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Abstract: This paper tests whether social trust affects total factor productivity (TFP). Using both development and growth accounting, we find strong evidence of a causal positive effect of social trust on the level and growth of TFP. We moreover observe that the effect of social trust on TFP runs through economic-judicial institutions, but not through political institutions. Those findings resist a series of robustness checks.

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1. Introduction

Whilst the concept of social trust originated in sociology and political science, economists quickly joined the research agenda, as early results indicated that such features contributed to explaining economic growth (Putnam, 1993; Helliwell and Putnam, 1995). The work of Knack and Keefer (1997) supported this contention, thereby fuelling the economic interest in trust.

The literature has shown that the association between social trust and economic growth is both robust and of economic significance (Whiteley, 2000; Zak and Knack, 2001; Beugelsdijk et al., 2004), but only hinted at what the transmission mechanisms are.[1] Although the evidence that trust affects the level and growth of output is convincing, it is not clear whether trust affects factor accumulation only or also productivity.

There is consistent evidence that trust affects factor accumulation, as reported in the original contributions of Knack and Keefer (1997) and Zak and Knack (2001). More recently, Dearmon and Grier (2011) show that trust is a determinant of both physical and human capital accumulation and that there seems to be a spill-over between these effects, confirming that trust is an important determinant of factor accumulation. The impact of trust on productivity is more debated. On the one hand, the theoretical literature suggests that social trust could enable cooperation and reduce rent-

[1] Berggren et al. (2008), who find that the trust-growth association is somewhat shaky in the medium run, partially contradict this. They, however, conclude that although the association is not particularly robust, it is more robust than other determinants of growth, such as education, often taken for granted by most economists.

seeking behavior, thereby increasing total factor productivity (TFP), a point made by Arrow (1972), Putnam (1993) and Fukuyama (1995). On the other hand, the empirical evidence has remained somewhat scarce. In particular, Knack and Keefer (1997) noted a correlation between social trust and labor productivity, but Zak and Knack (2001) found that social trust leads mainly to higher investment in physical capital, i.e. factor accumulation. Conversely, Bjørnskov (2012) finds evidence of a growth effect of trust through improved governance, which is not associated with investment or education. While he notes that this could be interpreted as a productivity effect, it remains speculative as he does not directly measure productivity. Several previous contributions to the trust literature thus suggest that social trust arguably affects productivity but provide no direct evidence.

The question is important because TFP has been shown to be the main driver of economic performance, a standard result of growth accounting, going back to Solow's (1957) first effort. It has been confirmed on a large sample of countries, for instance by Klenow and Rodriguez-Clare (1997), who observed that differences in TFP growth explain the bulk of cross-country growth differences. Similar results have been obtained in studies focusing on specific regions, such as Berthélemy and Söderling (2001) or Gómez-Sancho et al. (2013). The development accounting literature, featuring papers such as Hall and Jones (1999) and Caselli (2005), complements growth accounting by decomposing income levels instead of growth rates and comes to the similar conclusion that differences in TFP levels explain the bulk of cross-country differences in per capita incomes. Hence, while the growth accounting and development accounting literatures show that long-run growth and economic development are mainly driven by TFP, the more specific literature on the trust-growth association provides no clear answers as to whether trust affects TFP as well as factor accumulation. In short, we know that trust affects the level and the growth of output, but we do not know whether it affects the main engine of long-run output growth.

This paper, consequently, looks further into the association between social trust and both the level and the growth of TFP. We thus extend the work of Hall and Jones (1999) and Olson et al. (2001), who respectively showed a positive relationship between institutional quality and the level and the growth of TFP. In Williamson's (2000) terms, we take the analysis from the second to the first level of social analysis, the social embeddedness level, where norms, traditions and basic beliefs are located. Firstly, we find a clear and robust association between levels of TFP and social trust. We next observe a clear and robust relation between social trust and the growth of TFP. Most importantly, we find in both instances that trust affects TFP by increasing the quality of formal

institutions, i.e. the enforcement quality of formal legislation and regulations. More precisely, we find evidence that the transmission channel of trust to TFP to be economic-judicial institutions that protect property-rights, but not institutions that define the political system and the degree of democracy (political institutions). We therefore find that a dimension of the first level of social analysis, the set of unwritten rules and conventions of society, affects TFP through a specific dimension of the second level of social analysis, the written rules and their enforcement.

Across all those steps, we systematically consider both the level and the growth of TFP. We do so because although growth- and development accounting have evolved as complementary but distinct strands of literature, they lead to the same conclusion on the importance of TFP. Moreover, TFP levels capture long-run economic performance, as Hall and Jones (1999) argue, while TFP growth captures transitory dynamics. Studying both the long term impact of trust and its relationship with the catching-up process provides a more comprehensive view of the impact of trust on economic performance.

The rest of the paper is structured as follows. Section 2 discusses the theoretical reasons to believe that social trust affects TFP. Section 3 describes the data used in the empirical section 4. Section 5 concludes.

2. Why would trust affect productivity?

A basic theoretical question to ask is why we would expect social trust to affect TFP. The literature on the association between trust and economic growth surveyed by Bjørnskov (2009a) provides a number of clues. The arguments can be split into two different strands: 1) mechanisms directly enabling pro-social behavior and improved information flows; 2) indirect mechanisms associating trust with better formal institutions that in turn affect economic outcomes.

2.1. Economic effects connecting trust and TFP

Knack and Keefer (1997) provided a series of arguments relating trust to productivity. They first note that with higher levels of trust comes a lesser need to devote resources to securing individuals and firms from theft and expropriation, which allows the reallocation of resources from protection to actual production. Moreover, higher levels of social trust reduce the transaction costs implicit in any economic activity, as trust reflects the average trustworthiness of people and thus the likelihood

that they abide by both formal rules and informal social contracts (Arrow, 1972).[2] As a result, trustworthiness allows the production of a larger output with the same endowments of production factors. This is what TFP measures at the aggregate level.

By the same token, trust in other people implies that firms can apply longer time horizons when taking investment decisions, which allows them to invest in riskier, but potentially more productive processes. A related mechanism stressed by La Porta et al. (1997) is that high levels of social trust allow economic agents to write shorter contracts, covering only broad contingencies. Trust would therefore allow contracting for productivity gains, since such gains cannot logically be precisely described or covered by contractual contingencies. By the same token, Matsuyama (2014) provides a formal model relating the quality of investment to the intensity of agency problems on countries' financial markets. One may easily argue that that intensity is directly affected by trust, as originally suggested in Zak and Knack (2001). Assuming that agency problems are also more serious for more profitable projects, Matsuyama (2014) argues that entrepreneurs in countries with more serious agency problems will choose less profitable projects, resulting in lower aggregate productivity. La Porta et al.'s (1997) argument is consistent with Dearmon and Grier's (2009) finding that the marginal impact of investment on growth is larger in more trusting economies. One interpretation of their result is that the quality of investment is larger in higher-trust countries, leading to productivity gains in addition to the accumulation of physical and human capital.

A second series of mechanisms relates trust to innovation and technical progress. Knack and Keefer (1997) note that research activities are essentially non-monitorable. As Maskell (2000) notes, market interactions are generally incapable of transmitting the information needed to develop new products in interaction between firms, because the distribution of information between the seller and the buyer regarding the main characteristics of what is offered for sale is asymmetric. This problem and the characteristic of non-monitorability imply that firms either have to closely screen information or trust the agents providing it. The optimal screening effort is consequently decreasing in social trust, which affects the transaction cost of hiring the most productive

[2] This argument rests on the assumption that trust and trustworthiness are approximately the same. As outlined in Bjørnskov (2007), if this were not the case a substantial part of the population would have systematically biased beliefs about the trustworthiness of others. Noting that most national trust scores are stable and thus tend to reflect long-run equilibria, the existence of such a bias is implausible. Similar implications follow from the literature on trust responsiveness surveyed in Bjørnskov (2007, 2010).

employees. This means that firms in high-trust societies are both more likely to be close to the technological frontier and more likely to adopt new technologies earlier (Bornschier, 2005).

