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Inefficient Growth?

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Abstract: The notion that legal institutions matter for growth and development can hardly be disputed in a world of non-zero transaction costs. This research advances the hypothesis that transaction costs explain large and wide-standing cross-country productivity differences. We examine the contribution of transaction costs to total factor productivity for a large panel of countries. We show that transaction costs reflect the policy constraints, country-specific policies, distortions and barriers to entry that discourage the adoption of the efficient use of technology by protecting the vested interests in the existing production process. Our findings suggest that lower costs of contract enforcement, low-cost and efficient insolvency framework and accessible property rights contribute substantially to TFP growth over time while weaker effects are found for lighter business registration and licensing requirements. Our results are stable across a variety of estimation techniques. By exploiting the variation in pre-industrial urbanization rate, disease environment, and latent cultural traits, we show that the negative effect of rising transaction costs on TFP appears to be causal.

JEL classification: C23; K20; K23; K40, O40
Keywords: TFP; transaction costs; economic growth; cross-country productivity differences

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1 Introduction

The relative differences in total factor productivity (TFP) across countries have received widespread scholarly attention (Färe et al. 1994, Young 1994, Coe and Helpman 1995, Edwards 1998, Prescott 1998, Temple 1999, Miller et al. 2000, Baier et al. 2006, Restuccia and Rogerson 2008). It is widely acclaimed that the differences in TFP over time account for the wide-standing gaps in per capita income levels across countries (Romer 1987, 1993, Jones 1995, Caselli et al. 1996, Parente and Prescott 2005, Córdoba and Ripoll 2008). Countries with lower TFP are condemned to substantially slower path of economic growth over time, which largely determines the international income per capita gaps. (Prescott and Boyd 1987, Parente 1994).

If TFP differences are the ultimate source of per capita income gaps across countries, the obvious question to ask is what explain contrasting differences in TFP levels across and within countries. Parente and Prescott (2000) suggest that TFP differences are primarily the result of country-specific policies, distortions, and barriers to entry that establish constraints on labor supply, and on the application of better firm-level production methods. They argue that many of these barriers protect the interests of groups vested in the current production processes, discourage technology adoption and lead to slow economic growth over time. Although the importance of barriers to the efficient use of technology is essential for understanding why Northwestern Europe and United States were the first to embark on the path of modern economic growth (Rosenberg and Birdzell 1986, Clark 1987, Mokyr 1992, Bairoch 1993, Landes 1998, Pomeranz 1998, Maddison 2005, Milanovic 2011, Van Zanden et al. 2014, Bolt and van Zanden 2014), it remains less clear which particular types of policy constraints and distortions are the most important ones in influencing the efficient use of technologies and adoption of new ones.

Since the early days of new institutional economics, we know that transaction costs and legal institutions have a significant impact on the efficient use of technology, and the wealth of nations (Arruñada and Garoupa 2007, La Porta et al. 2008, Cooter and Schäfer 2012). The precedence of transaction costs in explaining the efficient use of technology has been widely discussed by Coase (1960), Arrow (1969),

Cheung (1969), Demsetz (1988), North (1990), Williamson (1996, 2000) and Posner (1998, 2010) among many others. However, it remains less clear how the legal institutions can be appropriately operationalized to explain large gaps in the adoption of efficient technology across countries. It remains somewhat of a mystery which particular types of transaction costs influence the (in)ability of countries to adopt the efficient use of technology. Such an inquiry may nevertheless unravel the critical country-specific policies, distortions and barriers to entry that serve the vested interests, impede the efficient use of technology and, hence, condemn societies to slow growth and persistent income and technology gap behind the frontier countries such as United States and Switzerland.

Conventional economic wisdom holds that growth is always efficient. In the world with non-zero transaction costs, growth may occur even in the presence of resource misallocation. Modern growth theory suggests that growth based on factor accumulation alone without the adoption and use of efficient technologies is bound by the diminishing returns to scale (Easterly et al. 1993, Aghion et al. 1998, Howitt and Aghion 1998, Jones 1999, Segerstrom 2000, Aghion and Howitt 2005). Hence, factor accumulation without efficiency gains may never allow catching-up countries to close the income gap behind the frontier (Durlauf and Quah. 1999, Salinas Jiménez et al. 2006, Jerzmanowski 2007, Erosa and Cabrillana 2008), and condemn them to inefficient growth (Acemoglu and Zilibotti 2001). The notion that institutional environment is the ultimate force behind long-run growth differences has become widely acknowledged (Scully 1988, Knack and Keefer 1995, Gould and Gruben 1996, Hall and Jones 1999, Rodrik et al. 2004, Acemoglu et al. 2005, Trebilcock and Leng 2006, Auer 2013). Countries with institutional framework that strengthens property rights and minimizes contract enforcement costs between citizens tend to be substantially richer than countries with weaker property rights and costly contracting institutions (Torstensson 1994, Barro 1996, Brunetti et al 1998, Levine 1998, Acemoglu et al. 2001, Mahoney 2001, Falvey et al. 2006, Djankov et al. 2006, Amaral and Quintin 2010, Acemoglu and Robinson 2010), and enjoy greater levels of financial development (Clague et al. 1996, 1999, Beck et al. 2003, Claessens et al. 2003, Beck and Levine 2008, Helpman 2009). Although the relationship between various types of property rights- and contracting institutions and long-run economic growth is well-documented, the link between transaction costs and TFP is less clear.

In this paper, we set to examine the contribution of transaction costs to TFP across and within countries to unveil the barriers, constraints, policies and distortions that prevent the adoption of new technologies or a more efficient use of existing ones. The cornerstone of our argument is that high transaction costs discourage the adoption of new technologies or more efficient use of existing one, and favor factor accumulation as the underlying engine of growth. Because of the differences in initial conditions, high transaction costs dampen the efficiency gains and lead to the inefficient growth trap, i.e. subsequent low TFP growth in less developed countries and TFP slowdown in advanced economies. We further unravel the heterogeneity and non-linearity of transaction costs in influencing growth and show that cost-induced policy distortions strongly discourage TFP, particularly in high-income countries. This suggests that transaction costs in frontier economies might be crucial in explaining TFP growth over time.

Several papers are related to our one. Acemoglu et al. (2006) build a formal model of the economy where firms undertake innovation and the adoption of frontier technologies. They show that as the economy approaches the frontier, selection of high-skill managers becomes more important while countries at lower stages of development tend to pursue accumulation-based strategy and rely on factor accumulation sacrificing selection. Closer to the technology frontier, economies switch to innovation-based strategy with younger firms, more efficient use of technology and the adoption of new technologies, and with better selection of firms and managers. Distortionary policies and sources of transaction costs such as limits on product market competition and investment subsidies may be beneficial in the short run but have significant long-run costs as they are likely to prevent the economies from exiting the investment-based strategy, failing to converge with the world frontier. Prescott (1998) shows that differences in factor accumulation and the stock of available knowledge are of minor importance in explaining large international income differences, and suggests that TFP differences account for the bulk of variation in income levels across countries. If the institutional environment is the fundamental force behind long-run growth differences, the differences in transaction costs as the key layer of contracting institutions should have a non-negligible role in the origins and mechanisms behind the TFP differences across and within countries. Concurrently, Rodrik (2008) suggests that any normative implication on

how to improve the institutional environment to foster economic growth is contingent on identifying the binding constraint on economic growth, which starkly differs across countries, and is far from a universal "one-size-fits-all" variety of institutional reform set. And lastly, Posner (1998) and Beck (2010) suggest that although coercion-constraining institutions that guarantee private property rights and effective, predictable, and fair low-cost enforcement of contracts foster entrepreneurship, trade and market exchange, and help economies grow faster, much less is known about which layers of institutions matter most (Acemoglu and Johnson 2005).

We test the transaction costs-TFP hypothesis in a sample of 143 countries in the period 2003-2014 using 24 different comparable country-level indicators. To this end, we reconstruct the TFP levels both across and within countries from the augmented Solow growth model using the data from Penn World Tables (Feenstra et al. 2016). We show that conventional measures of TFP may be subject to temporal and spatial bias resulting from the hidden effect of common technology shocks and country-specific heterogeneity (Serot 1993, Mairesse and Mohnen 2002, Mahadevan 2003, Di Liberto et al. 2008, Del Gatto et al. 2010). We exploit the variation in historical urbanization rate, the prevalence of toxoplasma gondii parasite (Maseland 2013), and cultural traits as possibly exogenous sources of variation in transaction costs, and show that the negative effect of rising transaction costs on TFP appears to be causal.

Our results show that transaction costs might be one of the missing puzzles explaining TFP differences across and within countries. Higher transaction costs are associated with marked decline in TFP levels across and within countries. However, not all transaction costs are created equal. Higher administrative transaction costs, such as stricter licencing requirements, are associated with marked TFP gains over time. On the other hand, higher procedural transaction costs and the administrative costs related to the duration of procedure tend to produce either stationary TFP growth, sustained TFP decline or short-lived, mean-reverting TFP increases. The effect of procedural transaction costs on TFP is both quantitatively large and statistically significant at conventional acceptance rates.

Several caveats should be stated. First, the data availability does not allow us to explore the entire realm of transaction costs and their underlying effect on TFP more fully. The established effects correspond to a fraction of observable transaction costs rather than to the whole

spectrum of costs. Second, the time period of our investigation comprises 12 years. We are fully aware that a more nuanced analysis of the relationship between transaction costs and TFP would require the data spanning across several decades before the effects are fully materialized. Thus, the evidence presented in this paper offers a first look at the results of transaction costs on TFP over a relatively short period of time. Nonetheless, despite the temporal limitation, the evidence still confirms the fundamental importance of transaction costs for TFP development over time even under a relatively short time span which arguably suggests that transaction costs are simply all too important for TFP to be left to scholarly neglect.

