Does Trust Create a Culture of Innovation?

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Abstract

We investigate the impact of social trust on technological innovation. In a large sample of industry-country-year observations based on both public and private firms from 42 countries over the 1991-2008 period, our analysis shows that a country's social trust is positively related to its innovation activities. Multiple identification strategies point to a causal interpretation of the relation. We further find support for three economic channels through which trust enhances innovation output, namely, the collaboration channel, the tolerance channel, and the funding channel. Finally, we show that trust promotes economic growth and productivity gains, mainly in industries with greater innovation potential.

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"The network structure of the biotechnology industry in the United States and the regional-based industrial system in Silicon Valley, California are used to show how social capital affects innovation in science and technology…The central arguments regarding social capital and its relationship to innovation transcend national boundaries, and many of the policy recommendations are important for western European, some East Asian and several other industrial states."

– Jane E Fountain, 1998,
"Social capital: Its relationship to innovation in science and technology"

1. Introduction

Firms do not operate in a vacuum and their growth is influenced by a society's norms and networks – social capital. The growth effect of social capital has been observed at both the country and firm levels.[1] For example, the well-cited work by Knack and Keefer (1997) documents a strong link between a country's level of trust and its economic growth. However, the underlying economic mechanisms through which social capital affects growth are less well understood (Guiso, Sapienza, and Zingales, 2004). In this paper we propose one such mechanism: technological innovation.[2] Specifically, we focus on a key dimension of social capital, i.e., social trust, and investigate its impact on corporate innovation.

Trust is defined as the subjective belief that an individual assigns to the event that a potential counterparty takes an action that is at least not harmful to that individual (Gambetta, 1988).[3] Our first hypothesis postulates that a higher level of trust in a society enhances innovation. This hypothesis is based on three reasons. First, innovation is a costly and risky process that often requires the efforts of more than one single individual or firm. Therefore, the success of innovation hinges critically on the effectiveness of collaboration within a firm or across firms (sometimes in the form of strategic alliances or joint ventures, see, e.g., Fountain, 1998; Dovey, 2009). A higher level of trust among individuals within a firm or across firms can encourage inventors to share ideas and knowledge with each other, because they are less worried about the possibility that their intellectual inputs are expropriated by their peers. The free exchange of intellectual assets increases

[1] See Knack and Keefer (1997) and Zak and Knack (2001) for the evidence on economic growth, and Guiso, Sapienza, and Zingales (2015) and Lins, Servaes, and Tamayo (2017) for the evidence on firm value.
[2] According to Chang et al. (2016) and Kogan et al. (2016), innovation is a key contributor of economic growth in the 20th and 21st centuries.
[3] As with other aspects of culture, trust is deeply rooted in individuals' ethnic, religious, familial, and social backgrounds and is a relatively persistent behavioral trait (Putnam, 1993; Fukuyama, 1995; Guiso, Sapienza, and Zingales, 2006, 2010). It has also been shown that trust acts as a substitute for formal institutions at the country level (Guiso, Sapienza, and Zingales, 2004; Carlin, Dorobantu, and Viswanathan, 2009; and Aghion et al., 2010).

the likelihood and efficiency of collaboration and results in more innovation. We label this view *the collaboration channel*.

Second, the theoretical model of Manso (2011) and the experimental study of Ederer and Manso (2013) show that optimal incentive contracts that motivate innovation should exhibit substantial tolerance for early failure and reward long-term success. A high level of trust on the part of investors can provide firms with more insurance against early failure, because investors in high-trust environments are less likely to attribute bad outcomes to managerial opportunism and penalize managers for unsuccessful innovation efforts. Consistent with this notion, Hilary and Huang (2015) show that firms located in U.S. counties with higher social trust utilize lower-power compensation schemes and are less likely to fire their CEOs. The same argument applies to the employer-employee relationship as well. According to a survey conducted among 16,000 employees in 17 countries by the advisory firm, LRN, high-trust companies are deemed 11 times more innovative than their peers by the respondents. LRN summarizes its survey results as "*when innovation fails, it's because companies don't put enough faith in employees to let them take risks*."[4] Taken together, we posit that a more trusting environment engenders greater tolerance for short-term failure and encourages managers and employees to take more risk and target firms' long-term growth, which can potentially boost the innovation output. We term this view *the tolerance channel*.

Third, innovative firms typically have an expanded set of investment opportunities. As a result, they are likely to exhaust internal capital and rely heavily on external finance (Brown, Fazzari, and Petersen, 2009; Brown, Martinsson, and Petersen, 2012). When financial markets cannot observe the full spectrum of managerial actions, managers tend to steer their investment choices toward safer and shorter-term ones to mitigate information asymmetry and funding difficulties. A higher level of trust reduces investors' concern about managerial moral hazard and increases the supply of debt and equity capital (Guiso, Sapienza, and Zingales, 2008a; Bottazzi, Da Rin, and Hellmann, 2016; Giannetti and Wang, 2016; Levine, Lin, and Xie, 2017; Dudley et al., 2017). Thus, trust can promote corporate innovation by increasing firms' access to external capital and allowing them to pursue riskier and longer-term investments. We call this view *the funding channel*.

By contrast, our second hypothesis argues that a higher level of trust in a society may impede corporate innovation. A key ingredient for innovation is a healthy dose of skepticism among

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[4] Why trust motivates employees more than pay – Jennifer Reingold (*Fortune*, April 27, 2016).

collaborating parties over the process of decision making. For example, Carl Sagan, an American astronomer, has a famous quote: "*It is the tension between creativity and skepticism that have produced the stunning and unexpected findings of science.*" Peer challenging and monitoring can lead to refined ideas, improved processes, and elevated efforts, thereby increasing the odds of successful and impactful innovation. However, when collaborating parties are too trusting of each other, they could develop affinity and reduce peer skepticism. Under weak skepticism, participants in the process of innovation devote insufficient efforts to monitoring and challenging each other, and hence innovation activities may fail to achieve desired outcomes. Moreover, when investors (employers) are too trusting of managers (employees), managers (employees) may have less incentive to expend the necessary time, energy, and resources on developing an impactful research and development (R&D) program.[5]

To test the two competing hypotheses, we construct a large international sample of 9,944 industry-year observations consisting of both publicly traded and privately held firms across 42 countries over the 1991-2008 period. Following previous literature (La Porta et al., 1997; Guiso, Sapienza, and Zingales, 2008a, b; Ahern, Daminelli, and Fracassi, 2015; Pevzner, Xie, and Xin, 2015), we measure social trust as the average response in each country and year to the following question in the World Values Surveys (WVS): "*Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people*?" To measure innovation output, we collect global patent information from the Orbis patent database.[6] This dataset allows us to observe both the number of patents a country generates and the number of citations these patents receive post-registration. Accordingly, we are able to explore the effect of social trust on both the quantity and quality of innovation output.

Our baseline results show that the level of trust in a country is positively related to its innovation output. This relation is both economically and statistically significant. For example, a one standard deviation increase in a country's social trust is associated with a 64% increase in the number of

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[5] Butler, Giuliano, and Guiso (2016) find a hump-shaped relation between trust and economic performance at the individual level. Their interpretation is that highly trusting individuals tend to assume high social risk and to be cheated more often, ultimately performing less well than those with a belief close to the mean trustworthiness of the population.

[6] Compared to the National Bureau of Economic Research (NBER) Patent and Citation database that is compiled based on the United States Patent and Trademark Office (USPTO), the Orbis database has a much broader coverage. In addition to the patents filed in the U.S. administrated by the USPTO, the Orbis database covers patents filed in 93 non-U.S. patent offices (including national patent offices and regional and international organizations, such as the European Patent Office (EPO) and the African Intellectual Property Organization). Therefore, we are able to directly measure a country's innovation level using the Orbis database, instead of inferring it indirectly through the NBER database.

patents and a 56% increase in the number of patent citations, both relative to the mean. This is consistent with our first hypothesis that social trust *enhances* innovation. Our findings continue to hold in an extensive set of robustness checks using alternative model specifications and innovation measures.

Endogeneity is an important consideration of our empirical tests because i) potential omitted variables can be correlated with both social trust and innovation, and ii) technology development may affect the evolution of trust. We employ a multipronged approach to address the endogeneity concerns. First, we augment our baseline regressions with a battery of additional control variables that can potentially relate to both trust and innovation. Second, we follow Algan and Cahuc (2010) and construct an inherited trust measure based on the trust beliefs of descendants of immigrants to the U.S. We then examine the effect of inherited trust on innovation. Third, we employ a two-stage least squares (2SLS) regression approach where we use the rate of intentional homicide in a country as an instrument for trust. Finally, to remove any confounding effects of cross-country differences in legal institutions and economic development, we conduct a single-country analysis based on publicly traded firms in the U.S., where we explore the differences in social trust across states. Our findings remain intact through all these tests.

We further provide supporting evidence on three underlying economic channels through which social trust promotes innovation, namely, *the collaboration channel, the tolerance channel,* and *the funding channel*. First, we find that the effect of trust on innovation is more pronounced in countries with weaker contract enforceability and poorer intellectual property protection. This evidence suggests that social trust, as an informal contracting mechanism, enhances innovators' collaboration and thus spurs innovation. Second, social trust plays a more important role in spurring innovation in countries with weaker employee protection and creditor-friendly bankruptcy regime. This finding supports the tolerance mechanism that social trust promotes firms' innovation by alleviating innovators' concerns when the costs of innovation failures are high. Third, following Rajan and Zingales (1998) and Brown, Martinsson, and Petersen (2012), we use a country's financial disclosure as well as auditing and accounting standards as proxies for financial market development. Consistent with the funding mechanism, the effect of social trust on innovation is stronger for countries with poorer financial market development.

Finally, we close the loop by investigating whether social trust indeed affects economic growth through innovation. Given that an economy can achieve growth through either productivity improvement or capital accumulation, we examine the effect of trust on both the growth of industry value added (total economic growth) and the growth of industry total factor productivity (TFP), respectively, for each country and industry. Our results show that social trust is significantly and positively related to the growth of both industry value added and industry TFP. More importantly, this relation is concentrated in more innovative industries, suggesting that innovation is an important channel through which social trust promotes economic growth.

Our study lies at the intersection of two major strands of literature, one on culture in general and trust in particular and the other on innovation and economic growth. Our study is the first to investigate the effect of social trust on corporate innovation in a multi-country setting. While previous research has identified a number of country-level factors that explain the cross-country differences in innovation output and efficiency, we provide the first evidence that a country's informal institutions, in particular social trust, affect its innovation process. To the extent that innovation activities are key drivers of economic growth, we further contribute to the trust literature by providing evidence on an important channel through which trust contributes to value creation in a country.

The rest of the paper is organized as follows. Section 2 describes sample construction and reports summary statistics. Section 3 presents our main empirical findings and a variety robustness checks. Section 4 explores plausible underlying economic channels through which social trust affects innovation. Section 5 discusses the relation between trust, innovation, and economic growth. Section 6 concludes.

2. Data, variables, and sample

2.1. Data and sample

We construct our innovation output variables based on Bureau van Dijk's Orbis patent database, which records global patents filed to 94 regional, national, and international patent offices. The source of the database is the Worldwide Patent Statistical Database (PATSTAT) maintained by the European Patent Office (EPO). The Orbis patent database links 36 million ultimately granted patents to both public and private firms in the Orbis database from 1850 to 2012.

The Orbis patent database has a much wider coverage than the National Bureau of Economic Research (NBER) Patent and Citation database because the NBER database only records patent filings to the U.S. Patent and Trademark Office (USPTO). Previous international studies on innovation, e.g., Acharya and Subramanian (2009), Hsu, Tian, and Xu (2014), and Acharya, Baghai, and Subramanian (2014), mainly rely on the NBER database to construct innovation output measures. However, as acknowledged in these studies, doing so may lead to a sampling bias because many countries, especially emerging economies, do not file patent applications to the USPTO and this bias varies across countries and over time (Chang et al., 2016). The Orbis database mitigates this bias because it covers patents filed by firms to both domestic and overseas patent offices.

We collect data on social trust from the World Values Surveys (WVS), which are available since 1987. We extract industry-level data at the two-digit International Standard Industrial Classification (ISIC) from the United Nations Industrial Development Organization Industrial Statistics (UNIDO) database and country-level data from the World Development Indicator (WDI) database compiled by the World Bank.