Emphasizing a related indirect mechanism, Bjørnskov (2009b) presents a simple growth model in which firms' investment in labor-augmenting technological improvements is determined by the costs and necessity of monitoring skilled employees with complex work tasks. As high-trust employees are both better at cooperating and need less monitoring, social trust affects TFP through its effects on the demand for higher education. The model also suggests an effect through norms of cooperation, consistent with Dearmon and Grier's (2009) finding that trust increases the impact of education on growth. If education in high-trust countries has an impact that goes beyond the accumulation of human capital, it must impact TFP growth.

Building on Austrian entrepreneurship theory (Kirzner, 1997), Ikeda (2008) argues that a minimum of social trust is necessary to access the information available in networks through what Granovetter (1973) termed "weak ties", social ties to people one either does not know or barely knows. Trust therefore allows entrepreneurs to access a wider range of knowledge resources. High-trust societies should consequently have a competitive edge in innovative activities. Kwon and Arenius (2010) present cross-country evidence supporting these links between trust, weak tie investments and entrepreneurial activity. The idea is further corroborated by Akçomak and ter Weel (2009), who find that trust significantly affects patentable innovation activity, measured by the number of patent applications in European regions. As patents are bound to affect productivity, trust would correlate not only with the level of TFP but also with its growth.

One may connect trust and TFP through its influence on tolerance of atypical behaviors and lifestyles. Florida and Gates (2001) and Florida (2002) argue that innovations typically come from atypical groups, while Uslaner (2002) shows that trusting individuals are, on average, more tolerant of different lifestyles. The adoption of innovations would be more likely in high-trust societies.[3] Similar arguments can be found in the early trust literature in which a culture of open-mindedness is argued to be consistent with high levels of trust (Fukuyama, 1995).

Finally, trust also impacts market integration. Within countries, trust has been found to increase participation in the formal economy, thereby yielding higher incomes, for instance by Tu and Bulte (2010). Trust has moreover been found to increase a country's integration in the international

[3] Berggren and Elinder (2012) show that different aspects of social tolerance are associated in different ways with economic growth. While tolerance of other races is positively associated with growth, tolerance of homosexuality appears to be negatively associated with growth.

economy. Guiso et al. (2009) and Shu et al. (2015) find that higher trust in a country results in larger bilateral trade-flows, whilst Edwards (1998) found that TFP growth was positively related to openness to trade. Trust may therefore affect the level of productivity by allowing countries to better exploit their comparative advantages and by increasing competition on their domestic market. Moreover, Guiso et al. (2009) observe that higher trust not only affects the volume but also the quality of exchanged goods, with trust leading to larger trade volumes in more sophisticated goods. As a result, trust should also affect countries' TFP through trade, by moving their specialization up the quality ladder. Finally, Guiso et al. (2009) report that trust results in more foreign direct investment. Since FDI has been found to boost TFP growth, for instance by Kose et al. (2009), this is another reason why trust should positively affect TFP.

2.2. Institutional effects connecting trust and TFP

Knack and Keefer (1997) originally argued that the influence of social trust on economic growth might be channeled through the quality of legal and bureaucratic institutions. More directly, Bjørnskov (2012) and Boulila et al. (2008) identify institutional quality as an important link. Noting that trust affects growth above its influence on education and investment, Bjørnskov (2009b) suggests that the main transmission mechanism is through improving the quality of formal economic-judicial institutions, which in turn affects the rate of TFP growth. Bjørnskov and Méon (2013) even observe that once the impact of trust on education and institutions is controlled for, it is difficult to observe a direct and significant effect of trust on output. For this transmission channel to operate, two conditions must be met: trust must affect the quality of the relevant institutions, and the quality of institutions must affect TFP.

The importance of social trust for the quality of formal institutions was central to Putnam's (1993) study of regional governance in Italy. Knack (2002), likewise, shows that social trust is a determinant of the quality of state institutions and policies across the US. In cross-country studies, trust is also significantly associated with corruption (Putnam, 2001; Uslaner, 2002), legal quality and bureaucratic efficiency and, perhaps, also participation in the political process, as measured by voter turnout (la Porta et al., 1997).

Radical productivity enhancing innovations may often cause unforeseen institutional challenge, and pose regulatory challenges requiring reforms. Knack (2002) and Heinemann and Tanz (2008) suggest that trust enables institutional reforms, i.e. the sort of institutional adaptation that radical innovation may necessitate.

Institutional quality may in turn affect productivity in many ways. Firstly, poor institutions act as a tax on investors, giving them an incentive to use existing resources less intensively. With better institutions, formal or informal, market agents will optimally devote a smaller part of their time and resources to predation, rent-seeking, the protection of their property against these factors, and monitoring (Knack and Keefer, 1997; Baumol, 1990). Secondly, poor institutions may result in the accumulation of less than fully efficient factors of production. This would, for instance, be the case if agents invested in general-purpose, as opposed to specific, factors of production to hedge against the risk of policy reversals, or if the quality of infrastructure was affected.[4]

The contention that the quality of formal institutions affects productivity is indeed backed by consistent evidence. Hall and Jones (1999) document a strong causal link from what they refer to as "social infrastructure" to TFP. Their index of social infrastructure is essentially a measure of the protection of property rights by the government, namely law and order, bureaucratic quality, corruption, risk of expropriation and government repudiation of contracts. Méon and Weill (2005) and Klein and Luu (2003) show that a broad spectrum of measures of the quality of governance is associated with higher aggregate efficiency.

Now, the concept of institutions is a broad concept and specific facets of institutions may relate differently to trust and to TFP. Most studies of the impact of trust on institutions consider economic-judicial institutions that protect private property rights and allow for an efficient provision of central public goods, be it because they result in a stronger rule of law, as in Knack and Keefer (1997) or Bjørnskov (2012), lower corruption, as in Putnam (2001) or Uslaner (2002), or a more efficient public bureaucracy, as in Bjørnskov (2010). However, some early papers suggest that trust also matters to institutions that determine the way governments are elected and deposed, as Putnam (1993), la Porta et al. (1997) and Uslaner (1999). We refer to the former as economic-judicial institutions and the latter as political institutions (i.e. democracy).

The distinction may be important when assessing the economic consequences of trust mediated through institutions. Firstly, whilst almost all measures of formal institutions covary, these two overall types are conceptually different and statistically separable (Munck and Verkuilen, 2002; Knack and Langbein, 2010). Secondly, Bjørnskov (2010) observes that once common covariates are

[4] To save on space, we only briefly sketch the impact of institutions on productivity. The interested reader will find more exhaustive discussions in Hall and Jones (1999), Méon and Weill (2005) and Méon et al. (2009). The impact of institutional quality on the quality of infrastructure can for instance be illustrated by the finding of Mohamad (2014) on the telecommunication sector.

taken into account, trust only affects the quality of economic-judicial institutions, but not political/democratic institutions. Thirdly, the effect of democratic political institutions is a priori ambiguous. The checks and balances associated with democracy may reduce policy uncertainties, but short-run election motives can increase uncertainty at the same time. Accordingly, while the impact of the rule of law on growth and TFP has been clearly observed by Knack and Keefer (1995) and Hall and Jones (1999), the impact of democratic institutions is more difficult to document. Rivera-Batiz (2002), for instance, finds that democracy ceases to be significantly correlated with TFP growth once the quality of governance is controlled for. Moreover, Méon and Weill (2005) find that the 'voice and accountability' indicator is the dimension of governance, which correlates the least with aggregate efficiency out of the six indicators published by the World Bank. In the following section, we therefore keep economic/judicial and political institutions separate.

