: Economic Policy*, American Economic Association, vol. 5(2), pages 222-50, May. DOI: 10.1257/pol.5.2.222
- [52] Nooteboom, Bart., 1999. "Interfirm Alliances: International Analysis and Design." Routledge, London. ISBN: 978-0415181549
- [53] Nooteboom, Bart, 2000. "Institutions and forms of coordination in innovation systems." *Organization studies*, vol. 21(5), pages 915-939. September. DOI:10.1177/0170840600215004
- [54] Nooteboom, Bart, 2001, "Learning and Innovation in Organizations and Economies." Oxford University Press, Oxford ISBN-13: 9780199241002
- [55] Nooteboom, Bart. 2006. "Innovation, learning and cluster dynamics", in Bjorn Asheim, Philip Cooke and Ron Martin (Ed.) *Clusters and Regional Development: Critical Reflections and Explorations*, pages, 137-163. ISBN: 978-0415578622
- [56] Nooteboom, Bart, Wim Van Haverbeke, Geert Duysters, Victor Gilsing and Ad van den Oord , 2007. "Optimal cognitive distance and absorptive capacity," *Research Policy*, Elsevier, vol. 36(7), pages 1016-1034, September. DOI: 10.1016/j.respol.2007.04.003
- [57] Putnam, Robert D., Robert Leonardi and Raffaella Y. Nanetti. 1994." Making democracy work: Civic traditions in modern Italy". Princeton university press. ISBN: 9780691037387
- [58] Putnam, Rorbet. D., 1995. "Bowling alone: America's declining social capital." *Journal of democracy*, vol. 6(1), pages 65-78. August. DOI: 10.1353/jod.1995.0002
- [59] Putnam, Robert. D., 2000. "Bowling Alone: The Collapse and Revival of American Community." New York : Simon & Schuster. ISBN 9780743203043
- [60] Rabin, Matthew, 1993. "Incorporating Fairness into Game Theory and Economics," *American Economic Review*, American Economic Association, vol. 83(5), pages 1281-1302, December. DOI: 10.2307/2117561
- [61] Rosenkopf, Lori, and Giovanna Padula, 2008. "Investigating the microstructure of network evolution: alliance formation in the mobile communications industry." *Organization Science*, vol. 19(5), pages 669-687. doi.org/10.1287/orsc.1070.0339
- [62] Sapienza Paola, Anna Toldra - Simats and Luigi Zingales, 2013. "Understanding Trust," *Economic Journal*, Royal Economic Society, vol. 123(12), pages 1313-1332, December. DOI: 10.1111/eoj.12036
- [63] Tabellini Guido, 2010. "Culture and Institutions: Economic Development in the Regions of Europe," *Journal of the European Economic Association*, MIT Press, vol. 8(4), pages 677-716, 06. DOI: 10.1111/j.1542-4774.2010.tb00537.x

- [64] Torche, Florencia and Eduardo Valenzuela, 2011. "Trust and reciprocity: A theoretical distinction of the sources of social capital". *European Journal of Social Theory*, vol.14(2), pages 181-198. DOI: 10.1177/1368431011403461
- [65] Tu, Qin and Bulte, Erwin, 2010. "Trust, Market Participation and Economic Outcomes: Evidence from Rural China," *World Development*, Elsevier, vol. 38(8), pages 1179-1190, August. DOI:10.1016/j.worlddev.2009.12.014
- [66] Wuyts, Stefan, Colombo, Massimo G., Dutta, Shantanu and Nootboom, Bart, 2005. "Empirical tests of optimal cognitive distance," *Journal of Economic Behavior & Organization*, Elsevier, vol. 58(2), pages 277-302, October. DOI:10.1016/j.jebo.2004.03.019
- [67] Young, H. Peyton, 2011, "The dynamics of social innovation." *Proceedings of the National Academy of Sciences*, 108(Supplement 4), pages 21285-21291. DOI: 10.1073/pnas.1100973108
- [68] Zak, Paul J., Stephen Knack, S., 2001. "Trust and growth." *The Economic Journal*, Royal Economic Society, vol. 111(470), pages 295–321, March. DOI: 10.1111/1468-0297.00609

APPENDIX

A1: Countries in the sample

Argentina, Australia, Brazil, Bulgaria, Burkina Faso, Canada, Chile, China, Colombia, Cyprus, Egypt, Ethiopia, Finland, France, Georgia, Germany, India, Indonesia, Italy, Jordan, Korea, Malaysia, Mali, Mexico, Moldova, Morocco, Netherlands, New Zealand, Norway, Peru, Poland, Romania, Russian Federation, South Africa, Spain, Sweden, Switzerland, Syrian Arab Republic, Thailand, Trinidad and Tobago, Turkey, Ukraine, United Kingdom, United States, Uruguay, Vietnam, Zambia.