Our initial sample consists of all industries in countries that are jointly covered by the Orbis, WVS, UNIDO, and WDI databases. We match patent data with industry level data using the crosswalk from the International Patent Classification (IPC) to the ISIC provided by Lybbert and Zolas (2014).[7] We further filter the sample according to the following criteria. First, due to the limited coverage of the UNIDO database, our sample only includes manufacturing industries with two-digit ISIC codes from 15-37.[8] Second, similar to previous studies, e.g., Hirshleifer, Low, and Teoh (2012), we exclude countries that have no patent at all during the entire sample period. Third, in accordance with prior studies (e.g., Acharya and Subramanian, 2009, Hsu, Tian, and Xu, 2014, and Moshirian et al., 2015), we remove the U.S. from our sample but use U.S. industries to control for industry-level patenting activities or innovation opportunities over time.

[7] We are grateful to Travis J. Lybbert and Nikolas J. Zolas for sharing their data on the "Algorithmic Links with Probabilities (ALP) Industry Level-to-Patent/Technology Level Crosswalk". Specifically, the ALP concordance is constructed using probability weighting, meaning that the weights provided for each industry level-patent level matching is between 0 and 1. All weights by industry or technology class should also sum up to one. See Lybbert and Zolas (2014) for a detailed description.

[8] Manufacturing industries are the most innovative industries according to the 2008 Business R&D and Innovation Survey by the National Science Foundation (available at http://www.nsf.gov/statistics/infbrief/nsf11300). Furthermore, patenting innovation is important to manufacturing industries because these industries heavily rely on patents as a means of appropriating new technologies (Cohen, 1995).

Our final sample consists of 23 industries in 42 countries from 1991-2008.[9] Due to missing values for some control variables, our main sample is an unbalanced panel with 9,944 industry-country-year observations.

2.2. Measuring innovation output

Following previous studies (e.g., Aghion, Van Reenen, and Zingales, 2013; Seru, 2014), we measure innovation output using two proxies. The first proxy is the number of successful patent applications by firms in each ISIC industry for each country in each year (*Patent*).[10] Although innovation output is not directly observable, patents offer a good indicator of the level of innovation output since patenting is one of the most important means for firms to protect their intellectual property.[11] However, a firm may protect its invention in multiple jurisdictions by filing applications for patent protection to patent offices in different countries, all of which are recorded by the Orbis patent database. We deal with this issue by counting one patent per innovation. For example, if a Chinese firm patents an innovation in China, the U.S., and Japan, we would count this as one patent by the Chinese firm. Another issue is that a patent application on the same invention can be filed to different patent offices on different dates. To determine the actual year of innovations for these cases, we choose the earliest application date for an innovation.

Patent counts only reflect the quantity rather than the quality of a firm's inventions. As more significant patents are expected to be cited more frequently by other patents, forward citations of patents reflect the quality of a firm's innovation and better capture the technological or economic significance of the firm' inventions (Hall, Jaffe, and Trajtenberg, 2005). Consequently, we use the

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[9] Our sample period begins in 1991 because the WVS data cover few countries prior to 1990 and we lag the trust measure by one period in the regression analysis. Our sample ends in 2008 because the UNIDO data are incomplete after 2008. As a robustness check, we include data prior to 1991 and find the results are largely the same. In addition, as noted by Hall, Jaffe, and Trajtenberg (2001), there is, on average, a two to three year lag between the patent application date and the patent grant date. However, because our sample period ends in 2008, this truncation issue has a minimal impact on our study.

[10] We use the patent application date rather than the grant date in the analysis because applicate date is closer to the actual time of inventions compared with the grant date according to Hall, Jaffe, and Trajtenberg (2001).

[11] Another measure of firms' innovation activities is R&D expenditure, which mainly captures the quantitative input to the innovation process (Aghion, Van Reenen, and Zingales, 2013). However, data availability is better for patents than for R&D expenditure, especially for non-U.S. firms (e.g., Koh and Reeb, 2015; Koh et al, 2016). Koh and Reeb (2015) find that many innovative U.S. firms strategically avoid reporting R&D expenditures in their financial statements. Considering the consistent reporting standards on R&D and strong enforcement in the U.S., non-U.S. firms are even more likely to have such reporting discretion (Koh et al, 2016). Therefore, results relying on reported R&D expenditures as the dependent variable are confounded by the concern that firms strategically disclose R&D as permitted by a country's accounting standards.

number of citations made to firms' patents in each ISIC industry for each country in each year as the second proxy for innovation output. Because patents in certain technology class and year tend to receive more citations (Hall, Jaffe, Trajtenberg, 2005), we adjust raw citations using the time-technology class fixed effects recommended by prior literature, e.g., Atanassov (2013), Hirshleifer, Low, and Teoh (2012), and Chang et al. (2015). Specifically, citation counts adjusted for time-technology class fixed effects are defined as raw citation counts scaled by the average citations in the same year and in the same technology class (*Citation*).

Despite the wide acceptance and usage of the above measures in previous literature (e.g., Acharya and Subramanian, 2009; Hsu, Tian, and Xu, 2014; Moshirian et al., 2015) to capture the technological advances and the output of innovation, these measures are subject to certain limitations. For example, not all innovations meet the patenting criteria and firms may keep their technology secret for strategic purposes.

2.3. Measuring social trust

Following previous literature, e.g., La Porta et al. (1997), Guiso, Sapienza, and Zingales (2008a, b), and Pevzner, Xie, and Xin (2015), we define social trust as the average response to the question "*Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people*?" in each country year (*Trust*). In particular, we code the response to this question as one if a survey participant reports that most people can be trusted and zero otherwise, and then calculate the mean of the response in each country year as our measure of social trust.

2.4. Control variables

We control for several industry and country characteristics that may potentially be correlated with social trust and innovation. The first variable we consider is a country's macroeconomic conditions since social trust is positively associated with economic development (La Porta et al., 1997; Knack and Keefer, 1997). In addition, wealthier countries may innovate more (Acharya and Subramanian, 2009; Acharya, Baghai, and Subramanian, 2013). We hence use the logarithm of GDP per capita in real terms at constant national prices in 2005 U.S. dollars (*Ln*(*GDP*)) as a proxy for a country's macroeconomic conditions.

Second, free trade may encourage firms to patent their innovations and to protect domestic sales and secure foreign sales (Acharya and Subramanian, 2009; Hsu, Tian, and Xu, 2014; Chang et al., 2016). Moreover, Guiso, Sapienza, and Zingales (2009) show that bilateral trust between countries promotes international trade. We thus include the ratio of import plus export over GDP (*Trade*) to capture the trade openness of a country.

Third, we control for a country's financial development. Hsu, Tian, and Xu (2014) document financial development as an important determinant of a country's patenting activities. Guiso, Sapienza, and Zingales (2004, 2008b) find that social trust promotes financial development. We hence include in the regressions the financial development in a country, which is defined as the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP (*FinDev*).[12]

Fourth, we control for a country's formal institutions as prior literature documents that formal institutions and informal institutions such as social trust interactively affect economic activities (Knack and Keefer, 1997; Williamson and Mathers, 2011). Following Williamson and Mathers (2011), we use the index of economic freedom compiled by the Fraser Institute as a proxy for formal institutions (*FormalInst*). The index of economic freedom has a comprehensive coverage of a country's formal institutions including the effectiveness of a country's legal system, the protection of private property rights, and the openness of labor, financial, and product markets.

Fifth, to account for heterogeneities in size and development across different industries in a country, we add as an additional control the logarithm of value added in a two-digit ISIC industry in a country in each year (*Ln*(*VA*)), where industry value added is computed in real terms at constant national prices in 2005 U.S. dollars.

Finally, as pointed out by Hall, Jaffe, and Trajtenberg (2001), the patenting propensity in different industries varies over time.[13] We thus control for the time trend of industry-level patenting activities. Specifically, we follow Acharya and Subramanian (2009) and Moshirian et al. (2015) and include the median number of patents applied by U.S. firms for each ISIC industry in each year as a proxy for the industry level patenting intensity (*Intensity*). We choose the U.S. as the benchmark to adjust for the time trend because the U.S. has the most comprehensive patent

[12] Our results do not change qualitatively if we include equity market development and credit market development separately instead of financial market development in the regressions.

[13] See Hall, Jaffe, and Trajtenberg (2001) and Cohen, Nelson, and Walsh (2000) for a detailed discussion on this pattern.

data across different technology classes over time, the most developed financial market to fund the technological growth opportunities, and the most favorable research environment in the world. Therefore, patenting activities by U.S. firms in different industries can serve as reasonable indicators of each industry's innovation potential.

2.5. Variables for analysis of economic growth

In the analysis of the effect of social trust on economic growth, our dependent variables are the annual growth of industry value added and the annual growth of industry total factor productivity (TFP). Following previous literature, e.g., Fogel, Morck, and Yeung (2008) and Chang et al. (2016), we control for initial conditions of factor inputs, such as industry value added (*VA*), industry capital stock (*K*), and the total number of employees in each industry (*Emp*), in the regressions.[14]

According to the standard Cobb-Douglas production function, the annual growth of industry value added is defined as the annual change of the logarithm of industry value added ($\Delta Ln(VA)$), while the annual growth of industry TFP is defined as the annual change of the logarithm of industry TFP ($\Delta Ln(TFP)$). Because industry TFP data are not available in the UNIDO database, we need to construct $\Delta Ln(TFP)$ using the production function in Eq. (1) (country, industry and time subscripts are omitted for brevity):

$$Ln(VA) = Ln(TFP) + \alpha Ln(K) + (1-\alpha)\, Ln(Emp) \qquad (1),$$

where α and 1- α are capital and labor shares in the output. Assuming standard values of 0.3 and 0.7 for capital share (α) and labor shares (1-α) in the production function (Caselli, 2005), we compute annual industry TFP growth according to Eq. (2) below:

$$\Delta Ln(TFP) = \Delta Ln(VA) - 0.3\, \Delta Ln(K) - 0.7\, \Delta Ln(Emp) \qquad (2)$$

However, data on *K* in Eq. (1) and (2) are not immediately available from the UNIDO database either, though data on *VA* and *Emp* can be directly obtained. We thus follow Caselli (2005) and construct a series of capital stocks for each industry in each country using the perpetual inventory method by assuming that the economy under consideration is in its steady state. Specifically, according to Harberger (1978), the initial capital stock K_0 is defined in Eq. (3) as follows:

$$K_0 = \frac{I_0}{g+\delta} \qquad (3),$$

[14] Variables in dollar values are computed in real terms at constant national prices in 2005 U.S. dollars.

where I_0 represents gross fixed capital formation for a given industry for the first year when data are available, g corresponds to the average annual growth rate of industry value added in that industry for the period 1963-2008,[15] and δ constitutes the depreciation rate of physical capital that is set equal to 6%. After determining the initial capital stock K_0, we then compute capital stocks for the subsequent years according to Eq. (4) below:

$$K_t = (1 - \delta) \times K_{t-1} + I_{t-1} \quad (4)$$

Using the above approach, we are able to compute the industry value added growth, industry TFP growth as well as initial conditions of factor inputs, i.e., the logarithm of industry value added (*Ln*(*VA*)), the logarithm of industry capital stock (*Ln*(*K*)), and the logarithm of industry labor force (*Ln*(*Emp*)).

2.6. Sample distribution

Panel A of Table 1 reports the sample distribution of the aggregate patent and citation counts and the average social trust score by country. Column (1) shows the number of observations for each country. Columns (2) and (3) report the aggregate innovation measures. Specifically, in column (2), Japan has 220,054 patents, the largest number among all countries, followed by Korea, Germany, and China, while Indonesia has only 5 patents, which is the lowest among all sample countries, followed by Jordan, Morocco, and Philippines. However, column (3) indicates that the citations of patents by Japanese and German firms are much larger than those by Korean and Chinese firms, which suggest a noticeably larger impact of innovations by Japanese and German firms. The observation that patents in developed countries are technologically more significant than those in emerging economies highlights the importance of using patent citations as a measure of innovation output.

Social trust also displays large cross-country variations as shown in column (4). In particular, Sweden and Norway have the highest scores of 0.656 and 0.653 followed by China and Finland, while Brazil and Philippines have the lowest scores of 0.048 and 0.071 followed by Malaysia and Turkey.[16]

[15] 1963 is the first year when data on industry value added are available in the UNIDO database. Calculating the average growth from the first year is recommended by previous literature, e.g., Nehru and Dhareshwar (19993) and Caselli (2005).

[16] To safeguard against the possibility that a particular country's social trust measure is contaminated by large errors, we perform a robustness check to ensure that our results are not sensitive to excluding any one country from our analysis.