Our paper offers several normative suggestions to the policymakers on how to address the barriers, policy constraints and distortions that systematically hamper TFP growth. First, different types of transaction costs tend to influence TFP differently. The magnitude of the estimated effects is far from uniform. Our evidence suggests that rising procedural transaction costs tend to yield a quantitatively much larger effect on TFP than a corresponding change in administrative transaction costs. A well-intentioned policymaker aiming for removing the barriers to TFP should focus on establishing low-cost enforcement of contracts, strengthening property rights and creditor protection (Treblicock and Daniels 2009). Our model estimates suggest that TFP should rise substantially in response to shorter duration of procedures and lower monetary costs of contract enforcement and property rights. The role of administrative transaction costs in TFP growth is less certain. Contrary to popular policy notions, our evidence does not advocate TFP gains in response to markedly lower administrative transaction costs across the board. At best, our results suggest that shorter duration of administrative procedures may boost TFP levels whereas the effects appear to be hump-shaped with TFP-maximizing levels. Second, the evidence subscribes to Rodrik (2008) second-best view of institutional change with emphasis on transaction costs. According to this view, policymakers in developing countries should focus on establishing second-best institutional environment that takes into account context-specific market and government failures. Levels of transaction costs vary widely across countries. While some countries are constrained by the weakness of contract enforcement, others' primary concern is costly and creditor-biased insolvency framework. Hence, policymakers should focus

on targeting the set of transaction costs, which comprise the binding constraints on TFP growth. Once the binding constraint is identified, the policymakers should focus on designing the appropriate policy measures to remove the constraint rather than pursing a "one-size-fits-all" policy package (Rodrik 2006). Third, the evidence offers ample support to the notion that getting administrative transaction costs to zero is questionable (Arruñada 2007). If anything, removing the administrative barriers to business registration and licensing requirements altogether appears to yield no discernable increase in TFP while keeping such barriers as a screening device on incumbent firms tends to boost TFP consistently and may be viewed as a form of productive formalism (Epstein 1984).

The paper is structured as follows. In Section 2, we present and discuss the identification strategy. Section 3 presents the data. Section 4 discusses the results and a variety of robustness checks. Section 5 concludes.

2 Identification Strategy

Our goal is to estimate the contribution of transaction costs to total factor productivity (TFP) consistently. The basic cross-country TFP level relationship with the unobserved effects and common technology shocks that takes place is:

$$TFP_{j,t} = \gamma_0 + \hat{\lambda}_1 \cdot C_{j,t} + \hat{\mu}_1 \cdot k_{j,t} + \hat{\mu}_2 \cdot h_{j,t} + \mathbf{X}'\beta + \sum_{j=1}^{J} \hat{\Phi}_j \cdot 1\left[i \in \{0,1\}\right] + \sum_{t=1}^{T} \hat{\pi}_t \cdot 1\left[t \in \{0,1\}\right] + u_{j,t} \quad (1)$$

where TFP is the level of total factor productivity in j-th country where $j = 1, 2, \ldots J$, γ_0 is the common TFP level accessible to all countries, C denotes transaction cost variable, *k* denotes physical capital investment, *h* denotes human capital investment, the set of $\hat{\Phi}_j$ response coefficient comprises the full set of country-fixed effects, $\hat{\pi}_t$ is the full set of time-fixed effects capturing the influence of technology shocks common to all countries, **X** denotes the vector of control variables such as the size of

the manufacturing sector, share of R&D expenditure, various measures of financial development, trade openness and macroeconomic stability covariates, and u is the random error term capturing transitory stochastic disturbances. The key coefficient of interest is $\hat{\lambda}_1$ which denotes the contribution of transaction costs to TFP level.

To allow for arbitrary serially correlated stochastic disturbances and heteroscedasticity distribution of residual variance across and within countries, the standard errors are clustered on country-level and time-level using the non-nested multiway clustering estimator for the empirical distribution function (Cameron, Gelbach and Miller 2011). Allowing for the non-linearities in the effect of transaction costs on TFP, the basic empirical model setup is:

$$TFP_{j,t} = \gamma_0 + \sum_{p=1}^{P} \lambda_1 \cdot C_{j,t}(p) + \hat{\mu}_1 \cdot k_{j,t} + \hat{\mu}_2 \cdot h_{j,t} + \mathbf{X}'\beta + \sum_{j=1}^{J} \hat{\Phi}_j \cdot 1\left[i \in \{0,1\}\right] + \sum_{t=1}^{T} \hat{\pi}_t \cdot 1\left[t \in \{0,1\}\right] + u_{j,t} \quad (2)$$

where p denotes the p-th order polynomial term in the underlying transaction cost C variable of interest. The chief threat to the validity of fixed-effects TFP specification is posited by the violation of strict exogeneity assumption since the lagged levels of TFP are by default correlated with the error term. When the strict exogeneity assumption is violated, the fixed-effect estimate of $\hat{\lambda}$ in Eq. (2) is inconsistent. We mitigate the possible violation of strict exogeneity assumption by deploying Arellano and Bond (1991) dynamic panel data estimator, and eliminate the fixed-effects using first-differences in Eq. (2) to achieve parameter consistency and asymptotic efficiency in the presence of heteroskedastic residual distribution. In particular, we re-evaluate the effects of transaction costs on TFP by estimating the following dynamic panel data TFP specification:

$$TFP_{j,t} = \gamma_0 + \sum_{k=1}^{K} \alpha_k \times TFP_{j,t-k} + \mathbf{c}_{\mathbf{j,t}}^{'}\lambda + \hat{\mu}_1 \cdot k_{j,t} + \hat{\mu}_2 \cdot h_{j,t} + \mathbf{x}_{\mathbf{i,t}}^{'}\beta + \sum_{j=1}^{J} \hat{\Phi}_j \cdot 1\left[i \in \{0,1\}\right] + \sum_{t=1}^{T} \hat{\pi}_t \cdot 1\left[t \in \{0,1\}\right] + \xi_{j,t} \quad (3)$$

for each $j = 1,2,...J$, and $t = 1,2,...,T_i$ where α denotes k-th lag of the TFP with $k = 1$, $\mathbf{x}_{\mathbf{i,t}}$ is an $1 \times m_1$ vector of strictly exogenous covariates from Eq. (2), $\mathbf{c}_{\mathbf{i,t}}$ is the pre-determined and endogenous transaction costs to be estimated, λ is the set of transaction costs parameters, D_j and D_t is the set of panel-level country-fixed effects and time-fixed effects correlated with the covariances, and $\xi_{j,t}$ is the set of stochastic disturbances. Dynamic panel specification for TFP also allows us to determine which transaction costs matter for TFP after controlling for the TFP state dependence, and the set of technology shocks common to all countries.

Another key threat to the validity of our empirical strategy concerns the endogeneity of transaction costs. Since high-TFP countries are more likely to afford low transaction costs, the estimated coefficients, the estimated transaction cost parameters might be plagued by the reverse causation. In the absence of plausibly exogenous sources of variation, the estimated parameters do not unveil whether changes in TFP shape transaction costs or vice versa. Econometrically, the presence of omitted variable bias inherent in Eq. (2) implies that $\mathrm{cov}(C,u) \neq 0$ which renders the estimated transaction cost parameter implausible by violating the exogeneity assumption.

Our approach to tackle the reverse causation in the relationship between transaction costs TFP is to exploit time-invariant historical shocks, disease environment, and cultural traits as plausibly exogenous sources of variation to consistently estimate the contribution of transaction costs to TFP. Specifically, we isolate the effects of transaction costs on TFP

from other observables and unobservable channels by exploiting the cross-country variation in time-invariant shocks, disease environment and cultural traits by deploying four instrumental variables. First, following Acemoglu et al. (2002), we compute the country-level urbanization rate in 1500 as a relevant source of variation in long-run transaction costs. Second, similar to Maseland (2013), we use the prevalence of toxoplasma gondii parasite as a proxy for the disease environment to address the endogeneity of transaction costs as an institutional variable, and prevent the omitted variable bias from contaminating the model setup. And third, we exploit the variation in cultural traits as a relevant source of variation in transaction costs (Klasing 2013) to partially mitigate the reverse causation inherent in the nexus between transaction costs as an institutional variable and growth. Our key identifying assumption is that the historical shocks, disease environment, and cultural traits do not influence TFP beyond their effect on transaction costs, which we subject to rigorous tests. Econometrically, our covariance restrictions to maintain the exogeneity assumption, are $\operatorname{cov}\left(U_{j,t}^{1500}, u_{j,t}\right)=0$, $\operatorname{cov}\left(\Delta_{j,t}, u_{j,t}\right)=0$ and $\operatorname{cov}\left(\mathrm{K}_{j,t}, u_{j,t}\right)=0$, where $U_{j,t}^{1500}$ is the country-level urbanization rate in the year 1500, Δ is the measure of disease environment proxied by the prevalence of toxoplasma gondii, and *K* is the variable capturing latent cultural traits.

To address the reverse causation between transaction costs and TFP, we estimate the following first-stage specification for transaction costs

$$\begin{aligned} C_{j,t} &= \gamma_0 + \gamma_1 \cdot U_{j,t}^{1500} + \gamma_2 \cdot \Delta_{j,t} + \gamma_3 \cdot \mathrm{K}_{j,t} + \hat{\mu}_1 \cdot k_{j,t} + \hat{\mu}_2 \cdot h_{j,t} \\ &+ \mathbf{X}'\beta + \sum_{j=1}^{J} \hat{\Phi}_j \cdot 1\left[i \in \{0,1\}\right] + \sum_{t=1}^{T} \hat{\pi}_t \cdot 1\left[t \in \{0,1\}\right] + w_{i,t} \end{aligned} \tag{4}$$

where C denotes transaction costs in country j at time t, U^{1500} is the country-level urbanization rate in the year 1500, Δ denotes the disease environment proxied by the prevalence of toxoplasma gondii bacteria, and K denotes latent cultural traits while w denotes the first-stage random error term.

2.1 Threats to Identification

The key identifying assumption from our covariance restrictions is that the urbanization rate in 1500, the prevalence of toxoplasma gondii and latent cultural traits do not influence TFP through channels other than transaction costs. Although we subject the identifying assumption to rigorous testing, several theoretical caveats about its justification should be stated. While it might be superflous to use contemporary urbanization rate as an IV for transaction costs given the simultaneity bias, historical urbanization rate in 1500 is sufficiently exogenous to isolate the effect of costs on TFP as it mimics the historical shock at the juncture point. Second, a large strand of literature invokes geographical and climatic factors as an explanation for the quality of present-day institutions (Beck et al. 2003, Hall and Jones 1999, Acemoglu et al. 2001, Sachs and Malaney 2002). The disease environment contributed to the differences in institutional quality across country by lowering the costs of establishing extractive institutions, which promoted the exploitation of land by the political and economic elites. A similar argument is advocated by Sokoloff and Engerman (1997) who maintain that natural resource endowments in tropical countries evolved into an extreme inequality of land ownership by fostering the development of endowment-based economic activities (Bruhn and Gallego 2012) and institutional framework biased against non-elites (Acemoglu et al. 2014), which persist down to the present day. Combined with the disease environment, path dependence invokes the relevance of initial conditions to shape contemporary institutions (Auer 2013). Hence, the disease environment should matter only for the level of transaction costs without an independent and discernable effect on TFP. And third, cultural traits either enhance or restrain the cooperation among individuals. Cultural environment conducive to cooperation, individualism and trust tends to foster the efficient provision of public goods, improved state capacity and, thus shapes the level of transaction costs. On the other hand, the cultural environment characterized by high level of uncertainty avoidance, collectivist traits, and greater distrust have been shown to increase the demand for redistribution (Alesina and Giuliano 2011), and regulation (Aghion et al. 2010). Such cultural traits lower the cost of opportunistic behavior, maintain the disrespect for law and order as a cultural norm, which condemns institutional development through the persistence of high transaction costs.