3. Data and econometric strategy

To measure TFP and TFP growth, we resort to standard development accounting and growth accounting techniques, described in the next subsection. The following subsections describe how we measure social trust and other explanatory variables, to explain the level and variation of TFP. The fourth subsection describes our econometric strategy.[5]

3.1. Measuring TFP and TFP growth

Development accounting decomposes observed differences in the levels of output per worker across countries into differences in factor endowments and differences in TFP. Growth accounting decomposes output growth into growth of factor endowments and TFP growth. The basic assumption of both methods is that all countries' output can be approximated by the same aggregate production function. We assume the following standard production function:

$$Y = AK^{\alpha}(Lh)^{1-\alpha} \qquad (1)$$

where Y stands for output, K for aggregate capital stock, L for number of workers, and h for average stock of human capital. Lh thus measures the quality-adjusted labor force or "effective labor". Parameter α measures the elasticity of output to capital. A is TFP, namely our variable of interest. This specification of the production function is the main specification used in Caselli's (2005)

[5] Descriptive statistics are provided in Appendix A2.

survey. Similar specifications have been used by King and Levine (1994), Klenow and Rodriguez-Clare (1999), Prescott (1998) and Hall and Jones (1999).

Rewriting the production function in per-worker terms gives:

$$y = Ak^{\alpha}h^{1-\alpha} \quad (2)$$

where lower-case letters refer to per-worker variables.

Since *y*, *k*, *h* and α can be either observed or estimated, expression (2) is an equation with one unknown, *A*. TFP is then simply estimated by solving the equation for *A*. The workhorse measure of TFP is thus given by the following expression:

$$A = y / (k^{\alpha}h^{1-\alpha}) \quad (3)$$

Growth accounting is essentially equivalent to development accounting, except that it considers the variations of all variables, as opposed to their levels. Indeed, taking the logarithm of expression (2) and differentiating with respect to time gives:

$$\hat{y} = \hat{A} + \alpha\hat{k} + (1-\alpha)\hat{h} \quad (4)$$

where variables with a hat correspond to growth rates.

Since the growth rates of *y*, *k*, and *h* are again observable, one can easily infer the growth rate of TFP as a Solow residual:

$$\hat{A} = \hat{y} - \alpha\hat{k} - (1-\alpha)\hat{h} \quad (5)$$

To obtain TFP, with expression (3), or TFP growth, with expression (5), one needs the same data. Specifically, one needs a value for α and data on *Y*, *K*, *L*, and *h* to compute both *A* and $\hat{A}$.[6]

The number of workers and GDP can be obtained from the Penn World Tables 6.2 dataset (Heston et al., 2006). That dataset provides output per worker directly and allows inferring the number of workers from its other measures.[7]

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[6] Changes in the quality of goods, but also, as Caselli (2005) points out, of human capital and physical capital would affect productivity figures. There is, however, no satisfactory way to take the quality of goods and inputs into account. How these changes would relate to trust and institutions in a systematic way is also ambiguous. On the one hand, if trust raises the quality of goods, TFP will be underestimated. On the other hand, if trust raises the quality of inputs, TFP will be overestimated. Which effect dominates is unclear. We will to some extent address that concern in the robustness checks section by using capital stocks provided in version 8 of the Penn World Table, because that version considers six types of assets when computing accumulated physical capital, which partly takes into account the quality of the physical capital stock.

[7] The number of workers was obtained by dividing total GDP by GDP per worker, specifically *rgdpch*×*pop*×1000/*rgdpwok*, according to notations in the PWT6.2.

The physical capital stock is not measured directly, but can be estimated using the perpetual inventory method. A country's physical capital stock in a given year is thus defined as the discounted sum of past investments. Accordingly:

$$K_t = (1 - \delta)K_{t-1} + I_{t-1} \quad (5)$$

δ is the depreciation rate and is set to 0.06, which is considered a reasonable parameterization in the literature.[8] The Penn World Tables dataset provides investment series from 1950 to 2004. A common way to get an estimate is to assume that it is equal to its steady-state value in the Solow growth model. Accordingly, the initial stock of physical capital is given by $K_0 = I_0 / (g + \delta)$, where I_0 stands for the value of investment in the first year, for which an observation is available and g the average rate of growth for the investment series between that year and 1970.

Assuming that the initial capital stock corresponds to its steady state value in all countries is a rough approximation. To minimize its impact on estimates of TFP, one must refrain from using estimates of the capital stock that are too close in time to the initial year. We, therefore, include no country for which the investment series starts later than 1970 and compute TFP for the latest possible year, 2000. With an annual rate of depreciation set to six percent, the share of the initial capital stock still in use in 2000 does not exceed 15% of its initial value, which makes our assumptions on the initial capital stock virtually innocuous. Moreover, one may remark that this disclaimer only applies to development accounting and not growth accounting. Indeed, the latter only needs to consider variations of inputs. As a result, it does not require specifying the initial value of the capital stock. This allows us to study TFP growth over a longer period than the level of TFP and thereby get a priori more precise estimates.

To get an estimate of the human capital stock, we follow the standard procedure and approximate it as a function of years of schooling in the population. Specifically, we follow Hall and Jones (1999) and Caselli (2005) and define h as:

$$h = e^{\phi(s)} \quad (6)$$

where s is the average number of years of schooling in the population over the age of 25, taken from the Barro and Lee (2001) dataset. ϕ is a piecewise linear function such that $\phi(s) = 0.134 \times s$ if $s \leq 4$; $\phi(s) = 0.134 \times 4 + 0.101 \times (s - 4)$ if $4 < s \leq 8$; and $\phi(s) = 0.134 \times 4 + 0.101 \times 4 + 0.068 \times (s - 8)$ if $s > 8$.

[8] Although the value is standard in the literature, it is seldom motivated. We test the robustness of our results to that assumption in the robustness checks section by using an estimate of the capital stock provided in the latest version of the Penn World Table and based on a computation method that allows the depreciation rate to differ across countries and over time (see Feenstra et al. 2013).

Hall and Jones (1999) motivate this specification by remarking that in standard neoclassical frameworks, workers' wages should be proportional to their human capital. As the relationship between wages and education is commonly assumed to be log-linear at the country-level, albeit the cross-country pattern of this profile seems convex, a piecewise linear specification accounts for both within and cross-country evidence.

Finally, one needs an estimate for α. It is frequently set to around 0.3.[9] However, the estimates of α reported in the literature may be quite different. Cavalcanti Ferreira et al. (2004) estimate α to revolve around 0.43. Abu-Qarn and Abu-Bader (2007) find that α in oil-rich MENA countries can exceed 0.6, whilst Senhadji (2000) finds a mean of 0.55 in a sample of developed and developing countries. To limit the impact of arbitrary assumptions, we estimated α in our sample of countries using alternative strategies. They all yielded remarkably stable estimates of the parameter that were close to 0.4.[10] Since this estimate is not extremely different from the usual assumption, we used it to run baseline estimations. However, we also performed all analyses in the robustness checks section with alternative TFP measures, corresponding to different values of α.

Since Barro and Lee's (2001) data end in 2000, we focus on this year to estimate TFP. As data on human capital stocks are available for periods of five years, we compute TFP growth rates over periods of five years and over the whole 1980-2000 period.

3.2. Measuring social trust

To measure social trust, we rely on the standard question "In general, do you think most people can be trusted?". The trust data employed in this paper essentially derive from the five waves of the World Values Survey (Inglehart et al., 2004), supplemented by data from the 1995 and 2003 LatinoBarometro, the 2001-2004 Asian and East Asian Barometers, the 2001-2007 AfroBarometer and the 2002-2004 Danish Social Capital Project.[11] Bjørnskov (2007) suggests that trust scores are

[9] To be specific, Caselli (2005) and Hall and Jones (2003) precisely assume $\alpha = 0.3$, whereas Prescott (1998) considers $\alpha = 0.25$ and Collins et al. (1996) assume $\alpha = 0.35$.

[10] We estimated that parameter on a panel data set using a between, fixed country effect, and a random country effect model. All estimations are displayed in Tables A2 and A3 in appendix A3.