Table A.1 Summary statistics

	Variable	Mean	Std. Dev.	Min	Max
Overall	growth	2.818173	2.281498	-.4075148	16.54035
	trust	26.78087	16.13037	.79	74.17
	r_d	1.09511	1.053568	.0173263	4.443393
	patent	422.2302	747.8704	.1016112	3463.405
	educ	36.98855	23.65374	.69299	93.48646
	urban	63.66827	20.26547	12.1	100
	gdppc	12331.57	14577.38	268.9613	66652.16
	buddhist	.05537	.1854964	0	.902409
	chstian	.6341909	.406975	.001725	.9994151
	muslims	.2136052	.3483142	.0000256	.9981601
	religion	34711.89	141668.2	.2334209	796588.1
	politics	3.836538	2.49703	1	7

Table A.2 Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
pat	188	43677.44	127746.5	1	804892
patpc	187	13033	130418.2	.0030911	1732151
rdexp	118	.9689752	.9295007	.0216334	4.364987
trust05	57	.2676364	.1649724	.038	.7416503
trustfamp	51	.231306	.0281414	.1785936	.2852775
trustneip	51	.1747363	.0202711	.1272334	.2207311
trustforp	51	.1379036	.0085133	.1090874	.1544337
trustacqp	51	.1829767	.0137102	.157772	.2133176
trustrelp	51	.1529077	.0591095	.0306222	.2612718
truststrp	51	.1201697	.0069253	.0999578	.1410261
corruption	156	4.096581	2.1791	1.7	9.633333
gdp	199	162.491	513.041	.1231329	4439.152
gdppc	199	11.12733	17.97178	.1362782	129.9234
secondary	202	75.00103	27.8949	9.99286	134.951
gini	129	40.09429	9.034701	23	67.4
tertiary	175	29.77939	25.00599	.10328	93.82407
scieng	56	.6772641	.1330417	.3824959	.9228461
agov	181	.530796	.1271991	.00007	.9636363
wgov	181	.4747317	.1375929	.2328333	.9763495
buddhist	201	.0253351	.1171712	0	.8565155
chstian	200	.5997601	.3746771	.0002389	.981547
muslims	200	.218618	.3427556	0	.9912941

Table A.3 Correlation between different indexes for trust and innovation

	patre	pat	patnon	patrepc	patpc	patnonpc	rdexp	gerd	gerdpc	rdperson	researchers	technicians
patre	1.00											
pat	0.99	1.00										
patnon	0.78	0.85	1.00									
patrepc	0.91	0.91	0.78	1.00								
patpc	0.68	0.72	0.76	0.80	1.00							
patnonpc	0.12	0.17	0.40	0.23	0.76	1.00						
rdexp	0.47	0.49	0.48	0.60	0.62	0.37	1.00					
gerd	0.89	0.90	0.78	0.79	0.59	0.11	0.59	1.00				
gerdpc	0.36	0.37	0.36	0.46	0.56	0.41	0.93	0.48	1.00			
rdperson	0.25	0.26	0.26	0.36	0.52	0.46	0.88	0.35	0.92	1.00		
researchers	0.32	0.34	0.34	0.43	0.62	0.54	0.87	0.40	0.89	0.98	1.00	
technicians	0.02	0.02	0.03	0.12	0.18	0.16	0.74	0.16	0.84	0.87	0.76	1.00

Table A.4 summary of innovation and trust statistics by region.