3 Data

3.1 Total Factor Productivity

Our total factor productivity series encompasses 143 countries spanning across 2003-2014 period based on the underlying augmented Solow growth model with physical capital and human capital. Since the total factor productivity is measured as a residual from the cross-country growth regression, our approach is similar to Feenstra et al. (2015) where our data on real GDP per capita (Geary-Khamis 2005 constant prices) are from. Our measure of human capital is based on the average years of education (Van Leeuwen et al. 2011, Barro and Lee 2012) rather than a combined index of human capital return and years of schooling (Psacharopoulos 1994). The data on the stock of physical capital is from Feenstra et al. (2015) using the investment-to-GDP ratio as a proxy for the capital stock following Mankiw et al. (1992) and Acemoglu (2009) whereas the data on population growth is from *United Nations Demographic Yearbook* series. Since the level of TFP might exhibit a persistent serial correlation over time, the failure to correct the underlying for heteroscedasticity might mask the true path of TFP over time.

Our measure of total factor productivity (TFP) is based on computing the Solow residual to obtain the contribution of unobserved technology to productivity differences across and within countries. To this end, we use Penn World Tables 8 (Feenstra et al. 2015) to derive comparable TFP series both with between-country and within-country variation in two steps. In the first step, we use the output-based real GDP in current-year prices and deflate it with 2005 constant prices to obtain country-level real GDP differences over time. The constant prices output-based GDP series is derived from the national accounts to yield a representative set of growth rates without the PPP adjustment, which would change growth rates substantially. In the second step, we use the PPP conversion for 2005 benchmark year and apply the growth rates backward and forward to construct the TFP level for the full set of countries and years. Specifically, we deflate the observed differences in output-based GDP by the Törnqvist quantity index of factor endowments such as labor and human capital to obtain a meaningful and reasonably unbiased measure of PPP-adjusted productivity differences between countries. The Törnqvist quantity index of factor endowments is

constructed using the observed factor prices and shares. More specifically, the aggregate productivity of j-th country relative to the k-th country (i.e United States) is written as follows:

$$\ln Q_{\text{r}}_{Törnqvist}\left(\mathbf{v}_j,\mathbf{v}_k,\mathbf{w}_j^*,\mathbf{w}_k^*\right)=\sum_{l=1}^{L}\frac{1}{2}\left(\frac{w_{lj}^* v_{lj}}{\sum_m w_{mj}^* v_{mj}}+\frac{w_{lk}^* v_{lk}}{\sum_m w_{mk}^* v_{mk}}\right)\ln\left(\frac{v_{lj}}{v_{lk}}\right) \tag{5}$$

where $\left(\mathbf{v}_j,\mathbf{v}_k,\mathbf{w}_j^*,\mathbf{w}_k^*\right)$ is the set of factor endowments, and where w_{lj}^* and w_{lk}^* denote the factor prices from the reference price and share series. The corresponding TFP measure is computed using the growth rate of real output-side GDP from the national accounts data:

$$TFP_{j,t}=\frac{ry_{j,t}^{NA}}{Q_{\text{r}}_{Törnqvist}\left(\mathbf{v}_{j,t},\mathbf{v}_{j,t-1},\mathbf{w}_{j,t},\mathbf{w}_{j,t-1}\right)} \tag{6}$$

where TFP denotes the PPP-adjusted total factor productivity in country j at time t, ry^{NA} is the 2005 constant-price output-based real GDP[†], $Q_{\text{r}}_{Törnqvist}\left(\cdot\right)$ is the relevant Törnqvist quantity-related index. The advantage of the constant-price TFP measure is that it captures structural productivity shifts implied from the output-based real GDP level as a first-order approximation of TFP differences both across and within countries. By default, dividing the observed differences in real GDP by the Törnqvist quantity-related index of factor endowments relies on the strict neoclassical assumptions such as perfect competition in product and factor assumptions. Since TFP level is estimated from translog production function, the TFP measure in Eq. (6) reflects cross-country differences in aggregate technology as a rough but plausible proxy for TFP level.

One potential disadvantage of the derived TFP measure is the absence of the capital decomposition by asset, which implies that a portion

[†] Since we use national accounts data, the real GDP is measured in country-specific national currency unit.

of the TFP measure is measured with error. This presents a limitation per se to capture the full extent of TFP differences across and within countries in our approach. Given a large number of countries for which we observe TFP levels and differences, a complete decomposition of capital stock by type of asset is too difficult to warrant a conclusive quantification. Since the asset-based capital stock decomposition would change the underlying weight of the capital stock in approximating the TFP level, the contribution of human capital and other factor endowments remains generally intact and allows us to use the derived TFP measure to proxy TFP differences across countries and over time.

3.2 Transaction Costs

The data on the size and distribution of transaction costs is based on the series of *Doing Business* reports from the World Bank for the period 2003-2014. Our focus does not encompass the entire range of transaction costs but the subset of costs which can be observed consistently over the 12-year period across a large number of countries, and are in the realm of the firm's life cycle. Even though our approach does not address the entire realm of transaction costs, emphasizing several distinctive institutional categories of costs permits a first-order approximation of the size of transaction costs and its importance in influencing the paths of economic growth and total factor productivity. Six institutional categories and domains are considered in building the indices of transaction costs.

First, the costs of starting business records all procedures officially required and commonly held in practice to start and formally operate an industrial or commercial business (Djankov et al. 2002). The set of procedures includes obtaining all necessary licenses and permits, and completing any required notifications, verifications, and inscriptions for the firm and employees with the relevant authorities. The cost of starting business is decomposed into four sub-categories: (i) number of procedures, (ii) duration, (iii) monetary cost, and (iv) paid-in minimum capital requirements.

Second, the costs of dealing with construction permits records all necessary procedures for a firm in the construction industry to build a warehouse. The transaction costs of dealing with permits are decomposed into (i) number of procedures, (ii) duration, and (iii) cost of obtaining permits to comply with formalities to build a warehouse.

Third, the cost of property registration measures the full sequence for a firm to purchase a property from another firm, and to transfer the property title to the buyer's name to be used for expanding its business, as a collateral in taking new loans, or to sell the property to another firm. The total cost of property registration is broken down into three specific sub-categories: (i) the number of procedures to legally transfer title on immovable property, (ii) time required to complete each procedure, and (iii) cost required to complete each procedure. A procedure is defined as any interaction of the buyer or the seller, and their legally required agents with external agents (government agencies, inspectors, notaries, and lawyers).

Fourth, the cost of paying taxes measures the mandatory contributions that a medium-sized firm must pay in a given fiscal year, and the administrative burden of paying taxes and contributions (Djankov et al. 2010). Measured taxes and contributions include corporate income tax, social contributions, labor tax paid by the employer, property taxes, property transfer taxes, dividend tax, capital gains tax, financial transactions tax, waste collection tax, vehicle and road taxes, and other small taxes and fees. The difficulty of paying taxes is decomposed into two specific sub-categories: (i) time to pay taxes, and (ii) total tax rate.

Fifth, the cost of international trade measures the time and cost associated with the logistical and administrative process of exporting and importing goods (Djankov et al. 2008), and provides a comprehensive measure of long-distance trade costs. The cost of international trade is broken down into three sub-categories: (i) time to export and import, (ii) number of documents necessary to export and import, and (iii) monetary cost of export and import (in USD per container).

Sixth, the cost of contract enforcement measures the time and cost for resolving a commercial dispute through a local first-instance court. It provides a comprehensive measure of the efficiency of judicial system in resolving a commercial dispute (Djankov et al. 2003). Three distinctive sub-categories of contract enforcement cost are considered: (i) number of procedures to enforce a contract, (ii) duration of enforcing a contract, and (iii) cost of enforcing contracts.

And seventh, the cost of resolving an insolvent firm captures the time, cost and outcome of insolvency proceedings, and is derived from questionnaire-based responses by local practitioners on insolvency proceedings and bankruptcy systems (Djankov et al. 2008a) Three sub-categories are considered: (i) time to resolve an insolvent firm, (ii) cost

of resolving an insolvent firm, and (iii) creditor recovery rate (in cents per USD of creditor claim).

Table 1. Descriptive Statistics

		StD							
	Mean	Within	Between	Overall	Min	Max	P25	P75	P90
Panel A: Outcomes									
Real GDP Per Capita	12256	1375.92	13716	13741	204.01	70385	2233	17853	33405
Total Factor Productivity	0.000	0.219	0.758	0.787	-1.863	7.631	-0.516	0.572	0.927
Panel B: Transaction Costs									
Costs of Starting Business									
# Procedures	0.367	0.093	0.178	0.201	0	1	0.167	0.500	0.722
Duration (#days)	0.162	0.090	0.135	0.162	0	1	0.055	0.204	0.353
Cost (% per capita income)	0.024	0.061	0.037	0.071	0	1	0.001	0.004	0.049
Paid-in minimum capital (% per capita income)	0.004	0.024	0.011	0.026	0	1	0.000	0.001	0.009
Cost of Dealing with Construction Permits									
# Procedures	0.222	0.086	0.135	0.160	0	1	0.109	0.182	0.418
Duration (# days)	0.163	0.051	0.110	0.122	0	1	0.089	0.198	0.295
Cost (% warehouse value)	0.052	0.056	0.097	0.112	0	1	0.005	0.047	0.124
Cost of Property Registration									
# Procedures	0.359	0.049	0.170	0.176	0	1	0.231	0.429	0.571
Duration (# days)	0.074	0.052	0.079	0.095	0	1	0.021	0.085	0.167
Cost (% property value)	0.204	0.055	0.169	0.177	0	1	0.079	0.266	0.442
Costs of Paying Taxes									
Duration (# hours)	0.121	0.036	0.107	0.113	0	1	0.062	0.139	0.230
Total tax rate (% commercial profit)	0.128	0.056	0.097	0.112	0	1	0.079	0.143	0.199
Cost of International Trade									
# Documents to export	0.345	0.094	0.148	0.175	0	1	0.222	0.444	0.556
Time to export (# days)	0.221	0.055	0.178	0.186	0	1	0.095	0.288	0.476
Cost to export (USD per standardized cargo container)	0.160	0.043	0.143	0.149	0	1	0.064	0.198	0.333
#Documents to import	0.329	0.070	0.141	0.157	0	1	0.222	0.444	0.500
Time to import (# days)	0.225	0.069	0.174	0.187	0	1	0.090	0.310	0.500
Cost to import (USD per standardized cargo container)	0.147	0.043	0.126	0.133	0	1	0.067	0.176	0.311
Cost of Contract Enforcement									
# Procedures	0.468	0.023	0.178	0.179	0	1	0.353	0.588	0.676
Duration (# days)	0.325	0.045	0.189	0.194	0	1	0.198	0.396	0.561
Cost of enforcement (% claim)	0.190	0.040	0.176	0.181	0	1	0.091	0.221	0.360