[Insert Table 1 about here]

Panel B of Table 1 presents the sample distribution of average values of industry innovation output, industry value added (in millions of U.S. dollars), and industry innovation intensity across 23 industries. Columns (2) and (3) indicate that patent counts and patent citations vary significantly across different industries. Specifically, industries of machinery and equipment (ISIC 29), office, accounting, and computing machinery (ISIC 30), and chemicals and chemical products (ISIC 24) have the highest number of patent counts (199, 188, and 180) and citation counts (418, 440, and 430). In contrast, recycling (ISIC 37), leather (ISIC 19), and tobacco (ISIC 16) industries have the lowest number of patent counts (1, 5, and 7) and patent citations (1, 8, and 10).

Moreover, as observed in column (4), industries that contribute the highest value added are the food and beverage industry (ISIC 15) and chemical industry (ISIC 24) with an average value of \$74.14 billion and \$74.08 billion, respectively, while industries that contribute the lowest value added are the recycling industry (ISIC 37) and leather industry (ISIC 19) with an average value of \$0.31 billion and \$1.23 billion, respectively. Finally, column (5) shows that the innovation intensity measure constructed using the U.S. data displays a generally similar pattern as the average number of patents and patent citations in our sample countries.

2.7. Summary statistics

We report the summary statistics of variables in Panel A of Table 2. The means of *Patent* and *Citation* are 87 and 179, respectively. The standard deviations of these two variables are quite large, which are 227 and 580, respectively. Given that innovation measures are highly skewed, we use the logarithm of one plus each innovation output proxy, i.e., *Ln*(1+*Patent*) and *Ln*(1+*Citation*), in the regression analyses. For country level variables, the mean of *Trust* is 0.3, and the means of *Ln*(*GDP*), *Trade*, *FinDev*, and *FormalInst* are 8.76, 0.58, 1.47, and 6.89 respectively. With respect to industry level variables, we find that the means of *Ln*(*VA*) and *Intensity* are 7.22 and 0.1, respectively. For industry-level economic output growth measures, the means of annual growth of industry value added (*ΔLn*(*VA*)) and annual growth of industry TFP (*ΔLn*(*TFP*)) are -1.6% and -

2.4%, respectively.[17] For initial conditions of factor inputs, the means of *Ln*(*VA*), *Ln*(*K*) and *Ln*(*Emp*) are 7.29, 9.29, and 10.49, respectively.

[Insert Table 2 about here]

In Panel B of Table 2, we show the Pearson correlation matrix of the main variables in Panels A.1 and A.2. The correlation between *Ln*(1+*Patent*) and *Ln*(1+*Citation*) is fairly high at around 0.9. More importantly, the correlation between the two measures of innovation output and trust are 0.46 and 0.43, respectively, both significant at the 1% level. In line with previous literature, we find that social trust has a positive and significant correlation with *Ln*(*GDP*), *Trade*, *FinDev*, and *Ln*(*VA*) at the 1% level. In addition, consistent with Zak and Knack (2001), we find that social trust is positively and significantly correlated with formal institutions, suggesting that countries with higher social trust also have better formal institutions. We turn to multivariate tests in the next section.

3. Empirical findings

3.1. Baseline results

We empirically examine the effect of social trust on innovation outcomes by estimating the baseline regression model in Eq. (5) below.

$$Innovation_{i,j,t} = \alpha + \beta Trust_{j,t-1} + \gamma' X_{i,j,t-1} + Industry_i + Year_{t-1} + \varepsilon_{i,j,t-1} \quad (5),$$

where *Innovation* represents the two innovation output measures, i.e., *Ln*(1+*Patent*) and *Ln*(1+*Citation*), in industry *i*, country *j* and year *t*. Our main explanatory variable is *Trust* in country *j* measured in year *t*-1. *X* represents control variables in industry *i*, country *j*, and year *t*-1 described in Section 2.4. To account for time-invariant industry characteristics and business cycles, we also include in the regressions industry and year fixed effects.[18] Our key interest is in *β*, which captures the effect of social trust on innovation. The standard errors of the estimated coefficients allow for clustering of observations by country.

[Insert Table 3 about here]

[17] Similar to previous studies, e.g., Arizala, Cavallo, and Galindo (2009) and Samaniego and Sun (2015), we also find some unusually large values for *ΔLn*(*VA*) and *ΔLn*(*TFP*) in our sample, which might be due to data errors in the UNIDO database.

[18] Social trust in a country evolves slowly and thus the trust measure is persistent although there are some slightly small time-series variations. As a robustness check, we further include country fixed effects in the regressions and find similar results. Please see Section 3.2.1 for results from regressions with additional controls and country fixed effects.

The baseline results are reported in Table 3. In columns (1) and (2), we report results of regressions with year fixed effects only. In columns (3) and (4), we report results of regressions with both industry and year fixed effects. Empirical findings in Table 3 indicate that social trust has a positive and significant relation with a country's industry-level innovation output measured by both the number of patents and the number of citations of patents with *t*-statistics from 3.2 to 3.8. The positive relation between social trust and corporate innovation is significant not only statistically but also economically. Specifically, a one standard deviation increase in social trust (0.151) is associated with a 64% increase in the number of patents and a 56% increase in the number of patent citations, relative to their respective means.[19]

The coefficients of control variables are generally consistent with previous literature. For example, we find that *Ln*(*GDP*) has a positive and significant coefficient in all regressions, confirming that wealthy countries tend to be more innovative. *FinDev* also has a positive and significant coefficient, which supports the positive role of financial market in promoting innovation (Acharya and Subramanian, 2009; Hsu, Tian, and Xu, 2014). In addition, we find that *Ln*(*VA*) is positively associated with innovation at the 1% level for all regressions, confirming that larger industries tend to have more patents. Finally, without controlling for industry fixed effects, *Intensity* has a positive and significant coefficient, indicating that the patenting activities of U.S. firms in a given industry are positively correlated with those of non-U.S. firms in the same industry.

Collectively, the empirical evidence from the baseline regressions in Table 3 is consistent with our conjecture that social trust enhances innovation output in a country.

3.2. Identification

In this section, we employ multiple strategies to bolster our confidence in a causal interpretation of the positive relation between trust and innovation. The major challenge that we face is the omitted variable problem, i.e., some variables that are either unobservable or inadequately controlled for in our model are correlated with both trust and innovation. This is an especially pertinent concern for our study because there are many variables related to a country's political, legal, economic, and social environments that can be omitted variables. Another potential

[19] Because $d[Ln(1+y)]/dx = 1/(1+y)\times dy/dx$, $dy = d[Ln(1+y)]/dx\times(1+y)\, dx$. For example, when quantifying the effect of the change in *Trust* (dx) on the change in *Patent* (dy), we increase *Trust* by one standard deviation (0.151), so dx = 0.151. The change in *Patent* (dy) from its mean value (86.977) is then equal to 4.203×(1+86.977)×0.151 = 55.835, which amounts to 64% of the mean value of *Patent*.

endogeneity concern is the reverse causality problem, i.e., innovations affect trust among individuals in a society.[20] We adopt four approaches below to address the above endogeneity issues.

3.2.1. Controlling for omitted variables

As our first approach, we augment the baseline regressions with additional explanatory variables that may correlate with both trust and innovation according to prior literature. Specifically, we add controls for a country's political corruption, human capital, dominant religion, and other cultural dimensions. In some specifications, we also control for country fixed effects as a way to remove the influence of any time-invariant country specific characteristics.

We use the corruption index (*Corruption*) compiled by the International Country Risk Guide (ICRG) to capture a country's degree of corruption. A higher index value indicates a lower level of corruption. There is evidence that political corruption is negatively related to social trust (Rothstein, 2000; Delhey and Newton, 2005) as well as innovation (Ellis, Smith, and White, 2016). We measure human capital by the logarithm of the human capital index (*HCI*) from the Penn World Table (PWT) version 8.0, which captures the average education level in a country. Human capital is an important driver for innovation (Benhabib and Spiegel, 2005) and high-trust countries have more human capital (Papagapitos and Riley, 2009). For religion, we follow Djankov, McLiesh, and Shleifer (2007) and construct five binary variables to represent the dominant religion in each country, such as Catholic, Protestant, Orthodox, Muslim, or Buddhism. It has been shown that religious beliefs are related to social trust (Djankov et al., 2007) and innovation activities (Benabou, Ticchi, and Vindigni, 2015). With respect to other dimensions of national culture, we control for Hofstede's (1980) uncertainty avoidance, power distance, and individualism measures, which prior research has related to firms' risk-taking incentives and innovation (Li et al., 2013; Chen et al., 2015).[21] We re-estimate Eq. (5) with different combinations of these additional control variables and present the results in columns (1) to (4) of Table 4. We find that trust continues to have a positive and significant coefficient. In untabulated tests, we also find that our results are robust to controlling for a country's enforcement of insider trading laws, red tape, foreign direct

[20] This is unlikely to drive our results for two reasons. First, trust evolves very slowly because it is deeply rooted in individuals' ethnic, religious, familial, and social backgrounds and is a relatively persistent behavioral trait (Putnam, 1993; Fukuyama, 1995; Guiso, Sapienza, and Zingales, 2006, 2010). Second, it is not clear whether all innovations can have an impact on social trust, and for those that can, whether they build or erode trust.

[21] Hofstede's (1980) cultural indices include 6 dimensions: power distance, individualism, uncertainty avoidance, masculinity, long-term orientation, and indulgence. Our results are robust to controlling for all six.

investment, Gini index, and economic uncertainty, or replacing the formal institutions control in Eq. (5) with a country's legal origin and investor protection.

[Insert Table 4 about here]

In columns (5) and (6) of Table 4, we further augment our regression with country fixed effects. This approach has the benefit of removing the confounding effects of any time-invariant country-level characteristics that are not explicitly controlled for in earlier specifications, but it comes at the cost of absorbing the substantial cross-country variations in our key explanatory variable, social trust, and leaving only within-country over-time variations to drive our results. In other words, given the slow-changing nature of a country's social trust level, controlling for country fixed effects represents a more stringent identification strategy but it risks underestimating the economic relation between trust and innovation. Because the additional controls included in columns (1) to (4) are all time-invariant and therefore will be subsumed by country fixed effects, we supplement this model specification with two cultural dimensions constructed using the WVS data, i.e., individualism and hierarchy.[22] Unlike Hofstede's culture measures, these cultural values have some time-series variations because a country can be the subject of multiple waves of World Value Surveys. We find that the coefficient on trust remains positive and significant.

Overall, results in this section suggest that the positive relation between trust and innovation is less likely to be driven by a country's political corruption, education level, religious belief, other aspects of culture, and any other time-invariant country characteristics.

3.2.2. Inherited trust and innovation

To further mitigate the omitted variable concern and substantiate the forward causality running from social trust to innovation, we follow Algan and Cahuc (2010) and estimate the inherited component of social trust based on the beliefs of descendants of immigrants to the U.S. The rationale behind this approach is that children inherit their parents' social capital (e.g., Rice and Feldman, 1997; Putnam, 2000; Guiso, Sapienza, and Zingales, 2006), and the trust inherited by U.S. descendants from their ancestors who immigrated to the U.S. from different countries at

[22] Specifically, individualism is between 0 and 1, with 0 representing completely agreeing with the statement of "Incomes should be made more equal" and 1 representing completely agreeing with the statement of "We need larger income differences as incentives for individual effort". Hierarchy is between 0 and 1, with 0 representing that the survey participant agrees with the statement of "One should follow one's superior's instructions only when one is convinced that they are right" and 1 representing that the survey participant agrees with the statement of "One should follow instructions even when one does not fully agree with them".

different time periods (usually decades ago), is unlikely to be driven by the current conditions (e.g., political, economic, and industry) of their country of origin. We then examine the relation between inherited trust and innovation.

[Insert Table 5 about here]

We estimate the inherited trust using the General Social Survey (GSS), which records information on the trust beliefs of U.S. descendants of immigrants, and their ancestors' immigration periods and countries of origin. Similar to Algan and Cahuc (2010), we define U.S. descendants as the second-generation Americans (at least one parent born abroad), third-generation Americans (at least two grandparents immigrated to the U.S. and both parents were born in the U.S.), and fourth-generation Americans (more than two grandparents born in the U.S. and both parents born in the U.S.). After removing unidentified countries of origin and observations with missing values, we obtain a sample of 8,684 individual responses to the survey by U.S. descendants of immigrants from 30 countries during the 1977-2008 period. We infer the inherited trust by estimating the regression model in Eq. (6) below:

$$iTrust_{i,c,t} = \gamma_0 + \gamma_1 X_{i,t} + Origin_c + Year_t + \varepsilon_{i,c,t} \quad (6).$$

iTrust is a binary variable that takes the value of one if respondent *i* with country of origin *c* in year *t* answers "*Most people can be trusted*" to the question "*Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people*?", and zero if the respondent answers "*Can't be too careful*".[23] *X* represents a vector of individual characteristics measured in year *t*, such as age and age squared, gender, education, employment status, religion, and income category. In addition, we include in the regression the country-of-origin fixed effects and year fixed effects.[24] While year fixed effects account for the impact of shocks in a particular year, the coefficient estimates of the country-of-origin fixed effects capture the inherited component of social trust for each country (*InheritedTrust*).