VARIABLES	mean	Sd	max	min	N	mean	Sd	max	min	N	mean	Sd	max	min	N
	advanced country					developing country in central and eastern Europe					developing country in Asia				
pat(patent output)	36,697	99,778	414,022	48.13	33	1,009	1,234	4,777	101.1	13	17,745	48,136	176,372	6.667	13
patpc	747.5	858.8	3,241	19.74	33	206.1	382.4	1,461	17.79	13	65.76	82.31	269.7	2.249	13
rdexp(patent input)	1.89	0.995	4.365	0.399	33	0.574	0.3	1.062	0.0216	12	0.524	0.421	1.314	0.111	7
trust05	0.413	0.167	0.742	0.128	17	0.166	0.0797	0.22	0.0478	4	0.358	0.16	0.523	0.0883	7
trustfamp (strong-tie trust)	0.204	0.0261	0.256	0.179	14	0.248	0.0224	0.267	0.222	4	0.253	0.014	0.273	0.231	7
trustacqp	0.176	0.014	0.202	0.158	14	0.187	0.00861	0.197	0.178	4	0.194	0.00921	0.213	0.183	7
trustneip	0.159	0.0134	0.182	0.144	14	0.178	0.0101	0.193	0.169	4	0.2	0.0159	0.221	0.178	7

truststrp (weak-tie trust)	0.12	0.0049	0.125	0.11	14	0.122	0.00311	0.126	0.119	4	0.128	0.00795	0.141	0.12	7
trustforp	0.14	0.00432	0.149	0.132	14	0.142	0.00566	0.149	0.135	4	0.133	0.00594	0.14	0.126	7
trustrelp	0.201	0.0534	0.258	0.11	14	0.123	0.0348	0.165	0.0897	4	0.0919	0.04	0.142	0.0306	7
	developing country as commonwealth of independent states					developing country in Latin America and the Caribbean					developing country in Middle east and north Africa				
pat(patent output)	3,868	10,124	35,663	32.5	12	3,326	6,168	20,932	39.4	15	818.3	1,153	3,861	18.4	10
patpc	86.57	66.74	249.3	5	12	97.9	66.43	200.3	20.89	15	24.89	21.51	68.09	0.593	10
rdexp(patent input)	0.423	0.356	1.097	0.09	11	0.317	0.261	0.956	0.0416	15	0.393	0.347	1.027	0.0479	8
trust05	0.264	0.0939	0.408	0.179	5	0.137	0.0714	0.284	0.038	9	0.195	0.0843	0.313	0.106	5
trustfamp (strong-tie trust)	0.248	0.0224	0.267	0.222	4	0.241	0.0276	0.285	0.21	8	0.245	0.0109	0.258	0.235	4
trustacqp	0.187	0.00861	0.197	0.178	4	0.182	0.00919	0.198	0.171	8	0.196	0.00877	0.207	0.189	4
trustneip	0.178	0.0101	0.193	0.169	4	0.166	0.00931	0.174	0.15	8	0.201	0.0171	0.218	0.178	4
truststrp (weak-tie trust)	0.122	0.00311	0.126	0.119	4	0.114	0.00414	0.119	0.107	8	0.125	0.00135	0.126	0.123	4
trustforp	0.142	0.00566	0.149	0.135	4	0.136	0.00801	0.144	0.122	8	0.123	0.0095	0.13	0.109	4
trustrelp	0.123	0.0348	0.165	0.0897	4	0.162	0.0424	0.216	0.11	8	0.109	0.0331	0.143	0.0642	4
	developing country in sub-Saharan Africa														
pat(patent output)	761.2	2,307	7,326	1.333	10										
patpc	18.58	48.04	154.4	0.0924	10										
rdexp(patent input)	0.338	0.241	0.895	0.0272	12										
trust05	0.143	0.0603	0.244	0.0487	8										
trustfamp (strong-tie trust)	0.226	0.0168	0.247	0.201	8										
trustacqp	0.173	0.00939	0.187	0.162	8										
trustneip	0.174	0.0115	0.199	0.162	8										
truststrp (weak-tie trust)	0.121	0.00526	0.133	0.115	8										
trustforp	0.137	0.00681	0.146	0.126	8										
trustrelp	0.169	0.038	0.221	0.108	8										