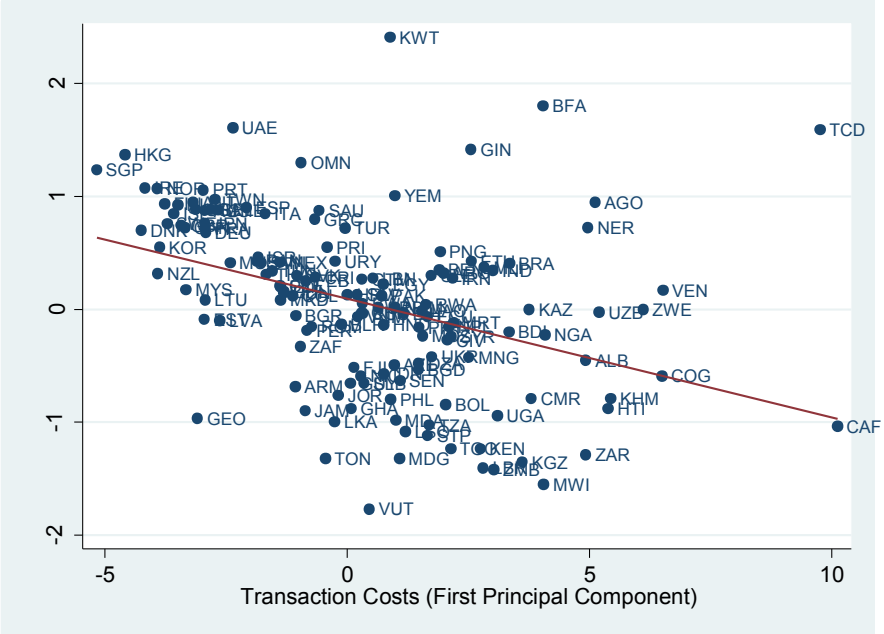
(cont'd Table1) Cost of Resolving Insolvency									
Duration (# years to resolve an insolvent firm)	0.284	0.081	0.149	0.169	0	1	0.160	0.360	0.510
Cost (% estate)	0.202	0.023	0.153	0.155	0	1	0.107	0.280	0.387
Recovery rate (cents per USD)	0.613	0.056	0.255	0.261	0	1	0.522	0.801	0.912

We construct the level of transaction costs for a total of 24 different indicators using the linear scaling transformation (Kovac and Spruk 2015) to normalize the differences in transaction costs are countries in the range without excessive sampling variation on the scale between 0 and 1 where higher values indicate greater transaction costs. Specifically, the linear scaling transformation for *i*-th indicator of transaction that takes place is:

$$\tau_{i,j,t} = \frac{\mathrm{T}_{i,j,t} - \min\limits_{T_{1t,2t,\ldots Jt}} \left\{\mathbf{T}\right\}}{\max\limits_{T_{1t,2t,\ldots Jt}} \left\{\mathbf{T}\right\} - \min\limits_{T_{1t,2t,\ldots Jt}} \left\{\mathbf{T}\right\}} \tag{7}$$

where τ is the normalized index of *i*-th transaction cost across $j = 1, 2, \ldots J$ countries and $t = 1, 2, \ldots T$ years, $\mathbf{T}$ is the original untransformed transaction cost indicator, and $\mathbf{T}$ is the vector of transaction cost values per indicator for each year. The key advantage of linear scaling transformation is that it allows us to observe a direct response of total factor productivity and growth paths to the change in transaction costs. Secondly, linear scaling transformation does not suffer from excessive sampling variation in the underlying indicators since the extent of transaction costs is normalized in a definite range between 0 and 1. And thirdly, normalizing cross-country differences in transaction costs partially alleviates the presence of outliers resulting from either excessively high or low observed transaction costs and does not render the identification strategy inconsistent or vaguely defined. In Table 1, some descriptive statistics for the key outcomes of interest and for the transaction costs is presented. Figure 1 plots the first principal component of the full set of transaction cost indicators against the TFP series in 2014 as a reference year, and shows a strong aggregate correlation between costs and TFP.

Figure 1. Transaction Costs and Total Factor Productivity Across 143 Countries



3.3 Covariates and Transmission Mechanism Variables

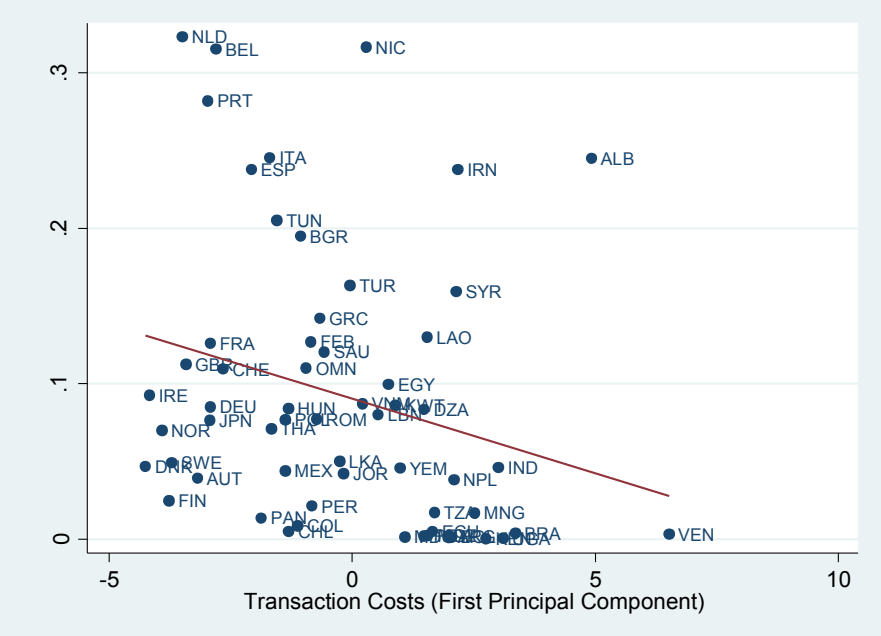
Our covariates and potential transmission mechanism variables proxy the mechanisms through which transaction costs exhibit the influence on TFP. This allows us to distinguish between the set of direct and indirect effects of costs on TFP. The set of covariates and transmission mechanism variables specifically consists of the share of R&D expenditure in percentage of GDP, credit-to-GDP ratio, share of trade in GDP, share of manufacturing in GDP, and inflation rate. These variables allow us to capture the channels such as financial development, innovation, trade openness, manufacturing and macroeconomic stability where the indirect effect of transaction costs on TFP may be perceptible. The data on the whole set of covariates and transmission mechanism variables is from *World Development Indicators* (World Bank 2015).

3.4 Instrumental Variables

3.4.1 Urbanization Rate in 1500

A large strand of scholarly literature suggests the pivotal importance of the initial conditions for long-term economic outcomes (Acemoglu et al. 2002). In a similar vein, we use to urbanization rate in 1500 to isolate the effects of transaction costs as an institutional variables on TFP. The data on urban population is from Fink-Jensen (2015). We compute the urbanization ratio by dividing the urban population with the country-level total population adjusted for administrative territorial boundary changes over time. A brief descriptive evidence suggests an arguable importance of urbanization rate in 1500 for present-day transaction costs, which is consistent with Acemoglu et al. (2005) who argue that the growth of Atlantic trade strengthen merchant groups by constraining the political power of monarchs, leading to changes in property rights institutions which laid the seeds of subsequent post-1500 growth. Therefore, urbanization rate in 1500 can be viewed as a rough proxy for pre-industrial development (Bairoch 1983, De Vries 1984, De Long and Shleifer 1993). Figure 2 plots the urbanization rate in 1500 against the first principal component of transaction costs described in Table 1.

Figure 2. Urbanization Rate in 1500 and Present-Day Transaction Costs



The aggregate evidence suggests a strong impact of initial pre-industrial development on present-day transaction costs. In particular, the descriptive evidence seems to suggest that societies with greater levels of pre-industrial development, particularly Belgium, the Netherlands, and a handful of other countries tend to have considerably lower transaction costs down to the present. The aggregate correlation (-.28) is statistically significant at 1%.

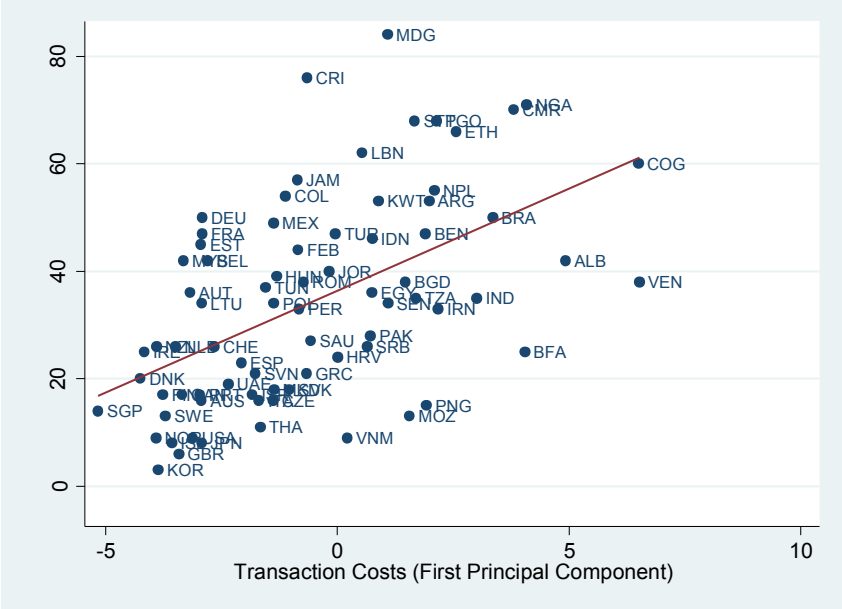
3.4.2 The Prevalence of Toxoplasma Gondii

Toxoplasma gondii is an intracellular parasite that causes toxoplasmosis. It is found worldwide and it is hosted by domestic cats' intestines in which the parasite can undergo sexual reproduction (Tenter et al. 2000, Hill and Dubey 2002). If the intermediate host is infected, the parasite is embedded in the brain, which enhances its life cycle (Berdoy et al. 2000, Flegr et al. 2014). The parasites may also affect the behavior of intermediate hosts by worsening the motor performance, incurring learning deficits, and reducing the avoidance of open spaces (Hrda et al. 2000, Flegr 2007, Sugden et al. 2016). A large and growing number of studies have linked the prevalence of pathogens such as toxoplasma gondii to the economic outcomes and political institutions. Letendre et al (2010) argue that infections diseases explain the incidence of civil wars and armed conflict, Thornhill et al. (2009) argue that the prevalence of pathogenic parasites successfully predicts the levels of democracy across countries. Flegr et al. (1996) and Webster (2001) demonstrate persistent adverse effects of toxoplasma gondii on individual behavior, linking it to higher levels of anxiety and fear, fear, worriness, and insecurity. Maseland (2013) shows that societies with greater prevalence of toxoplasma gondii have less cooperative cultural traits, greater levels of distrust, and deleterious institutional quality.