Comparing the inherited trust measure and the WVS trust measure, we find that country ranks based on the two measures are generally consistent. The signs of the coefficients of control variables in Eq. (6) are largely consistent with those in Algan and Cahuc (2010). For brevity, we

[23] There are a very small number of cases where the respondent answers "*Depends*", which we remove from the analysis. In an untabulated robustness test, we show that our results are not affected if we group these cases with either answer.

[24] To avoid perfect multicollinearity, we do not include the country of origin indicator for Yugoslavia. By doing so, we essentially treat the trust inherited by Yugoslavian Americans as the reference group in our sample.

do not tabulate the regression results of Eq. (6). We replace the WVS trust measure in Eq. (5) with the inherited trust and re-estimate the regressions. Table 5 presents the regression results, which show that *InheritedTrust* has a positive and significant coefficient in both columns. This evidence provides additional support for a causal interpretation of the relation between trust and innovation.

3.2.3. The instrumental variable approach

In this section, we employ a two-stage least squares (2SLS) regression framework as another method to address the endogeneity concerns. As an instrument for social trust, we use the rate of intentional homicide per thousand population in each country and year (*Homicide*). These statistics are from the United Nations Surveys of Crime Trends and Operations of Criminal Justice System Series provided by the University of Michigan,[25] where intentional homicide is defined as unlawful death purposefully inflicted on a person by another person. According to Hilary and Huang (2015), crimes such as intentional homicide can adversely affect the level of trust among people in a society. However, the intentional homicide rate is unlikely to be directly related to individuals' or firms' incentive to innovate. It is worth noting that we already control for the strength of a country's legal institutions (as part of the economic freedom index) in the baseline regressions. Hence this instrument appears to satisfy both the relevance and exclusion criteria.

[Insert Table 6 about here]

We report the results of the 2SLS regressions in Table 6. In the first stage regression in column (1), we observe that *Homicide* has a negative and significant coefficient, consistent with our conjecture that social trust is lower in societies with higher homicide rates. Our instrument also passes the weak instrument test with a *p*-value of less than 0.01. In the second stage regressions, we replace the actual value of social trust with the predicted value from the first stage regression. We find that the instrumented *Trust* continues to have a positive and significant coefficient in columns (2) and (3). Therefore, our results are robust to correction for endogeneity.[26]

3.2.4. A single-country analysis based on U.S. public firms

[25] The data can be retrieved from http://www.icpsr.umich.edu/icpsrweb/NACJD/studies/26462.

[26] In an untabulated test, we use a country's ethnic heterogeneity as an alternative instrumental variable in the 2SLS regressions. It is well documented that ethnic diversity reduces social trust (Keefer and Knack, 1997; Putnam 2007; and Dinesen and Sønderskov, 2015). To the extent that diversity promotes innovation, this particular instrument choice would bias against our finding a positive relation between trust and innovation in the 2SLS regressions. Despite this bias, we still find that the instrumented trust has a positive and significant coefficient in the second stage regressions.

To further ensure that the relation between trust and innovation we document is not merely the byproduct of some country-level characteristics that we fail to control, we perform a single-country firm-level study using a sample of U.S. public firms, where we relate the level of social trust in a given state to the innovation activities of firms headquartered in that state. The major advantage of such an investigation is to ensure that each year firms operate in a uniform macro-environment at the country level. We choose the U.S. as the country for this analysis based on three considerations. First, information is available to measure the state-level social trust in the U.S. Second, detailed accounting and stock return data are available for a comprehensive sample of publicly traded firms in the U.S. Third, because the U.S. is not part of our main sample, this analysis can be considered as an out-of-sample test.

We define state-level social trust as the average survey participant's response in each state and year to the following question in the GSS "*Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people*?" To isolate the effect of social trust on innovation output, we control for an array of firm characteristics in our regressions following Chang et al. (2015).[27] Specifically, we first control for R&D expenses over total assets (*R&D/Assets*) as a measure of input to innovation and the logarithm of the net property, plant, and equipment scaled by the number of employees (*Ln*(*PPE/Emp*)) as a proxy for capital intensity. Other firm characteristics include the leverage ratio (*Leverage*), the cash-to-assets ratio (*Cash/Assets*), the logarithm of total assets (*Ln*(*Assets*)) and the market-to-book ratio (*MB*) as proxies for firm size and growth opportunities respectively, the stock return (*Return*) and its volatility (*Volatility*) over the fiscal year, the return on assets (*ROA*) and the logarithm of firm age (*Ln*(*Age*)). In addition to firm characteristics, we also include several state characteristics. For example, we control for the logarithm of GDP per capita for each state each year (*Ln*(*SGDP*)) as a proxy for the level of local economic development. We also include state establishment entry rate (*Entry*) and exit rates (*Exit*) as well as state unemployment rates (*Unemployment*) to account for local economic conditions.[28] Finally, we include industry and year fixed effects in the regressions and adjust standard errors for state-level clustering.

[Insert Table 7 about here]

[27] All firm characteristics are constructed using data from Compustat and CRSP.

[28] Data on state GDP and population are obtained from the Bureau of Economic Analysis and the U.S. Census Bureau, respectively, while data on state business entry and exit rates and state unemployment rates are extracted from the Business Dynamics Statistics of the U.S. Census Bureau and the U.S. Bureau of Labor Statistics, respectively.

Table 7 reports the regression results. We find that the level of social trust in a state is positively and significantly related to the innovation output of firms in that state. Their own caveat notwithstanding,[29] these results help alleviate the concern that the relation between trust and innovation that we document is just an artifact of some omitted country characteristics. .

In sum, although we can never completely address the endogeneity issue, the collection of empirical approaches we apply and the body of corroborative evidence they produce point to a causal interpretation of the relation between trust and innovation.

3.3. Robustness tests

To verify the validity of our results, we conduct a battery of robustness tests in this section by employing various alternative variables and model specifications. For brevity, the results and discussions of these robustness checks are in the Internet Appendix. We find that none of the following variations has a material effect on our results: (*a*) adding a squared term of *Trust* in the regressions to investigate the nonlinear effect of trust on innovation; (*b*) using per capita patent counts and citation counts as the dependent variables to further account for the effect of industry size (e.g., a large-sized industry may have a higher level of innovation output); (*c*) using two alternative measures of innovation output, i.e., the number of innovative firms and patent family size, as dependent variables; (*d*) replacing *Trust* with social distrust, the opposite of social trust,[30] as the key explanatory variable to mitigate the potential mismeasurement of trust; (*e*) including country-industry fixed effects and industry-year fixed effects in the regressions to further control for the impact of time-invariant industry characteristics in each country or time-varying industry-specific characteristics, such as worldwide industrial development or industry mergers waves; (*f*) clustering standard errors at both country and year levels to mitigate the concern on the presence of residual correlation in both country and year dimensions following the suggestion of Petersen (2009); (*g*) measuring trust in year *t*-5 ($Trust_{t\text{-}5}$) instead of year *t*-1 to capture the long-term nature of innovation process (Manso, 2011); (*h*) conducting an analysis at the technology-class level following Hsu, Tian, and Xu (2014);[31] (*i*) excluding patents firstly filed by domestic firms to

[29] For example, it is impossible to control for all cross-state differences, just as it is for cross-country ones.
[30] Social distrust is constructed as the percentage of survey participants' responses to the question "*Do you think most people try to take advantage of you?*" from the WVS.
[31] The technology class level analysis is at the two-digit IPC code but our results are robust if we use the three-digit IPC code. In an untabulated test, we also aggregate industry level data to the country level and conduct an analysis at the country level and find similar results.

foreign patent offices to alleviate the concern that multinational corporations may choose to setup a R&D center overseas or acquire innovative foreign firms for their innovation.

In addition, in untabulated tests, we exclude Eastern Bloc countries before 1995 because of the regime changes in these countries in the early 1990s. Also, for all the countries in our sample, we exclude one of them at a time from the analysis. Our results remain intact, suggesting that the Eastern Bloc countries or any other country in particular is unlikely to be responsible for our findings.

4. Economic mechanisms

In this section, we explore cross-sectional variation in the relation between trust and innovation to shed light on the specific channels through which social trust can enhance innovation.

4.1. The collaboration channel

Innovation requires teamwork (Dougherty, 1992; Van de Ven, 1986). Trust as an informal contracting mechanism encourages the free exchange of intellectual assets and increases the likelihood and efficiency of collaboration (Durante, 2010), which are essential for innovation success. Alternatively, effective contract enforceability and strong intellectual property protection can also encourage collaboration among innovators by allowing them to capture the returns from their investments in highly risky innovative projects (Seitz and Watzinger, 2013; Lerner, 2009). However, writing and enforcing contracts on to-be-developed innovative products are particularly challenging and expensive. Meanwhile, a strong legal protection on innovators' intellectual inputs from the expropriation by their peers can be quite costly as it requires robust monitoring. In the absence of these formal legal institutions, we expect trust to play a more important role in facilitating collaboration and enhancing innovation output.

To examine our conjecture, we use the contract enforceability index constructed by Djankov et al. (2003) and the intellectual property protection index created by Park (2008).[32] We first partition the sample at the sample median of these two variables and then examine the effect of social trust

[32] The contract enforceability index, which has a scale from 0 (the lowest enforceability) to 10 (the highest enforceability), measures the relative degree to which contractual agreements are honored and complications presented by language and mentality differences. The intellectual property protection index is based on five unweighted scores that cover (i) inventions that are patentable; (ii) membership in international treaties; (iii) duration of protection; (iv) enforcement mechanisms; and (v) restrictions. For more information on the indices see Djankov et al. (2003) and Park (2008), respectively.

on innovation in countries with a high or low value of the contract enforceability index and a high or low value of the intellectual property protection index, respectively.[33] The results are presented in Panels A and B of Table 8.

[Insert Table 8 about here]

The coefficient estimates of *Trust* are positive and significant for the subsample of countries with a low value of the contract enforceability index or a low value of the intellectual property protection index but insignificant for the subsample of countries with a high value of the contract enforceability index or a high value of the intellectual property protection index. These results suggest that social trust, as an effective informal contracting mechanism, enhances innovators' collaboration and thus promotes innovation. We also compare the coefficients on *Trust* between subsamples with strong and weak contract enforceability and those with strong and weak intellectual property protection by conducting the *F*-tests. We find that the coefficients between the two groups are significantly different with *p*-values of less than 0.05.

4.2. The tolerance channel

Innovation involves a high probability of failure due to its dependence on various unpredictable conditions (Holmstrom, 1989). Given risk-averse agents, the optimal incentive scheme that nurtures innovation should exhibit substantial tolerance for early failure and reward for long-term success (Manso, 2011). Strong legal protections for employees and debtor-friendly debt enforcement alleviate firms' and employees' concerns about the adverse impact of innovation failure and hence encourage their risk-taking and innovation efforts (Acharya, Baghai, and Subramanian, 2014; Acharya and Subramanian, 2009). In the absence of such formal protections, a higher level of trust can encourage innovators to undertake risky ventures with less concern about potential adverse repercussions from failure, e.g., involuntary job separation for employees and forced liquidation for firms. In essence, trust can act as an informal insurance scheme for innovators and induce more risk-taking from them in the innovation process. Hence we expect that the positive impact of social trust on innovation is stronger in countries with poorer employment protection and creditor-friendly bankruptcy regime, where the potential costs of innovation failure to innovators are higher.

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[33] Since our partitioning variables in this section are country-level variables, we partition the sample by country rather than by country-industry, which leads to unbalanced numbers of observations for the two subsamples.

To test this conjecture, we empirically examine how our results vary depending on a country's employee protection and bankruptcy regime by partitioning the sample into countries with strong and weak employee protection and those with creditor-friendly or debtor-friendly bankruptcy regime according to the sample median of the employee protection index in Botero et al. (2004) and the indicator of debt enforcement strength in Djankov et al. (2008), respectively.[34] We then re-estimate the regressions for subsamples of countries with strong and weak employee protection and those with creditor- and debtor-friendly bankruptcy regime separately. The results are reported in Panels A and B of Table 9.