Table B.1 Description of variables for macro-evidence

variable	source	description	details
Buddhist	ARDA	the percentage of people believe in Buddhism	
Christian	ARDA	the percentage of people believe in Christian	
euro	IMF	1 if the country is in Euro Area	average of 2003-2007
gdp	World Bank	GDP, PPP (constant 2005 international \$) unit: billion dollars	average of 2002-2008
gdppc	World Bank	GDP per capita, PPP (constant 2005 international \$) unit: thousands dollars	average of 2002-2008
gerd		gross domestic expenditure on R&D	average of 2003-2007
gerdpc		gross domestic expenditure per capita on R&D	average of 2003-2007
gini	website	The Gini Index	
muslims	ARDA	the percentage of people believe in Muslim	
network	WVS V25 V26	participation level of voluntary associations Calculation: sport + art	
pat	World Bank;	Patent applications	average of 2003-2007
patpc	Statistics on Patents World	Patent applications per capital	average of 2003-2007
patnon	Intellectual Property	Patent applications , nonresidents	average of 2003-2007
patnonpc	Indicators, 2011 edition;	Patent applications per capital , nonresidents	average of 2003-2007
patre	http://www.uis.unesco.org	Patent applications , residents	average of 2003-2007
patrepc		Patent applications per capital, residents	average of 2003-2007
pnpc		The percentage of patent applications by nonresidents. Calculation: $\frac{patnon}{pat}$	
politics	Transparency International	by their perceived levels of corruption, as determined by expert assessments and opinion surveys	
rdexp		Research and development expenditure (% of GDP)	average of 2003-2007

researchers		Researchers in R&D (per million people)	average of 2003-2007
religion		the standard deviation of the percentage of people believe in each religion	
scieng	WVS	the percentage of people who choose “scientific advances will help mankind” of question No.90 in the questionnaire of 2005-2008WAVE in each country.	
secondary	World Bank	School enrollment, secondary (% gross)	average of 2004-2006
technicians	World Bank	Technicians in R&D (per million people)	average of 2003-2007
tertiary	World Bank	School enrollment, tertiary (% gross)	average of 2004-2006
trust05	WVS	the percentage of people who choose “people can be trusted” of question No.23 in the questionnaire of 2005-2008WAVE in each country.	
trustacq	WVS V127	index 1 for trust among people who know each other [absolute index] calculation: $4* trustacqa+3* trustacqb+2* trustacqc+ 1*trustacqd$ (the larger the more mutual trust among people who know each other in a country)	trustacqa: percentage of people who choose 1 in a country trustacqb: percentage of people who choose 2 in a country
trustacqp	WVS V127	index 3 for trust among people who know each other [relative index] calculation: $\frac{trustacq}{trustfam+trustnei+trustacq+truststr+trustrel+trustfor}$ (the larger the more relative mutual trust among people who know each other in a country)	trustacqc: percentage of people who choose 3 in a country trustacqd: percentage of people who choose 4 in a country
trustfam	WVS V125	index 1 for trust among family members [absolute index] calculation: $4* trustfama+3* trustfamb+2* trustfamc+ 1*trustfamd$ (the larger the more mutual trust among family in a country)	trustfama: percentage of people who choose 1 in a country trustfamb: percentage of people who choose 2 in a country
trustfamp	WVS V125	index 3 for trust among family members [relative index] calculation: $\frac{trustfam}{trustfam+trustnei+trustacq+truststr+trustrel+trustfor}$ (the larger the more relative mutual trust among family in a country)	trustfamc: percentage of people who choose 3 in a country trustfamd: percentage of people who choose 4 in a country

trustfor	WVS V130	index 1 for trust toward foreigners [absolute index] calculation: 4* trustfora+3* trustforb+2* trustforc+ 1*trustford (the larger the more trust toward foreigners in a country)	trustfora: percentage of people who choose 1 in a country trustforb: percentage of people who choose 2 in a country trustforc: percentage of people who choose 3 in a country trustford: percentage of people who choose 4 in a country
trustforp	WVS V130	index 3 for trust toward foreigners [relative index] calculation: $\frac{trustfor}{trustfam+trustnei+trustacq+truststr+trustrel+trustfor}$ (the larger the more trust toward foreigners in a country)	
trustnei	WVS V126	index 1 for trust among neighbors [absolute index] calculation: 4* trustneia+3* trustneib+2* trustneic+ 1*trustneid (the larger the more mutual trust among neighbors in a country)	trustneia: percentage of people who choose 1 in a country trustneib: percentage of people who choose 2 in a country trustneic: percentage of people who choose 3 in a country trustneid: percentage of people who choose 4 in a country
trustneip	WVS V126	index 3 for trust among neighbors members [relative index] calculation: $\frac{trustnei}{trustfam+trustnei+trustacq+truststr+trustrel+trustfor}$ (the larger the more relative mutual trust among neighbors in a country)	
trustrel	WVS V129	index 1 for trust toward people of other religions [absolute index] calculation: 4* trustrela+3* trustrelb+2* trustrelc+ 1*trustreld (the larger the more trust toward people of other religions in a country)	trustrela: percentage of people who choose 1 in a country trustrelb: percentage of people who choose 2 in a country trustrelc: percentage of people who choose 3 in a country trustreld: percentage of people who choose 4 in a country
trustrelp	WVS V129	index 3 for trust people of other religions [relative index] calculation: $\frac{trustrel}{trustfam+trustnei+trustacq+truststr+trustrel+trustfor}$ (the larger the more trust toward people of other religions in a country)	
truststr	WVS V128	index 1 for trust among strangers [absolute index] calculation: 4* truststra+3* truststrb+2* truststrc+ 1*truststrd	truststra: percentage of people who choose 1 in a country