The data on the country-level prevalence of toxoplasma gondii is from Flegr et al. (2007) who document the prevalence of toxoplasmosis in a set of 88 countries. We use the rate of prevalence adjusted to a standard age 22 years to eliminate prevalence-related differences caused by the differences in childbearing ages in various countries using Barber (2004) adjustment criteria. In Figure 3, we plot country-level prevalence of toxoplasma gondii against the first principal component of transaction costs. The evidence suggests that greater levels of toxoplasma gondii prevalence predict markedly higher level of transaction costs. The

correlation between toxoplasma gondii and transaction costs is 0.53, and is statistically significant at 1%, which confirms the relevance of toxoplasma for the varying levels of transaction costs across countries.

Figure 3. The Prevalence of Toxoplasma Gondii and Transaction Costs Across Countries



3.4.3 Cultural Traits

A large and growing strand of literature subscribes to the view that culture matters for institutional development (Weber 1904, Willaimson 2009, Tabellini 2008, Beugelsdijk and Maseland 2011, Beugelsdijk and Klasing 2016). Hence, culture should matter for transaction costs. Our measures of cultural traits are from Hofstede (2001) who distinguished between six latent dimensions of national culture. First, power distance captures the preferences for hierarchy and strong rules, which reflects the degree to which individuals tolerate unequal distribution of power. Second, individualism vs. collectivism dimension reflects the degree to which people rely on themselves or on the groups. Individualistic societies have looser personal ties, and often use "I" rather than "we" in personal communication. By contrast, collectivist societies have tight relationship prolonged into extended families and groups with mutually reinforcing support and loyalty when conflicts occur. Third, uncertainty avoidance reflects the tolerance for ambiguity where people face or avoid an unexpected situation away from the status quo. High-avoidance societies prefer strict rules, guidelines, and codes of conduct. By contrast,

low-avoidance societies more openly accept different thoughts and ideas, impose fewer regulations and permit greater freedom of choice in the social environment. Fourth, masculinity vs. femininity dimension reflects the preference for a society based on assertiveness and material rewards for success. By contrast, feminine societies emphasize the preference for cooperation, modesty, care for the weak and poor, and place the quality of live above the materialist values. Fifth, long-term vs. short-term orientation dimension associates the past with the present and future action. A low degree of the dimension reflects somewhat stronger preference for time-honored traditions, while a high degree suggests that people view adaption and pragmatic problem-solving as essential. And sixth, indulgence vs. restraint dimension reflects whether or not joys are fulfilled. For instance, indulgent society allows for a free and generous gratification of human desires for having fun and enjoying life. By contrast, restrained society controls the gratification of human needs and regulates via strict social norms. We compute a more parsimonious measure of culture by taking the first principal component of the six dimension indicators. The resulting rotated measure reflects the combined prevalence of latent cultural traits captured by six underlying indicators. The latent cultural trait variable ranges from -3.32 in Denmark to 2.40 in Albania, and designates strong cultural differences across countries. Figure 4 plots transaction costs against the first principal component of culture.

Figure 4. Transaction Costs and Latent Cultural Traits Across Countries

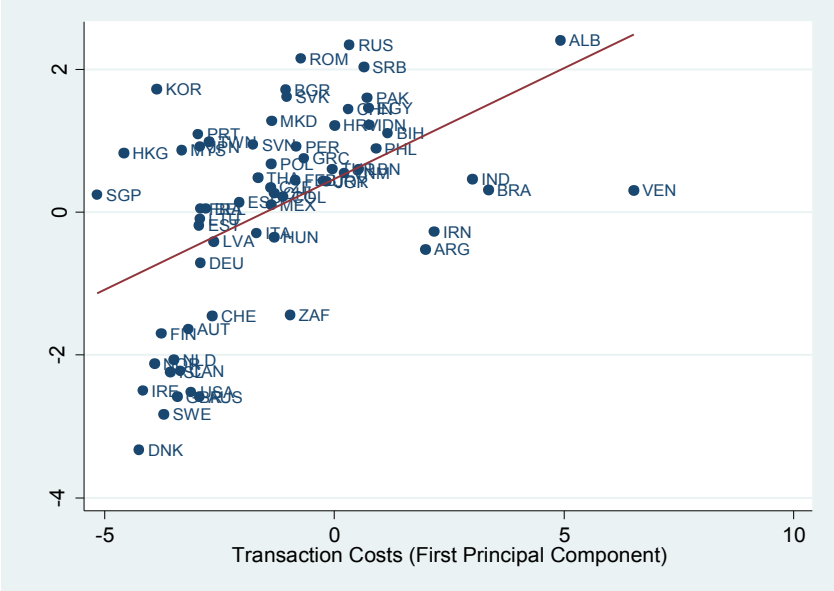


Figure 4 shows that higher values of the cultural traits variable are associated with higher transaction costs. Hence, societies with more collectivist tie, greater tolerance for unequal power distribution, greater uncertainty avoidance, greater masculinity, more short-term orientation and greater indulgence tend to experience considerably higher transaction costs. The aggregate correlation between transaction costs and cultural traits variable is 0.55 and statistically significant at 1%, respectively.

4 Results

4.1 Baseline Static and Dynamic Estimates

Table 2 reports the dynamic Arellano-Bond estimates of TFP specification. The evidence suggests that transaction costs matter for TFP performance both across and within countries. In columns (1), we examine the contribution of the costs of business registration to TFP. The parameter estimates suggest that the duration and per capita income cost of business registration procedures hampers TFP growth substantially while more stringent minimum capital requirements tend to improve it. By adding the full set of covariates and allowing for common technology shocks, the estimates arguably suggest that in the presence of country-level heterogeneity bias and the full of set confounders, the negative effect of greater duration of business registration prevails. In the long run, 1 basis point increase in the duration of business registration procedures leads to 11 percent TFP drop, respectively.

Column (2) exhibit the effects of construction licensing requirements on TFP. In the presence of country-level heterogeneity bias and common technology shocks, the evidence suggests rather weak and indiscernible effects of permit requirements, costs and duration on TFP. Controlling for the state dependence of TFP, parameter estimates suggest that in the presence of technology shocks and country-level heterogeneity bias, the effect of permit requirements on TFP is not statistically different from zero, and hence, does not explain the adoption of new technologies and better firm-level production methods. Column (3) presents the effects of property registration procedures on TFP. The OLS specification with country- clustered S.E suggests that greater duration of property registration procedures and greater procedural complexity tend to backdrop TFP growth considerably.

Table 2. Dynamic Effects of Transaction Costs on Total Factor Productivity Across 143 Countries, 2003-2014

	Cost of Starting Business		Cost of Dealing with Construction Permits		Cost of Property Registration		Cost of Paying Taxes		Cost of International Trade		Cost of Contract Enforcement		Cost of Resolving Insolvency	
	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	Arellano-Bond		Arellano-Bond		Arellano-Bond		Arellano-Bond		Arellano-Bond		Arellano-Bond		Arellano-Bond	
	Effect Size	Robust S.E.	Effect Size	Robust S.E.	Effect Size	Robust S.E.	Effect Size	Robust S.E.	Effect Size	Robust S.E.	Effect Size	Robust S.E.	Effect Size	Robust S.E.
# Procedures to start business	.055	.053												
# Days to start business	-.119**	.061												
Cost of starting business (% per capita income)	.194	.133												
Paid-in minimum capital (% per capita income)	-.113	.133												
# Procedures to deal with construction permits			.073	.054										
# Days to deal with construction permits			.055	.072										
Cost of dealing with construction permits (% warehouse value)			.072	.108										
# Property registration procedures					.005	.047								
# Days to complete property					.091**	.045								

registration procedures												
Cost of property registration (% property value)	-.059	.071										
# Hours to pay taxes per annum			.086	.109								
Total tax rate (% commercial profit)			.075	.089								
# Documents to export					-.036	.085						
# Days to export					-.073	.121						
Cost to Export (USD per standardized cargo container)					-.005	.127						
# Documents to import					.070	.100						
# Days to import					.057	.139						
Cost to import (USD per standardized cargo container)					.036	.173						
# Procedures to enforce a contract							.054	.235				
# Days to enforce a contract							-.103	.093				
Contract enforcement cost (% claim)							-.207***	.066				
# Years to resolve an insolvent firm									.040	.048		
Cost of resolving an insolvent firm (% estate)									.399*	.241		

Recovery rate (cents per USD)													-.093*	.067
Constant Term	.222	.189	.159	.221	.416**	.197	.417***	.177	.519**	.238	.383*	.223	.381**	.205
Obs	980		980		980		980		980		980		980	
Covariates (p-value)	YES		YES		YES		YES		YES		YES		YES	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Country-Fixed Effects (p-value)	YES		YES		YES		YES		YES		YES		YES	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Time-Fixed Effects (p-value)	YES		YES		YES		YES		YES		YES		YES	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
TFP Lags	1 Year		1 Year		1 Year		1 Year		1 Year		1 Year		1 Year	
Wald Test	[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]	
(Pr>χ2)														

Notes: the dependent variable is total factor productivity (TFP) index computed from the augmented growth model with human capital as Solow residual. Standard errors are adjusted for serially correlated stochastic disturbances and heteroscedasticity distribution of error variance allowing for intra-class residual correlation into 143 country-specific clusters. Cluster-robust standard errors are denoted in the parentheses for each empirical specification. Asterisks denote statistically significant sample regression coefficients at 10% (*), 5% (**), and 1% (***), respectively.

By allowing for the confounding influence of country-specific fixed effects, structural covariates and common technology shocks, we show that greater duration of property registration procedures tends to foster TFP growth considerably. The estimate confirms our notion of the screening effects of transaction costs, where a hike in transaction costs tends to improve productive efficiency by mitigating moral hazard, short-run opportunism and other sources of asymmetric information. In column (4), we find no effects of lighter tax payment procedures and lower rates on TFP either in or without the presence of fixed-effects and spatially dependent TFP behavior. Similar findings follow from column (5) where we find no effects of lower costs of international trade on the level of TFP, once time-varying technology shocks are controlled for.