[Insert Table 9 about here]

We find that social trust promotes innovation output only in the subsample of countries with weak employee protection or creditor-friendly debt enforcement, where the coefficient estimates of *Trust* are positive and significant at the 1% level. The coefficient estimates of *Trust* in the subsample of countries with strong employee protection or debtor-friendly bankruptcy regime, however, are insignificant. These findings support the notion that social trust as a tolerance mechanism promotes firms' innovation when the costs of innovation failures are high for firms and employees. We also find that the coefficients between the two groups are significantly different with *p*-values of less than 0.05, except for the test on the subsamples with *Ln*(1+*Citation*) as the dependent variable and the indicator of debt enforcement strength as the partitioning variable, which has a *p*-value of 0.12.

4.3. The funding channel

Innovative firms often need external financing as they exhaust internal funds (Brown, Fazzari, and Petersen, 2009; Brown, Martinsson, and Petersen, 2012, 2013). However, in an environment of high information opacity, costs of capital can be quite high especially for innovative firms, thereby hindering these firms' incentive and ability to innovate. Higher-quality financial disclosure and more stringent auditing and accounting standards help improve corporate information transparency (Rajan and Zingales, 1998), which can lower the cost of capital and thus promote

[34] The employee protection index is computed as a sum of the employment laws index, collective relations laws index, and social security laws index. A higher employee protection index indicates better employee protection. Debt enforcement strength indicator takes the value of one if reorganization is likely to be used in a country for debt enforcement (loose debt enforcement) and equals zero if foreclosure or liquidation is likely to be used (strong debt enforcement).

innovation. However, the implementation of these rules and regulations can be costly as it entails substantial monitoring costs for regulators and compliance costs for firms.

Trust, on the other hand, can reduce the information asymmetry between investors and firms. For example, Pevzner, Xie, and Xin (2015) provide evidence that in high trust countries, markets are more reactive to information. Garrett, Hoitash, and Prawitt (2014) find that trust encourages information production and information sharing, and thus improves financial reporting quality. The study of Jha and Chen (2015) shows that audit fees are significantly higher for firms headquartered in low trust counties in the U.S. As a result, we expect to find a stronger effect of social trust on innovation in countries with less financial disclosure and lax auditing and accounting standards, where the information environment is more opaque.

To examine this conjecture, we partition the sample at the sample median of a country's financial disclosure score or the strength of auditing and accounting standards and re-estimate the regression model in Eq. (5) separately in each subsample.[35] Table 10 reports the regression results. We find that the coefficient estimates of *Trust* are positive and significant at the 1% level in the subsamples of countries with lower financial disclosure scores or weaker auditing and accounting standards, but are insignificant in the subsamples of countries with higher financial disclosure scores and stronger auditing and accounting standards. Furthermore, the between-subsample differences in the coefficient on *Trust* are all statistically significant at the 1% level. These findings are consistent with our conjecture that social trust is especially important in promoting innovation in countries with poor disclosure and accounting and auditing standards by improving firms' information transparency and access to external capital.

[Insert Table 10 about here]

5. Trust, innovation, and economic growth

5.1. The effect of trust on economic growth as a function of industry innovativeness

Although our findings indicate that trust plays a positive role in encouraging innovation output in a country, an important question remains unanswered: Does trust affect a country's economic

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[35] Information on a country's financial disclosure score is from the *Global Competitiveness Report* 1999, which measures the level and effectiveness of financial disclosure in different countries. This score has been used in many prior studies such as Gelos and Wei (2002) and Jin and Myers (2006). Information on the strength of a country's auditing and accounting standards is from the *Global Competitiveness Report* 2003-2004, when *Global Competitiveness Report* first compiles this measure.

growth through innovation? To answer this question, we examine the effect of trust on industry value added growth and ask how the effect differs between more innovative and less innovative industries. Specifically, we first examine the effect of trust on economic growth by estimating the regression model in Eq. (7):

$$\Delta Ln(VA)_{i,j,[t-1,t]} = \alpha + \beta Trust_{j,t-1} + \gamma' Z_{i,j,t-1} + Industry_i + Year_{t-1} + \varepsilon_{i,j,t-1} \quad (7).$$

$\Delta Ln(VA)$ represents the growth of industry value added from year t-1 to year t in industry i and country j. The main explanatory variable is still *Trust* in country j and year t-1. Z represents control variables in industry i, country j, and year t-1 described in Sections 2.4 and initial conditions of factor inputs in industry i, country j and year t-1 described in Section 2.5. The results are presented in column (1) of Table 11. Consistent with previous literature (e.g., La Porta et al., 1997; Knack and Keefer, 1997; Zak and Knack, 2001), we find that trust does have a positive effect on industry value added growth and this effect is statistically significant at the 10% level.

[Insert Table 11 about here]

Next, we examine innovation as a channel through which trust promotes economic growth. If innovation is indeed a channel, we expect that the positive effect of trust on industry value added growth is more pronounced for more innovative industries than for less innovative industries. To test this conjecture, we split the sample into high and low innovation potential groups according to the sample median of *Intensity*, and estimate regressions separately for the two groups. The results are presented in columns (2) and (3) of Table 11. We find that the positive effect of trust on industry value added growth is mainly concentrated in more innovative industries: the coefficient estimate of *Trust* is only significant for high innovation potential industries and insignificant for low innovation potential industries. Moreover, the magnitude of the coefficient estimate of *Trust* for innovative industries is significantly larger than that for less innovative industries with a *p*-value of 0.08. These results suggest that one channel through which trust drives economic growth is by enhancing innovation output in more innovative industries.

5.2. The effect of trust on productivity as a function of industry innovativeness

Prior literature suggests that innovation contributes to economic growth mainly through enhancing productivity growth (Solow, 1957; Romer, 1986). In this section, we incorporate this insight into our analysis by examining the effect of trust on industry total factor productivity (TFP) growth and whether the effect differs across countries with different innovation potentials. We expect to find a positive effect of trust on industry productivity growth and a stronger effect in more innovative industries. To examine our conjecture, we first estimate the regression model in Eq. (8) below:

$$\Delta Ln(TFP)_{i,j,[t-1,t]} = \alpha + \beta Trust_{j,t-1} + \gamma' Z_{i,j,t-1} + Industry_i + Year_{t-1} + \varepsilon_{i,j,t-1} \quad (8).$$

$\Delta Ln(TFP)$ represents the growth of industry TFP from year t-1 to t in industry i and country j. Other variables are the same as in Section 5.1. We then partition the sample into high and low innovation intensity groups according to the sample median of *Intensity*, and estimate regressions separately for the two groups. The results are presented in columns (4) to (6) of Table 11.

In column (4), we find that the coefficient estimate of *Trust* is positive and significant at the 5% level, suggesting that trust does improve industry TFP growth. More importantly, the results in columns (5) and (6) indicate that trust promotes productivity growth mainly through enhancing innovation output in more innovative industries; the coefficient estimate on *Trust* is highly significant for high innovation intensity industries but insignificant for low innovation intensity industries. The magnitude of the coefficient is also significantly larger in high innovation intensity industries than in low innovation intensity industries with a *p*-value of 0.07. These results suggest that trust has a positive effect on productivity growth through fostering firms' innovation especially in more innovative industries.

Taken together, the empirical evidence in Sections 5.1 and 5.2 complements the findings in previous studies, e.g., La Porta et al. (1997), Knack and Keefer (1997), and Zak and Knack (2001), by identifying innovation as a source for the positive relation between trust and economic growth. Furthermore, such a positive effect is likely to be permanent as a result of an improvement in productivity growth.

6. Conclusion

We investigate two competing views on how social trust affects innovation using a large sample of observations drawn from 42 countries around the world. Our analyses indicate that trust has a positive and significant relation with innovation activities in a country, and multiple identification strategies suggest that the relation is causal. The effect of trust on innovation exhibits interesting cross-sectional variation along several dimensions of country characteristics. Specifically, our evidence suggests that trust plays a more important role in enhancing innovation in countries with poor contract enforceability and weak protection for intellectual protection, in countries with weak protection for employees and creditor-friendly bankruptcy regime, and in countries with insufficient financial disclosure and lax accounting and auditing standards. These results highlight three economic channels through which trust enhances innovation, i.e., the collaboration channel, the tolerance for failure channel, and the funding channel. Finally, our investigation indicates that innovation is an important channel through which trust contributes to economic growth. Specifically, we find that trust is positively related to the growth in an industry’s value added and total factor productivity, particularly in industries with more innovative potentials.

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Table 1: Sample distribution

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the World Value Survey (WVS) between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. In Panel A, *Patent* is the total number of patents in a particular country over the sample period. *Citation* is the total number of patent citations adjusted for time-technology class fixed effects in a particular country over the sample period. *Trust* is the country average and is defined using the WVS.

Panel A: Sample distribution by country

Country	(1)	(2)	(3)	(4)
	N	*Patent*	*Citation*	*Trust*
Argentina	238	70	114	0.177
Australia	314	10,134	26,436	0.436
Brazil	336	444	920	0.048
Bulgaria	235	188	52	0.267
Canada	172	23,916	129,428	0.389
Chile	268	104	164	0.205
China	349	121,780	55,955	0.547
Colombia	222	24	71	0.124
Czech Republic	282	5,077	1,739	0.288
Estonia	162	79	59	0.215
Finland	399	21,175	43,009	0.532
France	43	15,450	6,212	0.187
Germany	229	132,115	348,250	0.335
Hong Kong	30	617	1,718	0.411
Hungary	374	1,146	535	0.265
India	374	3,567	8,651	0.357
Indonesia	156	5	56	0.478
Israel	133	4,413	25,143	0.235
Italy	66	2,383	3,309	0.292
Japan	392	220,054	686,325	0.417
Jordan	140	7	0	0.287
Korea	407	150,958	219,884	0.307
Latvia	253	120	24	0.247
Lithuania	184	29	5	0.219
Malaysia	46	82	45	0.088
Mexico	376	455	2,170	0.255
Morocco	157	13	0	0.200
Netherlands	40	7,499	13,309	0.445
New Zealand	110	714	1,590	0.503
Norway	232	3,023	4,015	0.653
Philippines	184	14	80	0.071
Poland	379	6,622	487	0.239
Romania	222	722	140	0.193
Russia	226	4,636	4,558	0.248
Singapore	128	3,270	12,515	0.147
Slovenia	285	894	336	0.164
South Africa	261	1,940	3,116	0.168
Spain	399	25,201	5,945	0.306
Sweden	263	23,708	43,013	0.656
Switzerland	256	47,827	91,588	0.404
Turkey	394	4,280	672	0.113
United Kingdom	228	20,149	33,920	0.299
Total	9,944	864,904	1,775,557	0.296

Table 1: Sample distribution (cont'd)

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. In Panel B, all values are industry average at the two-digit ISIC. *Patent* is the total number of patents in a two-digit ISIC industry for each country each year. *Citation* is the total number of patent citations adjusted for time-technology class fixed effects in a two-digit ISIC industry for each country each year. *VA* is value-added (in $millions) in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars.

Panel B: Sample average by industry

ISIC	ISIC description	(1)	(2)	(3)	(4)	(5)
		N	*Patent*	*Citation*	*VA*	*Intensity*
15	Food and beverages	478	76.773	185.751	74,135	0.103
16	Tobacco products	325	6.836	9.801	20,613	0.093
17	Textiles	469	139.537	267.635	48,950	0.118
18	Wearing apparel, fur	446	133.631	247.867	43,159	0.184
19	Leather, leather products and footwear	394	5.000	7.763	1,225	0.036
20	Wood products (excluding furniture)	476	21.110	30.687	8,554	0.037
21	Paper and paper products	467	33.408	58.095	27,709	0.073
22	Printing and publishing	463	97.508	172.101	21,772	0.098
23	Coke, refined petroleum products, nuclear fuel	385	31.513	69.286	26,615	0.069
24	Chemicals and chemical products	459	179.940	429.784	74,084	0.122
25	Rubber and plastics products	476	32.758	70.901	36,050	0.065
26	Non-metallic mineral products	473	67.243	118.283	44,004	0.037
27	Basic metals	463	85.008	157.500	61,664	0.048
28	Fabricated metal products	465	145.424	310.997	11,422	0.071
29	Machinery and equipment, not else classified	467	198.571	418.020	60,437	0.159
30	Office, accounting and computing machinery	352	188.211	439.670	1,951	0.208
31	Electrical machinery and apparatus	463	57.156	93.000	55,114	0.060
32	Radio, television and communication equipment	373	135.939	289.838	8,954	0.107
33	Medical, precision and optical instruments	456	158.627	360.211	22,739	0.192
34	Motor vehicles, trailers, semi-trailers	464	90.571	176.083	62,450	0.212
35	Other transport equipment	391	31.636	53.517	3,240	0.115
36	Furniture; manufacturing, not else classified	464	34.518	50.876	3,874	0.055
37	Recycling	275	0.641	0.789	309	0.031

Table 2: Summary statistics

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Patent* and *Citation* are the total number of patents and the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's imports plus exports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added (in $millions) in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. *VA*, *K*, and *Emp* are value-added (in $millions), capital stock (in $millions), and total number of employees in a two-digit ISIC industry for each country each year. *ΔLn*(*VA*) and *ΔLn*(*TFP*) are annual value added growth and TFP growth. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. Figures in bold in Panel B are statistically significant at the 1% level.