[11] Early commentators tended to question the validity of the trust measures (Fine, 2001; Durlauf, 2002; Beugelsdijk, 2006). However, most find that national trust scores are relatively good proxies for trust and trustworthiness based on actual, honest behavior. For example, Knack and Keefer (1997) note that the trust scores correlate strongly with return rates from wallet drop experiments and Sapienza et al. (2013) show in a series of experiments that trust scores are good

in general very stable over time. Present day trust levels of second and third generation immigrants in the US have moreover been found to relate to trust levels in the country of origin of their ancestors (Uslaner, 2008; Guiso et al., 2008; Tabellini, 2008). We, therefore, use the averages of all available observations.

While a direct causality from TFP to trust is unlikely, a number of indirect mechanisms may cause simultaneity and reverse causal mechanisms. This would be a concern if, for example, trust became more prevalent as countries grew richer from TFP growth, as Paldam (2009) argues. Although the contention has been rejected by a number of other studies, like Delhey and Newton (2005) and Bjørnskov (2007), we control causality by systematically complementing OLS estimates with estimates obtained by instrumental variables regressions. We thus apply a set of instrumental variables for social trust following suggestions in Guiso et al. (2008), Tabellini (2008) and Bjørnskov (2012).[12] These variables include a dummy variable capturing whether the predominant language of a country exhibits Chomsky's (1981) 'pronoun-drop' characteristic and the average temperature in the coldest month of the year. Tabellini (2008) argues that cultures in which the language allows dropping the personal pronoun (the pronoun-drop characteristic) tend to exhibit less respect for the individual and individual rights, which in turn reflects a culture of individual mistrust. In collectivist cultures, asymmetric power relations among individuals would be more likely to develop, and promises would be conditional on whether or not the promised action is to the collective benefit, both of which reflect a culture of individual mistrust.

The idea that the severity of winters can affect cultural characteristics, such as social trust, goes back to Aristotle and Hippocrates. It is based on the argument that, historically, survival through winters depended to a much larger extent on the help from strangers in relatively colder climates than in the milder climates around the Mediterranean. This would make extending one's trust radius

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predictors of behavior when the stakes are economically relevant. Furthermore, Uslaner (2002) provides evidence from in-depth interviews that a majority of respondents consider 'the man in the street' or other strangers when answering the trust question. As such, social trust is a very different concept and even correlates negatively with particularized forms of trust as measured by respondents' trust in family, friends and colleagues (Uslaner, 2002; Alesina and Guiliano, 2011). Finally, the evidence in Reeskens and Hooghe (2008) shows (despite their conclusions) that the simple trust question is superior to alternative measures of perceived trust and trustworthiness.

[12] The trust literature has suggested a number of ways to instrument for trust. A recent example is the use of genetic distance in Gorodnichenko and Roland (2013). However, most instruments only identify trust in some parts of the world and not others, and might therefore bias the instrumented estimates in the existence of moderating factors (Dunning 2008).

to less familiar people a dominant evolutionary strategy outside this region, leaving the colder north with higher historical trust levels.[13]

Linguistic rules are inherited or evolve over horizons that exceed a century. They can therefore be considered predetermined. Similarly, a country's minimum temperature is clearly exogenous to its economic and cultural development. Both factors are, therefore, predetermined. Moreover, apart from their impact on culture, there is no reason why linguistic rules should affect productivity. It therefore meets the exclusion restriction. Climate may have a direct effect on productivity, but whether temperature in the coldest month of the year *as such* does is unclear.[14] In any case, our results will show that our instruments meet the exclusion restriction and are valid instruments of trust in our regressions.

3.3. Measures of institutional quality

Finally, to test for the importance of indirect mechanisms running through the quality of formal institutions, we distinguish political institutions, primarily determining the way governments are elected and deposed, and economic-judicial institutions, which protect private property rights and contract enforcement and allow for efficient provision of central public goods. In other words, we ensure throughout the paper that we separate aspects of democracy and aspects of legal and regulatory institutions, i.e. the quality of bureaucratic institutions (see Munck and Verkuilen, 2002). As for the measure of the quality of economic-judicial institutions, we use the Fraser Institute indicator of the characteristics of the legal system to proxy for the quality of the legal system (Gwartney and Lawson, 2008).[15] Our preferred measure of political institutions is Marshall and

[13] Regressing trust on these two instruments explains about one half of the cross-country variation in trust scores. Note that Kong (2013) and Durante (2011) tell a very similar story, and find substantial support for geographical and climactic determinants of trust. At the extreme, the climatic story and Aristotle's argument are consistent with the Inuit tradition to keep food under human-shaped stone landmarks called "inuksuk", for people in need. For the same reason, unattended refuges are kept unlocked for mountaineers and skiers to find a place to stay for the night.

[14] Most theories about direct climate effects revolve around either disease environments in countries with very hot climates or average temperatures conducive to farming. However, *average* temperatures are not significant predictors or social trust, while average temperature in the *coldest month of the year* correlates with social trust, which allows us to treat it as a potentially reliable instrumental variable.

[15] The index developed by the Fraser Institute is an un-weighted average of a set of subindices covering judicial independence, the impartiality of the courts, the protection of intellectual property rights, the degree of military interference in law and politics and the integrity of the legal system. The index conceptually measures the efficiency

Jaggers' (2004) Polity IV index, which has the benefit of resting on a relatively minimalist definition of democracy. We thus minimize the risk of conceptual overlap between the two indicators which has made several previous studies difficult to interpret.[16]

3.4. Econometric strategy

To assess the relation between the level of TFP and trust, we follow Hall and Jones (1999), and regress it on the social trust index, using a cross-section of countries in the latest year for which data are available. The specification thus reads:

$$TFP_i = a_0 + a_1\, trust_i + A.D_i + u_i \qquad (7)$$

where TFP_i is the estimate of TFP obtained for country i from (3), and $trust_i$ is that country's trust index. A is a vector of coefficients, D_i a vector of control variables, pertaining to country i, and u_i a random shock.

To capture the potential indirect mechanisms through which trust might work, we include our set of measures of formal institutions, split into economic-judicial and political institutions. Although there is no standard specification, the most obvious control variables are openness, measured by trade volume as a percentage of GDP, and a dummy capturing whether the country is a post-communist country. We supplement these with government expenditure and a measure of the extent of the shadow economy. Regressions controlling for those variables are reported in the robustness checks section.

The strategy to measure the impact of trust on TFP growth is slightly less straightforward than for the level of TFP. As explained above, we can be more confident in the panel dimension of the dataset here, and therefore want to use that dimension. On the other hand, trust is a country's deep structural characteristic best considered time-invariant. We, therefore, resort to the same two-stage method as Olson et al. (2001). Namely, in the first stage, we run a panel regression, where TFP growth over spells of five years, $\hat{TFP}_{it}$, is explained by time-variant control variables and country fixed effects:

$$\hat{TFP}_{it} = b_0 + B.V_{it} + \eta_i + \varepsilon_{it} \qquad (8)$$

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and independence of the judicial system and, thus, provides a clean measure of the likely quality of national judicial institutions.

[16] The robustness checks section reports results obtained using alternative institutional indices.

where B is a vector of coefficients, V_{it} a vector of time-variant control variables, pertaining to country i, η_i is country i's fixed effect and ε_{it} the error term. In the second stage, we regress the country fixed effects estimated in the first stage on trust, and time-invariant control variables. The cross-section regression thus reads:

$$\eta_i = c_0 + c_1\, trust_i + C.F_i + e_i \quad (9)$$

where C is a vector of coefficients, F_i the vector of control variables, and e_i a random shock.[17]

In what follows, the control variables used in the first-stage regression are initial per capita income and initial human capital stock to control for conditional convergence.[18] In the second-stage equation, we use the same control variables as in the regressions explaining TFP levels.

Finally, we want to test the hypothesis that trust causally affects TFP *via* the quality of institutions. Indeed, the association between trust and TFP could, in principle, be due to institutions creating trust or a simple reflection effect (Berggren and Jordahl, 2006). In general, the literature is ambiguous on whether trust affects institutions, institutions affect trust, or the association is bidirectional. To test the hypothesis, we use a three-stage least-squares estimation, and estimate a system of equations, where trust is regressed on predetermined instruments in the first-stage, the relevant measure of institutional quality is regressed on trust in the second-stage, and TFP is regressed on the relevant measure of institutional quality in the third-stage.