In stark contrast, column (6) exhibits the effects of contract enforcement costs on TFP performance. The evidence unequivocally suggests that higher costs of contract enforcement are associated with a marked drop in TFP level. The beta coefficient on the contract enforcement cost is by far the largest among all transaction cost coefficients in our cross/within-country TFP regressions. In particular, 1 standard deviation increase in the cost of contract enforcement relative to the value of the claim, tends to backlash TFP roughly by a quarter of the standard deviation, both of which is economically large and statistically significant at 1%. Allowing for the full set of unobserved effects and spatial dependence of TFP, we find that 1 percent increase in the cost of enforcing contracts tends to depress TFP by 0.20 percentage point respectively, and is statistically significant within 1% bound. In a similar vein, the estimates in column (7) confirm the persistent positive effects of better insolvency framework, proxied by recovery rate and duration of procedures, on TFP growth. Hence the baseline set of our regression confirms the dominant effects of contract enforcement costs and insolvency framework in explaining TFP dynamics across and within countries. In the Appendix, we present the full set of OLS estimates against the dynamic Arellano-Bond estimates from Table 2, and show that the OLS estimated parameter are consistent with the dynamic estimates.

4.2 Instrumental Variable Estimates

In Table 3, we address the endogeneity and potential reverse causation between transaction costs and TFP growth. This allows us to test

whether transaction costs happen before TFP, and whether a slowdown in TFP precedes rising transaction costs. We test the endogeneity of transaction costs by including each cost indicator separately in the structured setup to push out the potential collinearity bias inherent in the causal inference. The evidence readily suggests that the effect of transaction costs on TFP appears to be causal. However, not all transaction costs are equally relevant for TFP.

Panel C shows the effects of the costs of business registration on TFP. The evidence suggests that the effect of per capita income costs on TFP tends to produce the negative causal impact while the duration of procedures, number of procedures, and minimum capital requirements do not. In particular, 1 basis point increase in the per capita income cost of starting business leads to 37% drop in TFP level in the long-run. The first-stage evidence on the plausibly exogenous sources of variation in TFP suggests that greater prevalence of toxoplasma gondii and less cooperative cultural traits tend to push transaction costs on a higher level, which produces the negative effect of business registration cost on TFP. By contrast, the other indicators of business registration costs do not seem to produce the negative structural effect on TFP. Panel D displays the effects of permit costs on TFP. In particular, the evidence shows that more complex permit procedure translate into the negative TFP effect while other types of permit costs do not.

Table 3. The IV Estimated Effects of Transaction Costs on TFP Across and Within Countries

	Panel A: Second Stage Structured Setup			Panel B: First-Stage OLS Regression for Transaction Costs			IV Diagnostics	
	Structural Effect	R2	Covariates	Urbanization Rate in 1500	Toxoplasma Gondii	Cultural Traits	Cragg-Donald Weak ID Test	Stock and Yogo (2005) Max. Relat. IV bias
Panel C: Costs of Business Registration								
# Procedures to start business	-.020 (.021)	0.26	✓	-.158 (.297)	.002 (.001)	-.014 (.021)	5.36	Less than 30%
# Days to start business	-.057 (.072)	0.06	✓	-.152 (.264)	.0002 (.001)	-.004 (.012)	1.38	More than 30%
Cost of starting business (% per capita income)	-.375** (.182)	0.35	✓	-.017 (.014)	.0001* (.00009)	.002** (.001)	8.40	Less than 15%

Paid-in minimum capital (% per capita income)	-1.048 (.727)	0.03	✓	-.0001 (.009)	.00005 (.00043)	.0003 (.0004)	1.70	More than 30%
Panel D: Costs of Construction Permits								
# Procedures to deal with construction permits	-.029*** (.011)	0.39	✓	-.325 (.224)	.0004 (.001)	.051** (.020)	16.45	Less than 5%
# Days to deal with construction permits	.037 (.149)	0.63	✓	.207* (.121)	.0002 (.001)	.017* (.011)	22.20	Less than 5%
Cost of dealing with construction permits (% warehouse value)	-.157* (.082)	0.26	✓	-.097 (.080)	.0004 (.0004)	0.0004 (.0037)	3.84	More than 40%
Panel E: Costs of Property Registration								
# Property registration procedures	-.107*** (.042)	0.52	✓	-.400 (.272)	.007*** (.001)	.048** (.022)	81.10	Less than 1%
# Days to complete property registration procedures	-.067** (.035)	0.44	✓	-.039 (.076)	.0007* (.0003)	.012* (.006)	19.86	Less than 5%
Cost of property registration (% property value)	.405 (.793)	0.62	✓	.458*** (.185)	.022** (.001)	.010 (.017)	37.70	Less than 5%
Panel F: Costs of Paying Taxes								
# Hours to pay taxes per annum	-.048 (.043)	0.17	✓	-.421 (.355)	.001 (.002)	.013 (.015)	6.31	Less than 25%
Total tax rate (% commercial profit)	.018 (.022)	0.62	✓	.142* (.089)	.001** (.0004)	-.008 (.007)	20.58	Less than 5%
Panel G: Costs of International Trade								
# Documents to export	-.030*** (.013)	0.47	✓	-.191 (.163)	.0001 (.0008)	.042*** (.012)	17.38	Less than 5%
# Days to export	-.036* (.021)	0.51	✓	-.046 (.107)	-.0006* (.0003)	.018*** (.005)	10.58	Less than 10%
Cost to Export (USD per standardized cargo container)	-.003 (.017)	0.62	✓	.095 (.082)	.002*** (.0006)	-.010 (.007)	32.85	Less than 1%
# Documents to import	-.036*** (.012)	0.41	✓	-.212 (.164)	-.0006 (.0007)	.038*** (.012)	16.04	Less than 5%
# Days to import	-.120* (.072)	0.04	✓	-.018 (.075)	.0002 (.0002)	.007** (.003)	2.83	More than 30%
Cost to	-.001	0.63	✓	.093***	.001***	-.011**	46.87	Less

import (USD per standardized cargo container)	(0.179)			(.049)	(.0004)	(.004)		than 1%
Panel H: Costs of Contract Enforcement								
# Procedures to enforce a contract	-.025* (.015)	0.27	✓		0.0005 (.0008)	.030*** (.010)	44.62	Less than 1%
# Days to enforce a contract	-.014* (.086)	0.36	✓		0.0002 (.0011)	.053*** (.018)	57.98	Less than 1%
Contract enforcement cost (% claim)	-.085* (.049)	0.81	✓	-.211* (.125)		.015 (.012)	8.29	Less than 15%
Panel I: Costs of Resolving Insolvency								
# Years to resolve an insolvent firm	-.023** (.995)	0.29	✓	-.356** (.142)		.066*** (.011)	145.30	Less than 1%
Cost of resolving an insolvent firm (% estate)	-.048* (.027)	0.25	✓		.0004 (.0006)	.015** (.005)	53.15	Less than 1%
Recovery rate (cents per USD)	-.008* (.005)	0.48	✓		.0007 (.0009)	.089*** (.009)	303.55	Less than 1%

Notes: the table presents the structural effects of transaction costs on TFP. The dependent variable is total factor productivity (TFP) index computed from the augmented growth model with human capital as Solow residual. Standard errors are adjusted for serially correlated stochastic disturbances and heteroscedasticity distribution of error variance allowing for intra-class residual correlation into 143 country-specific clusters and 12 time-specific clusters using Cameron, Gelbach and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function allowing for cluster-robust parameter inference to remove the structural inconsistencies arising from biased OLS covariance matrix estimator. Two-way cluster-robust standard errors are denoted in the parentheses for each empirical specification. Asterisks denote statistically significant sample regression coefficients at 10% (*), 5% (**), and 1% (***), respectively.

The effect of more complex permit procedures is less pronounced. In particular, 1 basis point increase in the procedural complexity (by expanding the number of permit procedures) tends to dampen TFP growth by 2.9 percent, respectively, within 95% confidence interval. In the first stage, the effects of costs on TFP appear to be properly isolated by the plausibly exogenous variation in the cultural traits. In particular, societies with less cooperative cultural traits tend to have substantially more complex permit procedures than countries with more cooperative cultural

traits. The test of weak identification (Cragg and Donald 1993) suggests that the relative bias triggered by the full set of IVs is less than 5%, which refutes the threats to identification. Panel E unveils the structural effects of property registration costs on TFP. The evidence points out to the notion that the negative effect of costlier property registration process on TFP appears to be causal. For each one basis point increase in the index of property registration procedure, our parameters predict 10.7 percent drop in TFP within 99% upper and lower confidence bounds. In the first stage, higher prevalence of toxoplasma gondii and less cooperative cultural traits lead to markedly higher transaction costs, and produce the negative structural effect of more complex property registration procedures on TFP. We also confirm a similar effect for the duration of property registration procedures, although the magnitude of the effect is substantially smaller than the magnitude of procedural complexity effect, but yet statistically significant at 1%, respectively.

While we fail to confirm the negative effect of more complex tax payment procedures, our evidence testifies to the strong impact of costs of international trade on TFP despite the relatively weak OLS and dynamic panel evidence. In particular, greater administrative complexity in import and export procedures tends to stifle TFP growth consistently, which suggests that these barriers are an important vehicle behind the contrasting paths of TFP growth across and within countries. In the first stage, the less cooperative and rent-seeking cultural traits appear to be the dominant exogenous source of variation in TFP by pushing up transaction costs consistently. Lastly, we address the endogeneity of contract enforcement variables and insolvency framework variables. In Panel H, we find that 1 basis point increase in the procedural complexity of enforcing contracts tends to produce the 2.5% drop in TFP, respectively. In the first stage, less cooperative cultural traits are associated with higher costs of enforcement with both higher costs of enforcement both with respect to the number and duration of procedures. The parameter estimate on contract enforcement cost, by contrast, suggests that historical development, proxied by urbanization rate in 1500 largely explains the contrasting differences in modern-day transaction costs while cultural traits do not. In Panel I, we also confirm the negative causal effect of rising costs of resolving insolvency across the full set of indicators, which appears to be statistically significant. In the first stage, urbanization rate in 1500, and cultural traits properly isolate the effects of costs on TFP. Weak identification test confirm few threats to the validity of our exclusion

restriction since the IVs tend to have less than 1% relative bias both of which confirms the plausible exogeneity and relevance of the proposed IVs. Hence, the costs of contract enforcement and costs of resolving insolvent firms appear to be relatively more important for TFP than other costs considered herein.