Panel A: Descriptive statistics

Variables	Mean	STD	Min	Q1	Median	Q3	Max
Panel A.1: Measures of innovation output (N = 9,944)							
Patent	86.977	226.833	0.000	0.241	4.136	38.623	1,071.686
Ln(1+*Patent*)	2.193	2.100	0.000	0.216	1.636	3.679	6.978
Citation	178.556	579.787	0.000	0.000	1.820	39.945	3,606.328
Ln(1+*Citation*)	2.071	2.401	0.000	0.000	1.037	3.712	8.191
Panel A.2: Explanatory variables (N = 9,944)							
Trust	0.303	0.151	0.028	0.195	0.286	0.391	0.680
Ln(*GDP*)	8.764	1.205	5.747	8.020	8.627	9.934	10.580
Trade	0.576	0.462	0.056	0.280	0.457	0.811	3.116
FinDev	1.474	1.048	0.195	0.708	1.103	1.966	5.065
FormalInst	6.893	0.994	3.550	6.196	7.009	7.598	9.028
Ln(*VA*)	7.224	2.137	-0.027	5.890	7.338	8.633	16.795
Intensity	0.100	0.057	0.023	0.058	0.092	0.123	0.275
Panel A.3: Measures of economic growth (N = 7,487)							
ΔLn(*VA*)	-0.016	0.278	-1.272	-0.115	0.016	0.126	0.689
ΔLn(*TFP*)	-0.024	0.246	-1.079	-0.113	0.010	0.109	0.526
Ln(*VA*)	7.286	2.217	-0.027	5.938	7.392	8.735	16.795
Ln(*K*)	9.286	3.730	2.051	7.035	8.801	10.556	19.420
Ln(*Emp*)	10.489	1.802	5.966	9.243	10.586	11.792	14.220

Panel B: Correlation matrix

	Ln(1+*Patent*)	*Ln*(1+*Citation*)	*Trust*	*Ln*(*GDP*)	*Trade*	*FinDev*	*FormalInst*	*Ln*(*VA*)
Ln(1+*Citation*)	**0.895**							
Trust	**0.455**	**0.432**						
Ln(*GDP*)	**0.493**	**0.569**	**0.318**					
Trade	**0.093**	**0.156**	**0.079**	**0.464**				
FinDev	**0.492**	**0.585**	**0.269**	**0.540**	**0.311**			
EconFree	**0.326**	**0.463**	**0.272**	**0.725**	**0.560**	**0.633**		
Ln(*VA*)	**0.544**	**0.500**	**0.115**	**0.177**	**-0.259**	**0.257**	**-0.071**	
Intensity	0.193	0.166	-0.004	0.001	0.011	0.000	-0.007	0.007

Table 3: The effect of social trust on innovation

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)	(3)	(4)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)	*Ln*(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**4.210*****	**3.701*****	**4.203*****	**3.698*****
	(3.2)	**(3.8)**	**(3.2)**	**(3.8)**
Ln(*GDP*)	0.431**	0.443**	0.433**	0.441**
	(2.6)	(2.4)	(2.5)	(2.3)
Trade	0.128	-0.012	0.101	-0.038
	(0.6)	(-0.0)	(0.4)	(-0.1)
FinDev	0.387**	0.541***	0.396**	0.549***
	(2.4)	(3.2)	(2.3)	(3.0)
FormalInst	-0.159	0.236	-0.168	0.230
	(-0.8)	(1.2)	(-0.8)	(1.1)
Ln(*VA*)	0.439***	0.454***	0.433***	0.450***
	(5.2)	(5.2)	(4.2)	(4.3)
Intensity	7.080***	7.028***	1.032	1.636
	(10.0)	(8.0)	(0.8)	(1.1)
Year FE	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Observations	9,944	9,944	9,944	9,944
R-squared	0.61	0.64	0.65	0.67

Table 4: Controlling for potential omitted variables

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Corruption* is the corruption rating compiled by the *International Country Risk Guide* (ICRG). A higher rating indicates lower risk. *HCI* is the log of human capital index from Penn World Table (PWT) 8.0. *Catholic*, *Protestant*, *Orthodox*, *Muslim*, and *Buddhism* are binary variables that take the value of one if a country's primary religious belief is one of these six religions, and zero otherwise. In columns (3) and (4), $UncertAvoid_H$, $PowerDist_H$, and $Individualism_H$ are Hofstede culture dimensions. In columns (5) and (6), $Individualism_W$ and $Hierarchy_W$ are culture dimensions in WVS. Control variables are the same as those in Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)	*Ln*(1+*Patent*)	*Ln*(1+*Citation*)	*Ln*(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**2.943*****	**2.517*****	**3.321*****	**2.301*****	**2.863*****	**1.932****
	(2.8)	**(2.8)**	**(3.4)**	**(2.7)**	**(2.8)**	**(2.0)**
Corruption	0.240**	0.132	0.244**	0.098	-0.038	-0.066*
	(2.2)	(1.5)	(2.4)	(1.1)	(-0.8)	(-2.0)
HCI	1.738*	-0.077	1.414	-0.007	5.179***	4.844**
	(2.0)	(-0.1)	(1.4)	(-0.0)	(3.7)	(2.5)
Catholic	-1.201***	-1.166**	-1.315***	-0.959**		
	(-3.6)	(-2.4)	(-3.7)	(-2.2)		
Protestant	-1.381***	-0.917	-1.283**	-1.023		
	(-3.0)	(-1.5)	(-2.3)	(-1.5)		
Orthodox	-0.849**	-0.359	-1.109**	0.096		
	(-2.2)	(-0.7)	(-2.2)	(0.2)		
Muslim	-1.302***	-1.507***	-1.445***	-1.306***		
	(-3.8)	(-4.0)	(-3.8)	(-3.3)		
Buddhism	0.222	0.967	0.135	1.289*		
	(0.4)	(1.4)	(0.2)	(1.9)		
$UncertAvoid_H$			0.004	-0.001		
			(0.4)	(-0.1)		
$PowerDist_H$			0.009	-0.006		
			(0.7)	(-0.4)		
$Individualism_H$			0.006	-0.016		
			(0.5)	(-1.4)		
$Individualism_W$					-2.247**	-0.992**
					(-2.6)	(-2.1)
$Hierarchy_W$					-1.915***	-0.900
					(-3.1)	(-1.2)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	Yes	Yes
Observations	9,634	9,634	9,634	9,634	8,639	8,639
R-squared	0.72	0.74	0.72	0.74	0.87	0.84

Table 5: Inherited trust and innovation

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the General Social Survey (GSS) between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *InheritedTrust* is the trust inherited by U.S. descendants of immigrants, which is estimated according to Algan and Cahuc (2010). Other variables are defined in the legend of Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
InheritedTrust	**3.806*** **	**2.236** **
	(2.9)	**(2.2)**
Ln(*GDP*)	0.214	0.156
	(1.1)	(0.9)
Trade	0.567	0.665
	(0.9)	(0.9)
FinDev	0.619**	0.801***
	(2.8)	(3.8)
FormalInst	-0.149	0.394
	(-0.8)	(1.5)
Ln(*VA*)	0.529***	0.568***
	(4.9)	(4.7)
Intensity	2.919***	3.857***
	(3.9)	(3.5)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	7,503	7,503
R-squared	0.74	0.75

Table 6: The instrumental variable approach

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Homicide* is the intentional homicide counts per thousand population for each country each year. Other variables are defined in the legend of Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
Dependent variables	1st Stage	2nd Stage	
	Trust	*Ln*(1+*Patent*)	*Ln*(1+*Citation*)
Homicide	**-0.039*****		
	(-3.5)		
$\widehat{Trust}$		**8.840*****	**5.235*****
		(5.7)	**(4.2)**
Ln(*GDP*)	0.043	0.160	0.279
	(1.1)	(0.5)	(1.6)
Trade	-0.040	0.362	0.194
	(-1.0)	(1.3)	(0.7)
FinDev	0.025	0.292*	0.519***
	(1.4)	(1.9)	(3.2)
FormalInst	-0.013	-0.363	0.042
	(-0.3)	(-1.4)	(0.2)
Ln(*VA*)	0.000	0.541***	0.566***
	(0.0)	(5.4)	(5.2)
Intensity	0.027	1.162	2.044*
	(0.7)	(1.2)	(1.7)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Joint test of excluded instruments	$F(1,40) = 12.14$ Prob > F = 0.00	N/A	N/A
Observations	8,311	8,311	8,311
R-squared	0.33	0.61	0.70

Table 7: Social trust and innovation – A within-country analysis based on U.S. public firms

The sample consists of firm-years jointly covered by both Compustat and the USPTO patent and citation database between 1991 and 2008. *Ln*(1+*Patent*) is the log of one plus the total number of patents applied for. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted using the method of time-technology class fixed effect. *Trust* is the state level social trust score defined using the GSS. *R&D/Assets* is R&D expenses scaled by the book value of total assets. *Ln*(*PPE/Emp*) is the log of net Property, Plant, and Equipment (*PPE*) scaled by the number of employees. *Leverage* is the sum of short-term debt and long-term debt over the book value of total assets. *Cash/Assets* is the cash-to-assets ratio. *Ln*(*Assets*) is the log of book value of total assets. *MB* is the ratio of market value of assets over book value of assets. *Return* is buy-and-hold stock returns computed over the fiscal year. *Volatility* is the standard deviation of daily stock returns over the fiscal year. *ROA* is EBITDA/*Assets*. *Ln*(*Age*) is the number of years elapsed since a firm enters the CRSP database. *Herfindahl* index is computed based on the three-digit SIC code. *Ln*(*SGDP*) is the log of per capita GDP for each state each year. *Entry* and *Exit* are establishment entry rate and exit rate for each state each year, respectively. *Unemployment* is the state level unemployment rate. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given state. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**0.268****	**0.270****
	(2.5)	**(2.2)**
R&D/Assets	1.433***	1.312***
	(8.9)	(9.0)
Ln(*PPE/Emp*)	0.039*	0.034
	(1.7)	(1.2)
Leverage	-0.608***	-0.657***
	(-6.3)	(-6.9)
Cash/Assets	0.296***	0.268***
	(4.0)	(2.9)
Ln(*Assets*)	0.440***	0.427***
	(17.0)	(16.7)
MB	0.065***	0.072***
	(15.3)	(15.6)
Return	0.076***	0.089***
	(5.3)	(5.0)
Volatility	4.195***	4.134***
	(8.8)	(9.2)
ROA	0.063	0.060
	(1.5)	(1.4)
Ln(*Age*)	0.159***	0.138***
	(7.6)	(6.3)
Herfindahl	0.118	0.310
	(0.5)	(1.3)
Herfindahl^2	0.063	-0.110
	(0.2)	(-0.4)
Ln(*SGDP*)	0.375**	0.315*
	(2.4)	(1.9)
Entry	0.024**	0.029***
	(2.2)	(2.8)
Exit	-0.024	-0.019
	(-1.4)	(-1.0)
Unemployment	0.040**	0.046**
	(2.2)	(2.1)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	40,497	40,497
R-squared	0.45	0.39