4. Empirical results

A casual glance at the data reveals an apparent association between social trust and TFP. Applying an α of 0.4, average TFP in the full sample is 64.3 percent of US TFP, yet the average of the low-trust half – which includes countries such as France and Portugal – is only 55.8 percent of US TFP while the average of the high-trust sample, including a number of developing countries, is 75.1, a difference significant at any conventional level. The overall correlation of 0.5 between trust and TFP also appears in Figure 1a, although the figure shows two clear outliers (Ireland and Thailand).

[17] The results of the first-stage regression are reported in table A5 in Appendix A4. TFP growth appears negatively correlated with initial output and positively with initial human capital stock. The F test for country effects being jointly equal to zero supports the existence of country fixed effects, and the Hausmann test supports fixed effects over random effects, thereby validating the two-stage strategy.

[18] One reason for expecting convergence in TFP is that when an economy moves closer to the technological frontier, its TFP growth may slow down due to more difficulties in innovation than in imitation. We thank a referee for suggesting this possibility.

*** insert figures 1a and 1b here ***

Similarly, Figure 1b reveals a positive association between trust scores and the average growth of TFP over the period 1980-2000. Again, two outliers appear on the figure, Ireland and Jordan.
In the rest of this section, we verify the graphic intuitions provided by Figure 1a and 1b through proper econometric testing. The first sub-section reports baseline OLS estimates, so as to measure the simple association between the level and growth of TFP and their explanatory variables. The next sub-section controls for endogeneity through 2SLS. Sub-section 4.3 reports 3SLS regressions. Sub-section 4.4 outlines the results of a series of robustness tests.

4.1. TFP, formal institutions and trust – OLS estimates

In this section, we report the results pertaining to the impact of trust on the level of TFP, then those that assess the impact of trust on TFP growth. We start by providing simple estimates of the association, before controlling for the two types of institutions. The results are reported in Tables 1a and 1b.

*** insert tables 1a and 1b here ***

The results show that the associations between trust and TFP levels and TFP growth, respectively, are statistically significant at the one-percent level. The results imply that a one standard deviation change in social trust is associated with an increase in TFP levels of approximately 40 percent of a standard deviation.[19] The similar estimates for TFP growth imply that a one-point increase in the trust score results in a 0.3 to 0.4 percentage point increase in the average five-year growth rate of TFP.[20] This estimate, in turn, implies that a one standard deviation increase in trust would result in a more than six percentage point increase in the average growth rate of TFP. Including the Fraser

[19] The beta coefficient is simply computed by multiplying the estimated coefficient of the independent variable by the ratio of the standard deviation of the independent variable to the standard deviation of the dependent variable in the sample used in the regression.

[20] When interpreting the growth effects, one needs to bear in mind that the numbers are the long-run average country fixed effects from panel regressions, including the initial GDP per worker. They, thus, include a convergence effect and must, therefore, be thought of as conditional growth estimates.

Institute measure of legal quality, but not the Polity IV democracy indicator, yields estimates of institutions significant at the one-percent level, but also makes the coefficient of trust indistinguishable from zero at any reasonable level of significance. Specifically, controlling for such institutions reduces the direct impact of trust on TFP to zero while the estimate remains unchanged when controlling for political institutions. This is a first indication that the impact of trust on productivity may be mediated by the quality of economic-judicial institutions.

4.2. TFP, formal institutions and trust – 2SLS estimates

The estimates in Tables 1a and 1b could nevertheless suffer from a simultaneity bias. Tables 2a and 2b therefore use 2SLS, instrumenting social trust by the 'pronoun-drop' dummy and the average temperature in the coldest month of the year. In first stage regressions, these two instruments explain about one half of the variation of trust. Most first stage F-tests exceed the standard rule-of-thumb level of ten, and all Sargan-Hansen tests signal no significant correlation between instruments and residuals. As long as one instrument can be considered sufficiently exogenous, this confirms that the set of instruments is statistically valid.

*** insert table 2a and 2b here ***

The results of 2SLS regressions are qualitatively the same as those obtained with OLS. Concisely, social trust is correlated with TFP at the one-percent level of significance, until the quality of economic-judicial institutions is controlled for. Thereby, the 2SLS estimates confirm the need to separate types of institutions, as our preferred measure of political institutions remains insignificant and does not affect the significance of trust.

The size of effects obtained with 2SLS is also similar to those obtained with OLS. The point estimate of the impact of trust on the level of TFP increases slightly, implying that a one standard deviation increase in trust results in an increase in TFP of almost 60 percent of a standard deviation. A one point increase in the trust score results in a 0.6 to 0.69 percentage point increase in the five-year TFP growth rate.

4.3. TFP, formal institutions and trust – 3SLS estimates

So far, the estimates suggest that trust exerts a significant and causal effect on TFP. However, including measures of formal institutions suggests that the effect of trust occurs through the quality

of economic-judicial institutions. To ensure that these results are not due to institutions creating trust, we provide a set of 3SLS estimates in Table 3a and 3b, in which we instrument trust in a first stage, to establish that this part of the causal chain is indeed causal. The remaining stages track the effect of social trust on TFP through formal institutions, although one must bear in mind that we thereby force *all* trust effects through these channels. Table 3a estimates the effects on TFP levels, whilst Table 3b reports estimates on TFP growth rates.

*** insert tables 3a and 3b here ***

The results in both tables suggest that treating the findings from previous tables as evidence of a causal channel in either levels or growth regressions is unlikely to be misguided. Although we force all trust effects through formal institutions, we still find that results are stronger when exploring economic-judicial institutions. The third-stage test statistics suggest identification problems when using measures of political institutions, due to weak second-stage identification, where the association between trust and political institutions is fragile. Conversely, estimates using either measure of economic-judicial institutions are relatively cleanly identified. Following Williamson's (2000) typology, our estimates reflect how the first level of analysis can affect overall development by affecting factors at higher levels of analysis.

Moreover, the effect of trust on the level of TFP remains quantitatively similar to estimates obtained with OLS and 2SLS. For TFP levels, increasing trust by one standard deviation increases TFP of nearly 60% of a standard deviation. 3SLS estimates also imply that a one-point increase in trust should raise five-year average TFP growth by at least 0.6 percentage points. As a result, a one standard deviation increase in trust would cause a more than a six percentage point increase of five-year average TFP growth. The results, therefore, imply that the impact of trust on TFP and TFP growth is both statistically and quantitatively significant.

4.4. Robustness tests

In this section, we outline the results of addressing several possible limitations and determine the extent to which they may affect our results for both the level and the growth of TFP. Due to space limitations, we do not provide full results but merely summarize them in Table 4.[21] For each type of

[21] The full robustness analysis runs to 20 tables. All results in this section can be obtained from the authors or in the working paper version of the present paper.

test, we report the smallest and largest marginal effect and the particular specification (estimator, control variable, or excluded country) that yields this effect. All additional variables included in the robustness tests are listed in Table A1 in the appendix.