4.3 Heterogenous Effects of Transaction Costs by Income Level

The evidence in Table 2 and Table 3 shows that transaction costs matter greatly for TFP differences across countries. The question that arises from our estimates necessarily invokes the policy-related normative implications. Prior evidence is based on aggregate sample, which immediately invokes the effect heterogeneity across countries (Klick 2010). We address policy implications by replicating the core specification in Eq. (3) with the interaction effects between income level dummy variables and transaction cost indicators. This kind of structured setup allows us to detect which transaction costs policymakers at various country income levels should target to tackle the vested interests in the production process, policy distortions and barriers to entry that lead to sub-optimum TFP performance over time.

Does the effect of transaction costs on TFP differ across income levels? We tackle the potential effect heterogeneity by excluding each individual income group off the full sample used in Table 2 and Table 3. Under a naïve approach, we would interact the GDP per capita variable and the set of transaction cost covariates and simply replicate the baseline cross-country TFP model with the full set of interaction terms. But since the TFP level is computed as a residual of the cross-country growth regression model, the interaction term between GDP per capita and transaction costs is not feasible. Instead, we keep the structure of the TFP model intact. To tackle the potentially heterogeneous effects of transaction costs on TFP, we replicate the core TFP specification from Eq. (3) on each income group for which we rely on World Bank Income Classification Scheme. In Table 4, the heterogeneous effects are presented on the sub-samples. The evidence suggests the effects of transaction costs across income levels remain stable although not pervasive across income groups.

On balance, the evidence suggests that business registration procedures are relatively more important for TFP growth in low-income countries, but not at higher income thresholds. The barriers to

international trade appear to be pervasive across all income groups. The duration of property registration procedures appears to be a constraint on growth in low-income and high-countries but less so in middle-income countries. On the other hand, contract enforcement costs appear to be a major barrier to TFP growth in lower-income ladders. As countries sustain structural transformation, and achieve high-income threshold, our estimates indicate that inefficient insolvency procedures are possibly the major constraint on TFP growth, respectively.

Table 4. Heterogenous Effects of Transaction Costs on TFP by Income Level

Included Subset	(1) Low-Income	(2) Lower-Middle Income	(3) Upper-Middle Income	(4) High-Income
Panel A: Costs of Business Registration				
# Procedures to start business	-1.387**	.649	.015	-.195
	(.615)	(.589)	(.400)	(.434)
# Days to start business	.274	-.876	-.278	.450
	(.521)	(.572)	(.448)	(.689)
Cost of starting business (% per capita income)	.409	-.978	-.315	-.931
	(.256)	(.764)	(1.891)	(2.052)
Paid-in minimum capital (% per capita income)	9.973	10.993*	-16.658**	18.955
	(7.624)	(6.000)	(8.675)	(13.213)
Panel B: Costs of Construction Permits				
# Procedures to deal with construction permits	-.278	.009	-.254	-.187
	(.846)	(.488)	(.349)	(.323)
# Days to deal with construction permits	-.987	1.028	-.469	-.787
	(1.875)	(.998)	(.799)	(.713)
Cost of dealing with construction permits (% warehouse value)	-.175	.556	-.298	1.944
	(.842)	(1.065)	(.794)	(2.635)
Panel C: Costs of Property Registration				
# Property registration procedures	.417	-.301	-.096	-.203
	(.579)	(.594)	(.503)	(.453)
# Days to complete property registration procedures	-2.393*	.064	1.278	-.496**
	(1.400)	(1.569)	(1.392)	(.221)
Cost of property registration (% property value)	3.252**	.649	-.411	.593
	(1.415)	(.540)	(.587)	(.632)
Panel D: Costs of Paying Taxes				
# Hours to pay taxes per annum	.197	.843*	-.002	-1.771*
	(4.056)	(.545)	(.337)	(.991)
Total tax rate (% commercial profit)	.033	-1.297	.275	-.746
	(.407)	(1.782)	(.898)	(.930)
Panel E: Costs of International Trade				
# Documents to export	-.192	.571	-.054	-1.166*
	(.773)	(.458)	(.507)	(.673)
# Days to export	4.484**	-3.783**	1.291**	-2.112*
	(2.210)	(1.751)	(.676)	(1.202)
Cost to Export (USD per standardized cargo container)	-4.310*	1.265	-.363	.469
	(2.444)	(1.442)	(1.833)	(3.128)
# Documents to import	-1.051	1.125*	-.838	1.786
	(1.871)	(.658)	(.915)	(1.366)
# Days to import	-2.762*	1.894	-2.294***	.254
	(1.876)	(1.248)	(.848)	(1.305)
Cost to import (USD per standardized cargo container)	5.681**	-1.366	.330	-.637
	(2.371)	(1.285)	(2.475)	(3.943)
Panel F: Costs of Contract Enforcement				
# Procedures to enforce a contract	-1.474	.058	-.018	.770

	(1.140)	(.620)	(.995)	(.586)
# Days to enforce a contract	-1.552	1.074*	.329	-.039
	(1.421)	(.574)	(.374)	(.259)
Contract enforcement cost (% claim)	1.745***	.072	.157	-.929
	(.582)	(.294)	(1.688)	(.884)
Panel G: Costs of Resolving Insolvency				
# Years to resolve an insolvent firm	.984**	-.372	-.144	.475
	(.491)	(.633)	(.434)	(.448)
Cost of resolving an insolvent firm (%	-3.492***	-.628	1.370*	-1.113
estate)	(1.378)	(.975)	(.802)	(1.032)
Recovery rate (cents per USD)	.286	1.166	-.451	-1.169***
	(1.257)	(1.232)	(.390)	(.355)

Notes: the table presents the effects of transaction costs on TFP across and within countries on sub-samples across income groups. The dependent variable is total factor productivity (TFP) index computed from the augmented growth model with human capital as Solow residual. The table presents the effects of transaction costs on TFP Standard errors are adjusted for serially correlated stochastic disturbances and heteroscedasticity distribution of error variance allowing for intra-class residual correlation into 143 country-specific clusters and 12 time-specific clusters using Cameron, Gelbach and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function allowing for cluster-robust parameter inference to remove the structural inconsistencies arising from biased OLS covariance matrix estimator. Two-way cluster-robust standard errors are denoted in the parentheses for each empirical specification. Asterisks denote statistically significant sample regression coefficients at 10% (*), 5% (**), and 1% (***), respectively.

4.4 Indirect Effects of Transaction Costs on TFP

Is there a sizeable indirect effect of transaction costs on TFP both across and within countries? The evidence so far is primarily based on the direct effects of transaction costs while the indirect effects are neglected. We address the potential indirect effects of transaction costs and deploy five transmission channels based on the set of independent variables other than transaction costs. Using the expanded model specification with the full set of transaction cost covariates, we examine the indirect effects of transaction costs through five different exposure variables: (i) financial development (captured by credit-to-GDP ratio), (ii) trade openness (captured by trade-to-GDP ratio), (iii) macroeconomic stability (captured by log-normalized inflation rate), (iv) economic specialization (capture by the share of manufacturing in GDP), and (v) R&D (captured by the share of R&D expenditure in GDP). The evidence clearly suggests the indirect effects of transaction costs on TFP are substantially weaker although non-trivial.

In Table 5, the table presents the indirect effects of transaction costs on TFP across and within countries through five exposure variables. On balance, the evidence suggests that the indirect effects of administrative transaction costs are close to zero or marginally significant for individual covariates such as the number of start-up procedures. Greater administrative complexity in paying taxes is associated with less trade openness but somewhat greater specialization in productivity-enhancing manufacturing and greater R&D intensity. Costlier access to international trade is somewhat negatively associated with the level of financial development and with a lower share of manufacturing in GDP. In addition, the indirect effects of procedural transaction costs on TFP are noticeably stronger than the indirect effects of administrative transaction costs. Costly contract enforcement is significantly more likely to translate into a lower level of financial development compared to low-cost contract enforcement, and also makes the specialization in productivity-enhancing manufacturing less likely. In addition, dropping paid-in minimum capital requirements is associated with greater macroeconomic instability, which further undermines TFP growth. In a similar fashion, the weakness of creditor protection tends to downsize the level of financial development, and also appears to discourage the R&D intensity. On the whole, the evidence clearly suggests that indirect effects of transaction costs on TFP are too important to neglect although the strength of the indirect effects is noticeably stronger for procedural transaction costs in comparison with the almost non-existent indirect effects of administrative costs.

4.5 Non-Linear Effects of Transaction Costs

A final caveat about the validity of our estimates concerns the non-linear effects of transaction costs. We allow for the second-order polynomial in the baseline TFP model in Eq. (4.3) and introduce the quadratic term in the core model setup to tackle the potentially non-linear relationship between transaction costs and TFP. In Table 6, the non-linear effects captured by the quadratic term, are presented in more detail. Expanding the baseline TFP with the quadratic term allows us to examine whether the maximizing and minimizing levels of transaction costs can be invoked from the TFP model setup. The evidence confirms both the presence and persistence of non-linear effects of transaction costs on TFP although there is a notable distinction between the administrative and procedural transaction costs. Whereas the procedural transaction costs

tend to influence the between-country and within-country paths of TFP linearly, there appears to be a strong and sizeable set of non-linear effects of administrative transaction costs on TFP. In Panel A, three of the four variables capturing the start-up costs, exhibit statistically significant non-linear effect on TFP. The number of start-up procedures exhibits a typical hump-shaped effect on TFP with 12 procedures as the TFP-maximizing level. On the other hand, the cost of starting business tends to exhibit a U-shaped effect on TFP where the turn in the direction of the effect occurs at 66.1 percent of per capita income. In a similar vein, the relationship between paid-in minimum capital requirements and TFP is characterized by a U-shaped curve with the bottleneck occurring at 181.1 percent of per capita income.

A similar TFP turning point is indicated by the non-linear effects of the cost of dealing with construction permits, the number of property registration procedures and the number of hours to pay taxes. For procedural transaction costs, the evidence does not advocate the non-linear effects on TFP whereas the point estimates of the effects of administrative transaction costs highlight a substantially non-linear influence on TFP. The results convey the additional evidence on the ability of administrative transaction costs to enhance screening, deter moral hazard, and address adverse selection and the sources of short-run opportunistic behavior. In particular, the set of non-linear effects readily suggests that keeping the number and duration of procedures at a critical thresholds tends to accelerate aggregate efficiency and foster TFP growth both across and within countries. Keeping the administrative costs at the level that fails to tackle the sources of market failure tends to yield sub-optimum TFP growth and subsequently fails to materialize the efficiency gains and the technological breakthroughs necessary to uphold and sustain TFP at the frontier level.