Table 8: How does trust enhance innovation? The collaboration channel

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Contract enforceability index* is from Djankov et al. (2003). Contract enforceability index is defined as high (low) if it is above (below) the sample median. *Intellectual property protection index* is from Park (2008). Intellectual property protection index is defined as high (low) if it is above (below) the sample median. Other variables are defined in the legend of Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)	(3)	(4)
	Ln(1+*Patent*)		*Ln*(1+*Citation*)	
Panel A: Partitioning the sample according to the contract enforceability index				
	High	Low	High	Low
Trust	**-0.278**	**8.006*****	**-0.520**	**6.339*****
	(-0.4)	**(4.2)**	**(-0.2)**	**(3.9)**
Ln(*GDP*)	0.981***	0.717**	1.438**	0.565
	(3.6)	(2.4)	(2.6)	(1.6)
Trade	0.116	0.880	0.244	0.331
	(0.3)	(0.6)	(0.5)	(0.2)
FinDev	0.189	0.746	0.485	0.715
	(1.0)	(1.3)	(1.7)	(1.5)
FormalInst	-0.373	-0.431	-0.306	0.276
	(-0.8)	(-1.4)	(-0.6)	(0.8)
Ln(*VA*)	0.628***	0.320***	0.592**	0.373***
	(4.4)	(3.0)	(2.4)	(3.1)
Intensity	4.102***	-0.713	4.451***	0.191
	(3.8)	(-0.3)	(4.0)	(0.1)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Test of equal coefficients	*p*-value = 0.00		*p*-value = 0.01	
Observations	3,489	3,952	3,489	3,952
R-squared	0.77	0.57	0.70	0.53
Panel B: Partitioning the sample according to the intellectual property protection index				
	High	Low	High	Low
Trust	**-0.444**	**5.913*****	**-0.475**	**4.080*****
	(-0.5)	**(3.4)**	**(-0.3)**	**(4.7)**
Ln(*GDP*)	1.188***	0.327	1.474***	0.147
	(4.2)	(1.6)	(3.0)	(0.8)
Trade	0.167	-0.211	0.258	-0.576
	(0.5)	(-0.5)	(0.6)	(-1.5)
FinDev	0.209	0.386	0.499**	0.504*
	(1.5)	(1.1)	(2.8)	(1.8)
FormalInst	-0.603*	-0.692***	-0.313	-0.079
	(-1.8)	(-3.2)	(-0.9)	(-0.6)
Ln(*VA*)	0.584***	0.270***	0.549**	0.254***
	(5.1)	(3.3)	(2.9)	(4.2)
Intensity	3.877***	2.067	4.613***	2.842**
	(4.3)	(1.6)	(4.6)	(2.2)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Test of equal coefficients	*p*-value = 0.00		*p*-value = 0.02	
Observations	4,479	4,358	4,479	4,358
R-squared	0.78	0.58	0.75	0.51

Table 9: How does trust enhance innovation? The failure tolerance channel

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Labor protection* is the sum of employment laws index, collective relations laws index, and social security laws index from Botero et al. (2004). Labor protection is defined as strong (weak) if it is above (below) the sample median. We classify a country's debt enforcement as debtor friendly if reorganization is likely to be used in a bankruptcy proceeding, and creditor friendly if foreclosure or liquidation is likely to be used, based on information from Djankov et al. (2008). Other variables are defined in the legend of Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)	(3)	(4)
	Ln(1+*Patent*)		*Ln*(1+*Citation*)	
Panel A: Partitioning the sample according to labor protection				
	Strong	Weak	Strong	Weak
Trust	**1.188**	**6.446*****	**1.802**	**5.160*****
	(1.0)	**(4.6)**	**(1.5)**	**(5.5)**
Ln(*GDP*)	0.153	0.616***	0.180	0.557*
	(0.4)	(3.2)	(0.4)	(2.0)
Trade	0.724	0.086	1.047	-0.177
	(0.9)	(0.3)	(0.9)	(-0.6)
FinDev	0.594**	0.505***	0.547**	0.644***
	(2.5)	(3.0)	(2.4)	(3.4)
FormalInst	0.112	-0.601**	0.333	0.079
	(0.6)	(-2.1)	(1.7)	(0.3)
Ln(*VA*)	0.573***	0.299***	0.584***	0.354***
	(3.8)	(3.4)	(3.1)	(3.8)
Intensity	1.345	1.915	2.105	1.510
	(1.0)	(1.2)	(1.2)	(1.0)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Test of equal coefficients	*p*-value = 0.00		*p*-value = 0.03	
Observations	5,102	4,454	5,102	4,454
R-squared	0.69	0.71	0.67	0.72
Panel B: Partitioning according to debt enforcement				
	Debtor-friendly	Creditor-friendly	Debtor-friendly	Creditor-friendly
Trust	**0.672**	**5.700*****	**1.630**	**4.349*****
	(0.6)	**(3.6)**	**(1.2)**	**(3.6)**
Ln(*GDP*)	0.638**	0.314	0.487**	0.740***
	(2.5)	(1.3)	(2.3)	(3.0)
Trade	0.531	0.348*	0.498	0.119
	(0.4)	(1.9)	(0.3)	(0.5)
FinDev	0.637**	0.089	0.931***	0.352**
	(2.4)	(0.6)	(3.1)	(2.4)
FormalInst	-0.016	-0.317	0.070	-0.080
	(-0.1)	(-1.2)	(0.2)	(-0.3)
Ln(*VA*)	0.279	0.484***	0.326	0.462***
	(1.5)	(4.1)	(1.7)	(3.7)
Intensity	0.154	0.360	1.345	1.241
	(0.1)	(0.3)	(0.7)	(0.9)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Test of equal coefficients	*p*-value = 0.01		*p*-value = 0.12	
Observations	4,550	5,020	4,550	5,020
R-squared	0.69	0.71	0.72	0.68

Table 10: How does trust enhance innovation? The funding channel

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Financial disclosure index* is from the *Global Competitiveness Report* 1999-2000. Financial disclosure in a country is defined as transparent (opaque) if it is above (below) the sample median. *Strength of auditing and accounting standards index* is from the *Global Competitiveness Report* 2003-2004. Auditing and accounting standards are defined as strong (weak) if it is above (below) the sample median. Other variables are defined in the legend of Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)	(3)	(4)
	Ln(1+*Patent*)		*Ln*(1+*Citation*)	
Panel A: Partitioning the sample according to financial disclosure				
	Transparent	Opaque	Transparent	Opaque
Trust	**-0.237**	**8.777*****	**-0.723**	**6.545*****
	(-0.3)	**(4.7)**	**(-0.4)**	**(3.9)**
Ln(*GDP*)	1.375***	0.950***	1.616***	0.724*
	(5.4)	(3.1)	(3.5)	(1.9)
Trade	0.004	-0.845	0.170	-1.373
	(0.0)	(-1.1)	(0.4)	(-1.7)
FinDev	0.416**	0.293	0.533***	0.547*
	(2.4)	(1.0)	(2.9)	(2.0)
FormalInst	-0.251	-0.060	-0.323	0.504
	(-0.8)	(-0.1)	(-0.9)	(1.2)
Ln(*VA*)	0.517***	0.320***	0.528**	0.351***
	(3.6)	(3.2)	(2.7)	(3.6)
Intensity	4.160***	-0.048	5.402***	1.055
	(3.1)	(-0.0)	(3.6)	(0.5)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Test of equal coefficients	*p*-value = 0.00		*p*-value = 0.00	
Observations	4,243	4,438	4,243	4,438
R-squared	0.79	0.60	0.74	0.54
Panel B: Partitioning the sample according to strength of auditing and accounting standards				
	Strong	Weak	Strong	Weak
Trust	**-0.571**	**7.818*****	**-0.523**	**6.139*****
	(-0.7)	**(4.2)**	**(-0.3)**	**(4.5)**
Ln(*GDP*)	1.246***	0.714***	1.394**	0.670***
	(4.0)	(3.5)	(2.8)	(3.0)
Trade	0.059	0.042	0.172	-0.915*
	(0.2)	(0.1)	(0.4)	(-1.8)
FinDev	0.236	0.289	0.363*	0.561*
	(1.4)	(0.8)	(1.7)	(1.8)
FormalInst	-0.476	-0.258	-0.119	0.325
	(-1.3)	(-0.8)	(-0.2)	(1.1)
Ln(*VA*)	0.548***	0.338***	0.509**	0.329***
	(4.0)	(3.8)	(2.3)	(3.6)
Intensity	1.628	-0.001	2.056	0.485
	(1.1)	(-0.0)	(1.2)	(0.3)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Test of equal coefficients	*p*-value = 0.00		*p*-value = 0.00	
Observations	3,779	6,165	3,779	6,165
R-squared	0.75	0.67	0.67	0.70

Table 11: The effect of trust on economic growth and productivity gains – More innovative vs. less innovative industries

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *VA*, *K*, and *Emp are* value-added (in $millions), capital stock (in $millions), and total number of employees in a two-digit ISIC industry for each country each year. *ΔLn*(*VA*) is annual growth of value added. *ΔLn*(*TFP*) is annual growth of TFP. An industry is defined as less-innovative (innovative) if its average innovation intensity in the industry is below (above) the sample median, where innovation intensity is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Other variables are defined in the legend of Table 3. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	*ΔLn*(*VA*)			*ΔLn*(*TFP*)		
	Full sample	Less-innovative	More-innovative	Full sample	Less-innovative	More-innovative
Trust	**0.097***	**0.070**	**0.127****	**0.097****	**0.057**	**0.142*****
	(2.0)	**(1.3)**	**(2.7)**	**(2.2)**	**(1.2)**	**(3.4)**
Ln(*VA*)	-0.095***	-0.096***	-0.098***	-0.094***	-0.092***	-0.099***
	(-6.0)	(-6.3)	(-5.4)	(-8.1)	(-8.0)	(-7.6)
Ln(*K*)	-0.003	-0.003	-0.002	0.000	-0.000	0.001
	(-0.8)	(-0.8)	(-0.6)	(0.1)	(-0.1)	(0.4)
Ln(*Emp*)	0.096***	0.091***	0.103***	0.098***	0.093***	0.106***
	(6.3)	(6.4)	(5.5)	(8.9)	(8.2)	(8.1)
Ln(*GDP*)	0.038***	0.043***	0.032**	0.047***	0.050***	0.045***
	(3.1)	(3.3)	(2.5)	(4.5)	(4.4)	(4.1)
Trade	-0.050***	-0.068***	-0.035*	-0.046***	-0.061***	-0.032**
	(-2.8)	(-4.0)	(-1.7)	(-3.1)	(-3.8)	(-2.1)
FinDev	-0.009	-0.003	-0.015	-0.009	-0.006	-0.013
	(-0.9)	(-0.3)	(-1.4)	(-1.1)	(-0.7)	(-1.5)
FormalInst	0.050***	0.043**	0.057***	0.047**	0.046**	0.047***
	(3.0)	(2.2)	(3.4)	(2.6)	(2.2)	(2.9)
Intensity	0.208	2.172***	0.036	0.393**	1.586***	0.266
	(0.8)	(5.8)	(0.1)	(2.2)	(4.6)	(1.3)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Test of equal coefficients	NA	*p*-value = 0.08		NA	*p*-value = 0.07	
Observations	7,487	3,837	3,650	7,487	3,837	3,650

R-squared	0.29	0.31	0.27	0.31	0.31	0.33

Internet Appendix

This Internet Appendix provides supplemental analyses and robustness tests for the main results presented in the paper. To avoid any confusion, tables included in this section are labelled with the extension "IA" for "Internet Appendix" (e.g., Table IA1, Table IA2, etc.). Below is a list of the tables followed by a discussion of the results.

We first examine whether the relation between trust and innovation is monotonic over the entire distribution of trust. Bidault and Castello (2010) argue that a certain level of tension is beneficial for creativity as it encourages critical thinking. As a result, too much trust may impede innovation. To investigate this possibility, we add the quadratic term of *Trust*, i.e., $Trust^2$, to Eq. (5) as an additional explanatory variable and re-estimate the regression model. We present the regression results in Table IA1. We find that *Trust* has a significantly positive coefficient, while $Trust^2$ has a significantly negative coefficient. The magnitude of the coefficients suggest that innovation output increases with social trust, until social trust reaches the value of 0.97, after which point the relation between trust and innovation becomes negative. While this non-monotonicity provides some support for Bidault and Castello's (2010) claim, we note that the value of 0.97 is far outside of the distribution of social trust in our sample. Therefore, the relevant inference we draw from our analysis remains unchanged, i.e., social trust enhances innovation.

Second, in addition to industry fixed effects, we further account for the effect of industry size (e.g., a larger industry may have a higher aggregate level of innovation output) by replacing *Ln*(1+*Patent*) and *Ln*(1+*Citation*) with the logarithm of one plus per capita patent counts (*Ln*(1+*Patent/Emp*)) and the logarithm of one plus per capita citation counts (*Ln*(1+*Citation/Emp*)). *Patent/Emp* and *Citation/Emp* are defined as *Patent* and *Citation* scaled by the total number of employees in each two-digit ISIC industry. We present the regression results in Table IA2. We continue to find significantly positive coefficients on *Trust*.