*** insert table 4 here ***

One of the challenges of empirical studies of TFP differences is that there is no established minimum baseline specification. We, therefore, follow recent papers in choosing a small set of different control variables that are intuitively connected to productivity (Klein and Luu, 2003; Dreher et al., 2014). Openness, measured as trade volumes in percent of GDP, is included, as exposure to international competition provides a strong incentive to invest in productivity enhancing activities. Including government final expenditures (% of GDP) may have several different effects, of which we particularly note two possible effects (Barcenilla-Visus et al., 2013). On the one hand, government sectors are often less productive than private sectors, as well as less likely to innovate, due to adverse bureaucratic incentives (Mueller, 2003). They may also have a tendency to become relatively more expensive and consequently less productive over time through the Baumol-effect (Baumol and Bowen, 1966). The efficiency of the government could well determine the quality of public investments. According to Pritchett's (2000) CUDIE argument, government expenditures could, by reflecting the quality of public investments, cause higher observed TFP. The three variables are from the Penn World Tables, mark 6.2, and measured as ten-year averages (Heston et al., 2006). Our control variables also include a dummy for post communist countries in order to take out potential remains of unproductive communist facilities. As the fourth control variable, we include the share of economic activity that takes place in the unofficial or shadow economy. Tu and Bulte (2010) and D'Hernoncourt and Méon (2012) document a direct link of trust to the shadow economy. A lack of trust may, thereby, reduce official output and decrease TFP measured with official figures, simply because some activity is not recorded in official statistics. We ensure that the association between trust and TFP is not a simple accounting issue by controlling for the size of the shadow economy, using the data provided by Schneider (2005a, 2005b).

The results of including these variables overall confirm the findings from Tables 1-3. In particular, the introduction of control variables, when we do not control for formal institutions, does not affect the point estimates of trust at all.

Both development accounting and the growth accounting literatures show that measures of TFP and TFP growth are sensitive to the value of α, as Caselli (2005) illustrates. We have so far used $\alpha = 0.4$ to calibrate our production function, which is the value that we endogenously obtained when estimating the production function on our data set. However, a value of 0.3 is common in the literature. We have replicated the above analyses with either $\alpha = 0.3$ or $\alpha = 0.5$ for the level and growth of TFP, using the same two- and three- stage procedures as in previous tables.

The results are qualitatively unchanged if one assumes $\alpha = 0.3$. Trust remains positively correlated with TFP, unless institutional quality is controlled for. The main difference is quantitative. The coefficients of trust in the regressions are substantially larger with $\alpha = 0.3$ than with $\alpha = 0.4$, with 2SLS. Likewise, the implied effects of trust in the 3SLS estimates are similarly larger.

Increasing the value of α is a more demanding test than decreasing it. In doing so, the role of physical capital accumulation in explaining income differences is inflated, leaving less room for TFP. We raised α to 0.5, and expectedly obtained a smaller coefficient of trust, regardless of the estimation technique.[22] However, trust remained significant, at least at the five-percent level of significance in level regressions, and beyond the one-percent level of significance in growth regressions.

The rationale for these findings is straightforward, once one recalls that trust affects the accumulation of production factors, that TFP is estimated as a residual, and that the variation of the physical capital stock across countries is larger than the variation of the human capital stock. By decreasing (increasing) the value of α, one decreases (increases) the role of differences in the capital stock in explaining differences in output, and conversely raises (decreases) the role of TFP. Since higher trust results in larger capital stocks, decreasing (increasing) α implies that the share of the impact of trust on output that is attributed to its impact on TFP increases (decreases).

Thirdly, we reran all regressions using a set of alternative institutional indicators. Our alternative indicators of economic-judicial institutions are the specific measure of judicial independence from the Fraser Institute, the Law and Order index from ICRG (2009), and the Corruption Perceptions Index (CPI) from Transparency International (2008), the latter capturing the quality of institutions by measuring their evident failure (Knack and Langbein, 2010). To measure political institutions,

[22] We even raised α to 0.6, which is the threshold value where the role of TFP becomes very limited, as Caselli (2005) reports. We found that the results of growth regressions remained qualitatively unchanged, although no variable significantly correlated with trust in level regressions.

we use the Gastil index of political rights and civil liberties, either in full or as two separate measures of the two concepts (Freedom House, 2008). Again, we find qualitatively and quantitatively similar results. None of the measures of political institutions is robustly significant. Conversely, all economic-judicial measures are significant in levels regressions, and corruption is significant in the latter. In 3SLS regressions, in which we force the trust effect through each institutional measure, we find significant results throughout. Again, the goodness-of-fit tests indicate problems with most measures of political institutions, due to the weak association between trust and political institutions, but are unproblematic when with measures of economic-judicial institutions. The evidence that trust impacts productivity through institutions is, therefore, robust to applying a broad set of different institutional indicators.

Given the size of the sample, one may be concerned that our results may be sensitive to the specific countries included in the sample. To test for the influence of single observations, we ran a jack-knife experiment, where each regression was run anew excluding one country at a time. Overall, the jack-knife confirms previous results. This is particularly true for regressions where the level of TFP is the dependent variable. In this case, not only are estimated coefficients stable, but no coefficient ever loses significance due to the deletion of a single observation. The marginal effects of trust when deleting the most influential observations (Zambia and Lesotho) also remain economically significant. The only new result is that the Polity IV index sometimes becomes significantly positive when some countries are individually dropped from the sample (Egypt, Lesotho, Romania, Kenya and Singapore). This result, however, only holds for OLS regressions and not for 2SLS or 3SLS regressions, which are both qualitatively and quantitatively robust to dropping individual regressions.

Regressions where the dependent variable is the estimated fixed effects are slightly more sensitive to the exclusion of individual observations, when endogeneity is not controlled for. OLS regressions confirm the results of previous regressions, as trust and legal quality are robust to dropping individual observations. However, jackknife OLS regressions suggest that the association between TFP growth and the Polity IV index is rather shaky when trust is controlled for, thereby confirming that political institutions are unlikely to constitute a robust channel of transmission of trust. The same holds for the (additional) judicial independence index, which is also the case in OLS regressions. Again 3SLS regressions are both qualitatively and quantitatively robust to excluding individual countries.

Statistical inference may nevertheless be biased, because TFP and TFP growth are estimated variables, resulting in spurious statistically significant coefficients. We, therefore, reran all our estimations using bootstrapped standard errors. The results, again, provide ample support for previous findings, although with one difference: even when we force the effects of trust through institutions in the 3SLS estimates, political institutions are insignificant when the dependent variable is TFP growth. This result provides further evidence supporting the hypothesis that judicial and economic institutions, but not political institutions, are the channel of transmission from trust to TFP growth.

Our final concern is that differences between vintages of the Penn World Table have indeed spurred a lot of discussion in the literature (see e.g. Johnson et al. 2013). We therefore ran two series of robustness checks using version 8 of the Penn World Table (PWT8). In the first series of robustness checks, we applied to PWT8 data the perpetual inventory method described above to compute physical capital stocks. Our results were qualitatively unchanged. In level regressions, we thus observed that trust had a positive and significant effect on TFP, with OLS, 2SLS, and 3SLS. In OLS and 2SLS regressions we still found that legal quality and trust do not both turn significant when included in the same regression. They were, however, significant when included separately in 3SLS regressions.

The results obtained for TFP growth were also broadly in line with previous results. A key difference nevertheless is that the correlation of trust with TFP growth only appeared when parameter α was set to 0.3. Trust then positively correlated with TFP growth in OLS regressions. When legal quality and trust were jointly included, legal quality positively correlated with TFP growth, while the coefficient of trust was insignificant. When trust and the Polity index were jointly included, they both correlated positively with TFP growth; 2SLS results were similar. The difference in 2SLS results was that when trust and legal quality were both controlled for, none was significant, while when trust and Polity were jointly controlled for, only trust was significant. 3SLS results were completely in line with the results of the rest of the paper.

PWT8 allows another, more radical, robustness check. It directly provides two series of TFP estimates based on revised GDP figures and on a computation method that differs from standard TFP measures by letting the depreciation rate differ across countries and over time, and the share of labor differ across countries (see Feenstra et al. 2013).[23] Those two differences increase the

[23] By doing so, we also test the robustness of our findings to the assumption of a single depreciation rate.

predictive capacity of factor endowments. This is in particular true of the second, because it gives more explanatory power to differences in physical capital stocks. As a result, there is less room for TFP, which is why the use of these data provides a more demanding robustness test. Given that social trust affects the choice of production technology (e.g. Akçomak and ter Weel, 2009; Bjørnskov, 2009b), it is also likely to reduce the estimated role of trust.