		(the larger the more mutual trust among strangers in a country)	
truststrp	WVS V128	index 3 for trust among strangers [relative index] calculation: $\frac{truststr}{trustfam+trustnei+trustacq+truststr+trustrel+trustfor}$ (the larger the more relative mutual trust among strangers in a country)	truststrb: percentage of people who choose 2 in a country truststrc: percentage of people who choose 3 in a country truststrd: percentage of people who choose 4 in a country

Table B.2 Description of variables for micro-evidence

science_general	v90	In the long run, do you think the scientific advances we are making will help or harm mankind?	1 Will harm 2 Some of each 3 Will help
book	v227	People use different sources to learn what is going on in their country and the world. For books, please indicate whether you used it last week or did not use it last week to obtain information.	1 Used it last week 2 Did not use it last week
democracy	v163	How democratically is this country being governed today?	using a scale from 1 to 10, where 1 means that it is “not at all democratic” and 10 means that it is “completely democratic” .
fight_war	v75	Of course, we all hope that there will not be another war, but if it were to come to that, would you be willing to fight for your country ?	1 yes 2 no
life_thinking	v184	How often, if at all, do you think about the meaning and purpose of life?	1 often 2 sometimes 3 rarely 4 never
friends	v5	For friends, indicate how important it is in	1 Very important

		your life.	2 Rather important 3 Not very important 4 Not at all important
	V125	Could you tell me for each whether you trust your family completely, somewhat, not very much or not at all?	1 not at all 2 not very much 3 somewhat 4 completely
		Could you tell me for each whether you trust your neighborhood completely, somewhat, not very much or not at all?	1 not at all 2 not very much 3 somewhat 4 completely
		Could you tell me for each whether you trust people you know personally completely, somewhat, not very much or not at all?	1 not at all 2 not very much 3 somewhat 4 completely
		Could you tell me for each whether you trust people you meet for the first time completely, somewhat, not very much or not at all?	1 not at all 2 not very much 3 somewhat 4 completely
		Could you tell me for each whether you trust people of another religion completely, somewhat, not very much or not at all?	1 not at all 2 not very much 3 somewhat 4 completely
		Could you tell me for each whether you trust people of another nationality completely, somewhat, not very much or not at all?	1 not at all 2 not very much 3 somewhat 4 completely
Now I will briefly describe some people. Using this card, would you please indicate for each description whether that person is very much like			

you, like you, somewhat like you, not like you, or not at all like you?			
new_ideas	V80	It is important to this person to think up new ideas and be creative; to do things one's own way.	1 not at all like you 2 not like you 3 somewhat like you 4 like you 5 very much like you
adventure	V86	Adventure and taking risks are important to this person; to have an exciting life.	1 not at all like you 2 not like you 3 somewhat like you 4 like you 5 very much like you
Tradition	V89	Tradition is important to this person; to follow the customs handed down by one's religion or family	6 not at all like you 5 not like you 4 a little like me 3 somewhat like you 2 like you 1 very much like you
technology	v77	I'm going to read out a list of various changes in our way of life that might take place in the near future. Please tell me for "More emphasis on the development of technology", if it were to happen, whether you think it would be a good thing, a bad thing, or don't you mind?	1 bad thing; 2 don't mind; 3 good thing
expectation			