Third, following previous literature (e.g., Acharya and Subramanian, 2009; Ernst, Richter, and Riedel, 2013) we use two alternative measures of innovation output as our dependent variables, i.e., the logarithm of one plus the number of innovative firms (*Ln*(1+*NInnoFirm*)) and the logarithm of one plus patent family size (*Ln*(1+*PatentFamily*)). An innovative firm is defined as a firm with non-zero patents, and patent family size is defined as the number of filings of a particular patent application around the world. We find that our results are robust to these two alternative measures of innovation output (see Table IA3).

Fourth, we construct a measure of social distrust (*Distrust*), the opposite of social trust, based on the percentage of survey participants in each country who responded affirmatively to the following question in WVS: "*Do you think most people try to take advantage of you?*" We then replace *Trust* with *Distrust* in Eq. (5) and present the regression results in Table IA4. We find that the coefficient estimate of *Distrust* is always negative and significant at the 1% level, suggesting that our results are not sensitive to how we measure trust.

Fifth, we control for time-invariant industry characteristics in each particular country by including country-industry fixed effects, and time-varying industry-specific characteristics, such as worldwide industrial development or industry mergers waves, by including industry-year fixed effects. As *Intensity* is an industry-year variable, it is removed from the regressions when industry-year fixed effects are included. We report the regression results in Table IA5. Specifically, in columns (1) and (2) and columns (3) and (4), we include country-industry fixed effects and industry-year fixed effects, respectively, and in columns (5) and (6), we include both country-industry fixed effects and industry-year fixed effects. We find that our results continue to hold even with these additional fixed-effects controls, suggesting that time-invariant country-industry characteristics or time-varying industry-specific characteristics are unlikely likely to be responsible for our results.

Sixth, to further mitigate the concern of any residual correlation between sample observations in both country and year dimensions, we employ a two-way clustering by clustering standard errors at both the country and year level following the suggestion of Petersen (2009). Our results are robust to this two-way clustering (see Table IA6).

Seventh, to capture the long-term nature of innovation processes (Manso, 2011), we measure trust in year *t*-5 ($Trust_{t-5}$) instead of year *t*-1 in Eq. (5). We then re-estimate the regressions and present the results in Table IA7. The coefficient estimates of $Trust_{t-5}$ are always positive and significant at the 1% level, suggesting that our findings are robust to accounting for the possibility of delayed response of innovation output to trust.

Eighth, following Hsu, Tian, and Xu (2014), we conduct an analysis at the technology-class level. Specifically, we aggregate all variables at the two-digit International Patent Classification (IPC) class and re-estimate Eq. (5) with technology-class fixed effects instead of industry fixed effects. We present the regression results in Table IA8. We find that the baseline results do not change qualitatively as the coefficient estimates of *Trust* are positive and significant at the 1% level in all the regressions.

Finally, multinational corporations (MNCs) may choose to setup a R&D center overseas or acquire innovative foreign firms for their innovation. Thus a potential concern is that the level of trust in a firm's home country may not be relevant for all of the firm's innovation output. Although this possibility biases against our findings, we further alleviate the concern by excluding patents that are first filed by domestic firms with foreign patent offices, to the extent that such patents are likely to have originated from R&D centers and subsidiaries located overseas. We re-estimate the regression model and present the results Table IA9. The coefficients on *Trust* remain significant and positive, suggesting that our findings are not driven by multinational corporations' overseas R&D activities and acquisition activities.

References

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Table IA1: Non-monotonicity in the relation between trust and innovation?

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**15.214*** **	**13.649*** **
	(5.1)	**(4.0)**
Trust^2	**-15.700*** **	**-14.190*** **
	(-3.8)	**(-3.0)**
Ln(*GDP*)	0.511***	0.512***
	(2.9)	(3.0)
Trade	0.249	0.095
	(1.0)	(0.3)
FinDev	0.385**	0.540***
	(2.7)	(3.6)
FormalInst	-0.380**	0.039
	(-2.1)	(0.2)
Ln(*VA*)	0.446***	0.461***
	(5.3)	(5.3)
Intensity	1.063	1.664
	(0.8)	(1.2)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	9,944	9,944
R-squared	0.69	0.70

Table IA2: Using per capita innovation output measures as dependent variables
The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent/Emp*) is the log of one plus the total number of patents in a two-digit ISIC industry over the total number of employees in the industry for each country each year. *Ln*(1+*Citation/Emp*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry over the total number of employees in the industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent/Emp*)	*Ln*(1+*Citation/Emp*)
Trust	**0.974*** **	**1.138*** **
	(5.4)	**(3.7)**
Ln(*GDP*)	0.226***	0.281***
	(5.8)	(3.6)
Trade	0.074	0.121
	(1.1)	(1.1)
FinDev	0.081	0.182***
	(1.7)	(2.7)
FormalInst	-0.033	-0.000
	(-0.6)	(-0.0)
Ln(*VA*)	0.016	0.035
	(0.7)	(1.1)
Intensity	0.676	2.003*
	(0.8)	(1.8)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	9,332	9,332
R-squared	0.54	0.50

Table IA3: Using alternative measures of innovation output

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*NInnoFirm*) and *Ln*(1+*PatentFamily*) are the log of one plus the number of innovative firms and the log of one plus the patent family size in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*NInnoFirm*)	*Ln*(1+*PatentFamily*)
Trust	**4.720*** **	**4.485*** **
	(3.1)	**(3.5)**
Ln(*GDP*)	0.629***	0.467***
	(2.9)	(2.8)
Trade	0.102	0.149
	(0.3)	(0.6)
FinDev	0.301*	0.382**
	(1.8)	(2.3)
FormalInst	-0.289	-0.161
	(-1.2)	(-0.8)
Ln(*VA*)	0.435***	0.440***
	(4.0)	(4.3)
Intensity	0.372	0.715
	(0.5)	(0.5)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	9,944	9,944
R-squared	0.66	0.66

Table IA4: Using an alternative measure of trust

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Distrust* is defined as the percentage of survey participants who answer "Yes" to the question "*Do you think most people try to take advantage of you?*" from the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
Distrust	**-3.400*** **	**-2.536*** **
	(-2.9)	**(-3.6)**
Ln(*GDP*)	0.518**	0.440*
	(2.6)	(2.0)
Trade	-0.013	0.029
	(-0.0)	(0.1)
FinDev	0.459**	0.511**
	(2.1)	(2.3)
FormalInst	-0.434	0.145
	(-1.3)	(0.4)
Ln(*VA*)	0.604***	0.663***
	(6.0)	(6.1)
Intensity	1.357	0.769
	(0.6)	(0.2)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	3,753	3,753
R-squared	0.71	0.68

Table IA5: Controlling for various fixed effects

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)	*Ln*(1+*Patent*)	*Ln*(1+*Citation*)	*Ln*(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**2.555*** **	**1.581** **	**3.443** **	**2.256** **	**2.508*** **	**1.560***
	(3.0)	**(2.1)**	**(2.5)**	**(2.7)**	**(2.9)**	**(2.0)**
Ln(*GDP*)	2.091*	2.869**	1.593	2.582**	2.119*	2.874**
	(1.7)	(2.4)	(1.4)	(2.3)	(1.7)	(2.4)
Trade	-0.648**	-0.372	-0.880***	-0.581	-0.632**	-0.357
	(-2.2)	(-1.0)	(-3.3)	(-1.7)	(-2.2)	(-0.9)
FinDev	0.096	0.066	-0.008	-0.020	0.097	0.060
	(1.3)	(0.8)	(-0.1)	(-0.2)	(1.3)	(0.7)
FormalInst	-0.197	-0.186	-0.079	-0.085	-0.202	-0.188
	(-1.1)	(-1.2)	(-0.4)	(-0.5)	(-1.1)	(-1.1)
Ln(*VA*)	-0.125	0.005	0.113*	0.161***	-0.132	0.008
	(-1.4)	(0.2)	(1.9)	(3.7)	(-1.4)	(0.2)
Intensity	0.627	1.365*	-	-	-	-
	(0.9)	(1.7)	-	-	-	-
Year FE	Yes	Yes	No	No	No	No
Country FE	No	No	Yes	Yes	No	No
Industry-year FE	No	No	Yes	Yes	Yes	Yes
Country-industry FE	Yes	Yes	No	No	Yes	Yes
Observations	9,944	9,944	9,944	9,944	9,944	9,944
R-squared	0.95	0.93	0.86	0.85	0.95	0.93

Table IA6: Clustering standard errors by both country and year

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country and year, respectively. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**4.203*** **	**3.698*** **
	(3.2)	**(3.9)**
Ln(*GDP*)	0.433***	0.441**
	(2.6)	(2.4)
Trade	0.101	-0.038
	(0.4)	(-0.1)
FinDev	0.396**	0.549***
	(2.3)	(3.0)
FormalInst	-0.168	0.230
	(-0.8)	(1.2)
Ln(*VA*)	0.433***	0.450***
	(4.1)	(4.2)
Intensity	1.032	1.636
	(0.9)	(1.5)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	9,944	9,944
R-squared	0.65	0.67

Table IA7: Lagging trust by five years

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. $Trust_{t\text{-}5}$ is defined using the WVS and lagged for five years. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country, respectively. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
$Trust_{t\text{-}5}$	**4.386*** **	**3.807*** **
	(3.6)	**(4.3)**
Ln(*GDP*)	0.318*	0.323
	(1.8)	(1.6)
Trade	0.709*	0.402
	(1.9)	(1.1)
FinDev	0.431**	0.548***
	(2.5)	(3.1)
FormalInst	-0.313	0.180
	(-1.3)	(0.8)
Ln(*VA*)	0.548***	0.589***
	(5.4)	(5.1)
Intensity	0.566	0.600
	(0.4)	(0.3)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	7,649	7,649
R-squared	0.69	0.69

Table IA8: Analysis at the technology-class level

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit IPC technology class for each country in each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit IPC technology class for each country in each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is the log of a country's imports plus exports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit IPC technology class for each country in each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit IPC technology class in each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**3.867*** **	**3.165*** **
	(3.0)	**(3.9)**
Ln(*GDP*)	0.370**	0.305**
	(2.1)	(2.1)
Trade	0.007	-0.105
	(0.0)	(-0.4)
FinDev	0.004**	0.006***
	(2.4)	(2.8)
FormalInst	-0.149	0.253
	(-0.7)	(1.4)
Ln(*VA*)	0.514***	0.494***
	(3.9)	(3.4)
Intensity	0.355	0.270
	(1.3)	(0.9)
Year FE	Yes	Yes
Tech class FE	Yes	Yes
Observations	7,794	7,794
R-squared	0.68	0.65

Table IA9: Excluding patents first filed with foreign patent offices

The sample consists of countries with granted patents jointly covered by the UNIDO Industrial Statistical database, the BVD Orbis database, and the WVS between 1991 and 2008. We only count each innovation once, i.e., an innovation patented in different countries is counted as one patent. *Ln*(1+*Patent*) is the log of one plus the total number of patents in a two-digit ISIC industry for each country each year. *Ln*(1+*Citation*) is the log of one plus the total number of patent citations adjusted for time and technology class fixed effects in a two-digit ISIC industry for each country each year. *Trust* is defined using the WVS. *Ln*(*GDP*) is the log of GDP per capita. *Trade* is a country's exports plus imports as a fraction of GDP. *FinDev* is the ratio of stock market capitalization plus domestic credit provided by the banking sector over GDP. *FormalInst* is a country's formal institutions measured by the economic freedom index from the Fraser Institute. *Ln*(*VA*) is the log of value-added in a two-digit ISIC industry for each country each year. *Intensity* is the median number of patents held by a U.S. firm in a two-digit ISIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by country. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1)	(2)
	Ln(1+*Patent*)	*Ln*(1+*Citation*)
Trust	**4.143*** **	**2.852*** **
	(2.9)	**(3.2)**
Ln(*GDP*)	0.315	0.147
	(1.2)	(1.0)
Trade	0.247	0.402
	(0.6)	(0.9)
FinDev	-0.182	-0.146
	(-0.8)	(-0.7)
FormalInst	-0.111	0.141
	(-0.4)	(0.7)
Ln(*VA*)	0.372***	0.353**
	(3.0)	(2.5)
Intensity	-1.389	-2.266
	(-1.1)	(-1.6)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	9,944	9,944
R-squared	0.41	0.32