The first TFP estimate, labelled "ctfp" in PWT8, measures TFP levels at current PPPs, and is recommended for cross-country comparisons. The results for TFP levels are surprisingly in line with results obtained with other estimates of TFP levels. Specifically, we still find a relation between trust and TFP levels in OLS regressions and 2SLS regressions. When we include legal quality as an additional explanatory variable in the OLS regression, it is significantly positive while trust turns insignificant. In 2SLS regression, both are insignificant. When trust and the Polity index are jointly controlled for, trust remains significant and the Polity index is marginally significant at the ten-percent level in the OLS regression and insignificant in the 2SLS regression. 3SLS estimates are in line with previous results.

The second TFP series provided by the PWT8, labelled "rtfpna", measures TFP at constant national prices, and should therefore be used for growth accounting. We used that TFP series to replicate our previous results. While we failed to observe a statistically significant relation between TFP growth on the one hand and trust, legal quality and Polity on the other hand in OLS and 2SLS regressions, 3SLS results were broadly in line with our previous results.

Despite employing two very different approaches to measuring TFP and TFP growth, we therefore continue to find relatively robust evidence for a long-run effect of social trust on productivity. The bulk of the evidence suggests that this effect runs through the quality of economic-judicial institutions such that trust affects institutional quality which, in turn, allows countries to be more productive.

5. Conclusion

In this paper, we have revisited the question of the impact of social trust on TFP. Calculating levels and long-run growth rates of TFP in a cross-section of 67 countries in the early 2000's, and regressing these numbers on social trust, indicates a strong positive association. This association is robust, and not likely to be driven by endogeneity bias. However, the direct association between trust and TFP loses significance when entering standard measures of the quality of economic-

judicial institutions. While we cannot rule out all potential effects, the estimate of trust remains relatively unaffected by including political institutions, suggesting that the main effects run through economic-judicial institutions and not democracy.

Further results, in which we trace the effects of trust on institutional quality, also suggest that trust affects TFP through its influence on the quality of economic-judicial institutions. A battery of robustness tests indicates that the identified effects are robust to standard complications. The evidence in this paper therefore suggests that the trust effect is mainly indirect, although it should not be taken to mean that direct mechanisms do not exist. In particular, trust may affect factor accumulation, as suggested by several previous studies, and could also affect the direct measurement of national income. The evidence, however, implies that the general effect of trust on productivity operates through legal and regulatory governance.

Appendix

A1: Countries in the sample

Algeria, Argentina, Australia, Austria, Belgium, Benin, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Ghana, Greece, Guatemala, Honduras, Hong Kong, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kenya, Republic of Korea, Lesotho, Malawi, Malaysia, Mali, Mexico, Mozambique, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Romania, Rwanda, Senegal, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, Trinidad and Tobago, Turkey, Uganda, United Kingdom, United States, Uruguay, Zambia, Zimbabwe.

A2: Descriptive statistics

*** insert table A1 here ***

A3: Estimates of the capital share

We first estimate the production function by using the levels of per capita production and capital stocks. In a regression of the logarithm of output on the logarithm of the physical and human capital stocks, the coefficient of the physical capital stock directly provides an estimate of alpha. Using panel data for the largest available period (1950-2000), we ran both between and within regressions, the latter being estimated with both fixed and random country effects. The results are displayed in table A2 below.

*** insert table A2 here ***

The between-estimate of alpha tops 0.5. When country effects are allowed, the coefficient of the physical capital stock becomes smaller. In addition, the Hausman test suggests using fixed-country effects. The estimates of alpha obtained with fixed and random effects remain similar and in the vicinity of 0.4. One may also note that the F test for the restriction that the shares of the physical

and human capital stocks sum to one suggests that the probability of this restriction holding in the data is quite large. This finding provides support for using a Cobb-Douglas function with constant returns to scale.

An alternative way to estimate the coefficient of the production function is to run a regression on growth rates. We regressed the average growth rate of per worker output on the average growth rates of the physical and human capital stocks over 1980-2000 using OLS. Here again, the coefficient of physical capital stock in that regression provides a direct estimate of alpha.

*** insert table A3 here ***

We ran both an unconstrained regression and a regression restricting the sum of the coefficients of physical and human capital stocks to be equal to one. Again, in both cases, we found that the coefficient of physical capital stock was close to 0.4.

A4: Panel regression of TFP growth on time-variant variables

*** insert table A4 here ***

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Table 1a: Dependent variable: TFP level, OLS estimations

	(1a.1)	(1a.2)	(1a.3)
Social trust	0.277	-0.0513	0.231
	(3.725)	(0.605)	(2.940)
	***		***
Legal quality		3.313	
		(5.422)	
		***	
Polity IV			0.443
			(1.563)
Constant	22.16	12.42	20.09
	(9.673)	(4.629)	(7.695)
	***	***	***
Observations	67	66	66
R-squared	0.176	0.434	0.205
Adjusted R-squared	0.163	0.416	0.180
F test	13.87	24.11	8.134

Absolute t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1b: Dependent variable: TFP growth fixed effects, OLS estimations

	(1b.1)	(1b.2)	(1b.3)
Social trust	0.00468	-0.000412	0.00370
	(3.573)	(0.301)	(2.712)
	***		***
Legal quality		0.0491	
		(4.945)	
		***	
Polity IV			0.00950
			(1.931)
			*
Constant	-0.110	-0.241	-0.154
	(2.724)	(5.523)	(3.396)
	***	***	***
Observations	66	65	65
R-squared	0.166	0.407	0.212
Adjusted R-squared	0.153	0.387	0.187
F test	12.77	21.24	8.345

Absolute t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 2a: Dependent variable: TFP level, 2SLS estimations

	(2a.1)	(2a.2)	(2a.3)
Social trust	0.388	-0.0716	0.365
	(3.505)	(0.293)	(3.019)
	***		***
Legal quality		3.329	
		(2.456)	
		**	
Polity IV			0.283
			(0.926)
Constant	19.74	13.04	18.22
	(6.306)	(4.431)	(5.919)
	***	***	***
Observations	62	61	61
R-squared	0.177	0.415	0.199
Adjusted R-squared	0.163	0.395	0.171
2nd stage F-test	12.29	20.69	8.212
Sargan test (P-value)	0.655	0.278	0.743
1st stage F-test	25.65	26.80	19.21

Absolute t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 2b: Dependent variable: TFP growth fixed effects, 2SLS estimations

	(2b.1)	(2b.2)	(2b.3)
Social trust	0.00691	0.00252	0.00638
	(3.620)	(0.646)	(3.093)
	***		***
Legal quality		0.0306	
		(1.409)	
Polity IV			0.00650
			(1.246)
Constant	-0.155	-0.204	-0.189
	(2.872)	(4.339)	(3.605)
	***	***	***
Observations	62	61	61
R-squared	0.174	0.366	0.212
Adjusted R-squared	0.160	0.344	0.184
2nd stage F-test	13.10	17.88	9.615
Sargan test (P-value)	0.936	0.525	0.801
1st stage F-test	25.65	26.80	19.21

Absolute t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3a: Dependent variable: TFP level, 3SLS estimations

	(3a.1) Trust	(3a.2) Institutions	(3a.3) TFP	(3a.4) Trust	(3a.5) Institutions	(3a6) TFP
Pronoun-drop	14.55			13.95		
	(4.480)			(3.940)		
	***			***		
Minimum temperature	-0.614			-0.663		
	(3.973)			(3.915)		
	***			***		
Social trust		0.139			0.105	
		(7.135)			(2.394)	
		***			**	
Legal quality			2.726			
			(4.179)			
			***			
Polity IV						3.796
						(2.766)
						***
Constant	14.48	2.070	14.60	15.48	4.317	2.973
	(2.746)	(3.751)	(3.788)	(2.633)	(3.428)	(0.301)
	***	***	***	***	***	
Observations	61	61	61	61	61	61
R-squared	0.465	0.436	0.414	0.475	0.114	-1.706
F-test	26.61	50.91	17.47	27.67	7.651	5.730

Absolute t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3b: Dependent variable: TFP growth fixed effects, 3SLS estimations

	(3b.1) Trust	(3b.2) Institutions	(3b.3) TFP	(3b.4) Trust	(3b.5) Institutions	(3b.6) TFP
Pronoun-drop	14.24			14.30		
	(4.388)			(4.043)		
	***			***		
Minimum temperature	-0.629			-0.651		
	(4.079)			(3.842)		
	***			***		
Social trust		0.139			0.117	
		(7.142)			(2.645)	
		***			***	
Legal quality			0.0479			
			(4.655)			
			***			
Polity IV						0.0590
						(2.597)
						**
Constant	15.07	2.067	-0.237	14.88	4.002	-0.393
	(2.862)	(3.744)	(3.898)	(2.533)	(3.154)	(2.408)
	***	***	***	**	***	**
Observations	61	61	61	61	61	61
Adjusted R-squared	0.465	0.435	0.383	0.475	0.109	-1.171
F-test	26.59	51.01	21.67	27.86	7.00	6.743

Absolute t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Summary of robustness tests

Ef Test	(4.1) Smallest Effect	(4.2) Specification	(4.3) Largest Effect	(4.4) Specification
		TFP levels		
$\alpha = 0.3$	.68	2SLS	.70	3SLS, Polity
$\alpha = 0.5$	.37	3SLS, inst.	.40	3SLS, Polity
Alternative governance	.53	3SLS, Law…	.61	3SLS, Pol…
Control variables	.59	OLS, gov.exp.	.82	3SLS, all
Jack-knife	.41	OLS, (ZMB)	.67	3SLS, Polity (SGP)
Bootstrap	.42	OLS	.61	3SLS, Polity
PWT8, perpetual inventory	0.33	OLS, leg. qual.	4.45	2SLS
PWT8 TFP	0.0098	OLS, Polity	0.017	2SLS, Polity
		TFP growth		
$\alpha = 0.3$	1.09	2SLS	1.11	3SLS, Polity
$\alpha = 0.5$	.63	3SLS, inst.	.67	2SLS
Alternative governance	.76	3SLS, Law…	.89	3SLS, Gastil
Control variables	.57	OLS, gov. exp.	1.15	3SLS, all
Jack-knife	.42	OLS, (LES)	.70	3SLS, leg. qual. (SWE)
Bootstrap	.60	OLS	.89	2SLS
PWT8, perpetual inventory	-0.000697	OLS, leg. qual. (α=.3)	0.015	2SLS
PWT8 TFP	0.00046	OLS, leg. qual.	0.013	2SLS, leg. qual.

Gov. Exp. refers to government expenditures, Gastil to the full Gastil index, Law... to the Law and Order index, inst. to the institutional index, and Pol. to the political rights index. The country excluded from the estimation is indicated in parentheses for jack-knife estimations.

Table A1: Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Per worker output	25528.18	20164.3	1742.45	63909.14
Per worker physical capital stock	5855969	5771045	57405.35	1.93E+07
Per worker human capital stock	2.264	0.578	1.11	3.33
TFP, $\alpha = 0.3$	124.8134	53.7687	24.99866	233.4175
TFP, $\alpha = 0.4$	29.56481	10.19327	7.211648	51.62864
TFP, $\alpha = 0.5$	7.105934	1.936396	2.080427	11.41952
TFP growth, $\alpha = 0.3$	-0.00271	0.123	-0.314	0.267
TFP growth, $\alpha = 0.4$	-0.00559	0.120	-0.348	0.255
TFP growth, $\alpha = 0.5$	-0.00846	0.119	-0.383	0.245
Social trust	26.62	15.51	3.79	64.27
Legal quality	5.64	2.15	1.92	9.17
Polity IV	7.11	4.33	-7	10
Political rights	2.37	1.61	1	7
Civil liberties	2.46	1.35	1	6
Gastil total	2.42	1.45	1	6.5
Jud independence	5.64	2.42	0.91	9.15
Law and order	8.19	2.71	3.09	12
Corruption	5.02	2.41	1.8	9.3
Openness	74.27	54.08	18.24	337.86
Government expenditures	18.82	7.42	5.36	47.75
Post communist	0.0161	0.127	0	1
Shadow economy	34.01	15.84	8.4	68.3
Pronoun-drop	0.27	0.45	0	1
Minimum temperature	9.51	10.53	-16	27

Table A2: Estimates of the production function using levels

	Method	*k*	*h*	*Int.*	
A1.1	*Between*	0.549 (13.67) ***	0.532 (2.41) **	1.212 (2.60) **	R^2=0.881
A1.2	*Fixed country effects*	0.384 (23.27) ***	0.626 (8.61) ***	3.494 (16.67) ***	R^2=0.879
A1.3	*Random country effects*	0.423 (27.61) ***	0.626 (8.86) ***	2.935 (15.14) ***	R^2=0.880
		Hausman test for fixed effects			43.07 ***
		F Test for $\alpha_K + \alpha_L = 1$ (P value for the fixed effect model)			0.88

Table A3: Estimates of the production function using average growth rates

	Method	*k*	*h*	*Int.*	
A2.1	*Unconstrained*	0.407 (8.62) ***	-0.0236 (0.09)	0.07 (1.08)	R^2=0.502 Adj. R^2=0.488 F=37.24
A2.2	$\alpha_K + \alpha_L = 1$	0.419 (8.70) ***	0.581 (12.05) ***	-0.0521 (1.45)	RMSE=0.303

Table A5: Panel regression of TFP growth on time-variant explanatory variables (1950-2000), five-years subperiods

Dependent variable	TFP growth
Constant	1.631
	(6.283)
	***
Initial human capital stock	0.204
	(2.533)
	**
Initial output per worker	-0.187
	(6.039)
	***
Observations	623
Number of countries	80
R-squared	0.0701
F-test for no country effects	2.04
Hausman test (Chi-squared)	47.50

t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figure 1a: Trust and TFP, $\alpha = 0.4$

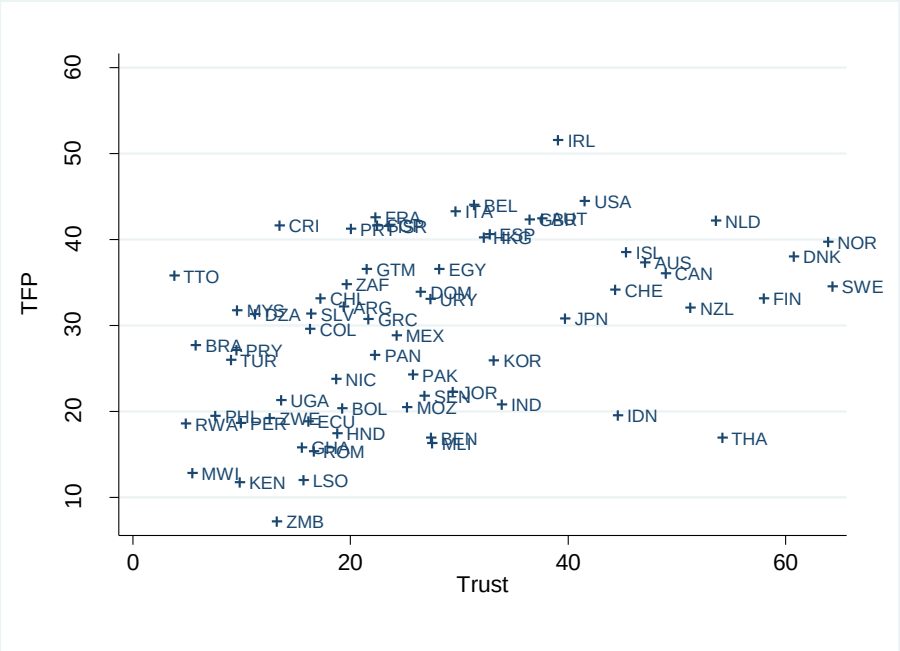

Figure 1b: Trust and TFP average growth 1980-2000, $\alpha = 0.4$