Table 5. Indirect Effects of Transaction Costs on TFP Across and Within Countries

	(1)	(2)	(3)	(4)	(5)
Transmission Channel	Financial Development	Trade Openness	Macroeconomic Stability	Economic Specialization	R&D
Exposure Variable	Credit-to-GDP Ratio	Trade-to-GDP Ratio	Log-Normalized Inflation Rate	Manufacturing-to-GDP Ratio	Share of R&D Expenditure in GDP
Panel A: Cost of Starting Business					
# Procedures to start business	-.511*	-.393**	.096	.138	-.960**
	(.278)	(.172)	(.197)	(.153)	(.427)
# Days to start business	-.122	-.424	.483	.221	-.065
	(.375)	(.339)	(.316)	(.285)	(.529)
Cost of starting business (% per capita income)	.384	-.138	.017	-.516	-3.163
	(.312)	(.099)	(.635)	(.450)	(1.984)
Paid-in minimum capital (% per capita income)	-.511	-.128	-9.910**	-.879	9.201
	(.438)	(.241)	(4.984)	(2.839)	(7.476)
Panel B: Cost of Dealing with Construction Permits					
# Procedures to deal with construction permits	.252	.139	-.218	.009	.650*
	(.250)	(.153)	(.262)	(.210)	(.400)
# Days to deal with construction permits	.259	-.345	.019	.620***	.380
	(.375)	(.226)	(.318)	(.243)	(.890)
Cost of dealing with construction permits (% warehouse value)	.626	.473**	1.046	.002	.290
	(.503)	(.214)	(.908)	(.419)	(1.411)
Panel C: Cost of Property Registration					
# Property registration procedures	.038	.134	.450	-.342**	.056
	(.294)	(.236)	(.330)	(.170)	(.374)
# Days to complete property registration procedures	-.502	.077	-.774***	.120	.662
	(.448)	(.140)	(.264)	(.359)	(.649)
Cost of property registration (% property value)	-.160	.077	.017	.120	.172
	(.240)	(.140)	(.486)	(.359)	(.478)
Panel D: Cost of Paying Taxes					
# Hours to pay taxes per annum	.465	-.635**	-.102	.083	1.030**
	(.444)	(.172)	(.379)	(.301)	(.497)
Total tax rate (% commercial profit)	-.250	-.535**	.404	1.026***	2.287***
	(.472)	(.186)	(.432)	(.416)	(.804)
Panel E: Cost of International Trade					
# Documents to export	-.957***	.153	-.132	-.518***	-1.588***
	(.341)	(.154)	(.381)	(.209)	(.565)
# Days to export	.090	.441	.349	-.260	-1.033
	(.649)	(.413)	(.789)	(.427)	(.819)
Cost to Export (USD per standardized cargo container)	.008	.368	.110	-.872*	-.838

	(.800)	(.369)	(.557)	(.490)	(1.070)
# Documents to import	.352	-.641*	.494	.683	1.109
	(.577)	(.340)	(.383)	(.514)	(.865)
# Days to import	-1.079	-.109	.895	-.044	.078
	(.683)	(.362)	(.902)	(.352)	(.630)
Cost to import (USD per standardized cargo container)	-1.570*	-1.297***	-.799	-.177	.698
	(.971)	(.472)	(.614)	(.558)	(1.203)
Panel F: Cost of Contract Enforcement					
# Procedures to enforce a contract	-.517*	-.478*	-.001	-.499**	-1.189***
	(.294)	(.261)	(.331)	(.246)	(.440)
# Days to enforce a contract	.306	-.336	-.007	.314**	.970***
	(.224)	(.231)	(.197)	(.149)	(.398)
Contract enforcement cost (% claim)	-.957***	-.290	-.426	-.212	.803
	(.254)	(.203)	(.348)	(.271)	(.812)
Panel G: Cost of Resolving Insolvency					
# Years to resolve an insolvent firm	.565**	.232	-.833***	.170	.970***
	(.284)	(.178)	(.238)	(.294)	(.398)
Cost of resolving an insolvent firm (% estate)	.956***	.149	-.485	-.3967	.803
	(.356)	(.248)	(.473)	(.341)	(.812)
Recovery rate (cents per USD)	-1.531***	.242	1.361***	.027	-2.404***
	(.294)	(.224)	(.199)	(.215)	(.376)
Constant Term	5.504***	5.001***	.760***	2.838***	1.113***
	(.162)	(.183)	(.199)	(.121)	(.239)
# Observations	1,634	1,692	1,605	1,560	1,297
Theil R2	0.55	0.22	0.25	0.28	0.54
# Country Clusters	139	141	138	134	110
# Regional Clusters	27	27	27	27	27
# Time Clusters	12	12	12	12	12

Notes: the table presents the indirect effects of transaction costs on TFP via the five exposure variables across and within countries. The dependent variable is total factor productivity (TFP) index computed from the augmented growth model with human capital as Solow residual. Standard errors are adjusted for serially correlated stochastic disturbances and heteroskedastic distribution of error variance allowing for intra-class residual correlation into 143 country-specific clusters and 12 time-specific clusters using Cameron, Gelbach and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function allowing for cluster-robust parameter inference to remove the structural inconsistencies arising from biased OLS covariance matrix estimator. Two-way cluster-robust standard errors are denoted in the parentheses for each empirical specification. Asterisks denote statistically significant sample regression coefficients at 10% (*), 5% (**), and 1% (***), respectively.

Table 6. Non-Linear Effects of Transaction Costs on TFP

	Linear Term	Quadratic Term	N	R2	Non-Linear Effects	TFP-Maximizing/Minimizing Level
Panel A: Cost of Starting Business						
# Procedures to start business	1.653*** (.577)	-1.369** (.648)	1,192	0.35	YES	12 Procedures
# Days to start business	-1.180 (.844)	1.168 (1.311)	1,192	0.35	NO	None
Cost of starting business (% per capita income)	-4.586*** (1.675)	8.788* (4.839)	1,192	0.35	YES	66.1 percent of per capita income
Paid-in minimum capital (% per capita income)	19.981** (9.112)	-232.21*** (76.505)	1,192	0.35	YES	181.1 percent of per capita income
Panel B: Cost of Dealing with Construction Permits						
# Procedures to deal with construction permits	-.223 (.661)	.802 (.673)	1,192	0.35	NO	None
# Days to deal with construction permits	-1.175 (1.337)	2.439 (2.547)	1,192	0.35	NO	None
Cost of dealing with construction permits (% warehouse value)	-3.117** (1.442)	3.616*** (1.481)	1,192	0.35	YES	25.4 percent of the warehouse
Panel C: Cost of Property Registration						
# Property registration procedures	-.954 (.611)	1.035* (.652)	1,192	0.33	YES	7 procedures
# Days to complete property registration procedures	-.372 (1.031)	.252 (.874)	1,192	0.33	NO	None
Cost of property registration (% property value)	-.947 (1.221)	1.079 (1.329)	1,192	0.33	NO	None
Panel D: Cost of Paying Taxes						
# Hours to pay taxes per annum	-2.040* (1.221)	2.159* (1.231)	1,192	0.33	YES	1,050 hours per year
Total tax rate (% commercial profit)	-.304 (1.885)	-.176 (1.809)	1,192	0.33	NO	None
Panel E: Cost of International Trade						
# Documents to export	-2.145*** (.481)	1.252*** (.120)	1,713	0.26	YES	10 documents
# Days to export	-2.104 (1l874)	2.344* (1.458)	1,713	0.26	NO	None
Cost to Export (USD per standardized cargo container)	-1.995 (1.405)	1.003 (1.254)	1,713	0.26	NO	None
# Documents to import	1.806 (1.321)	-1.332 (.873)	1,713	0.26	YES	None
# Days to import	-3.327** (1.566)	3.133** (1.431)	1,713	0.26	YES	55 days
Cost to import (USD per standardized cargo container)	2.225 (1.886)	-.070 (1.773)	1,713	0.26	NO	None
Panel F: Cost of Contract Enforcement						
# Procedures to enforce a contract	-4.097*** (1.414)	4.535*** (1.870)	1,192	0.42	YES	35 procedures
# Days to enforce a contract	.193 (1.120)	.243 (1.124)	1,192	0.42	NO	None
Contract enforcement cost (% claim)	-2.432* (1.467)	1.797 (1.440)	1,192	0.42	NO	None

Panel G: Cost of Resolving Insolvency						
# Years to resolve an insolvent firm	.986 (.922)	-.266 (.789)	1,192	0.36	NO	None
Cost of resolving an insolvent firm (% estate)	.485 (1.991)	-2.365 (3.828)	1,192	0.36	NO	None
Recovery rate (cents per USD)	-.993 (.857)	-.192 (.909)	1,192	0.36	NO	None

Notes: the table presents the non-linear effects of transaction costs on TFP across and within countries. The dependent variable is total factor productivity (TFP) index computed from the augmented growth model with human capital as Solow residual. The table presents the effects of transaction costs on TFP Standard errors are adjusted for serially correlated stochastic disturbances and heteroskedastic distribution of error variance allowing for intra-class residual correlation into 143 country-specific clusters and 12 time-specific clusters using Cameron, Gelbach and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function allowing for cluster-robust parameter inference to remove the structural inconsistencies arising from biased OLS covariance matrix estimator. Two-way cluster-robust standard errors are denoted in the parentheses for each empirical specification. Asterisks denote statistically significant sample regression coefficients at 10% (*), 5% (**), and 1% (***), respectively.

4.6 Counterfactual Scenario

Our results based on the OLS and IV methods suggest that higher transaction costs substantially reduce TFP level both across and within countries. The ultimate question pertains to the economic significance of the estimated effects. To what extent would TFP improve in response to lower transaction costs? Such a hypothetical counterfactual scenario might be the key to better understand the economic significance of transaction costs in shaping TFP levels.

Our hypothetical counterfactual scenario is built in several steps. First, we estimate the full dynamic model specification TFP specification with lagged TFP term, the full set of transaction covariates, time-fixed effects and country-fixed effects. Second, we predict the level of TFP based on the parameter estimates from the dynamic TFP model specification. Third, we select the countries facing high transaction costs as set them as quasi-treated countries. Fourth, we estimate TFP gains by taking transaction cost parameters and the difference in transaction costs between the quasi-treated country and the benchmark level. Two benchmark levels of transaction costs are selected: (i) the lowest value of observed transaction costs in the sample, and (ii) the lowest value of

transaction costs in quasi-treated country's income group. Such a hypothetical counterfactual scenario allows us to estimate the potential TFP gains if the high-cost country lowered transaction costs to the observed benchmark threshold. Since the potential TFP levels are observed in a panel, we average year-level TFP gains as a rough estimate of the TFP improvement in response to lower transaction costs.

Table 7 reports the counterfactual scenario for a selected set of transaction costs for the quasi-treated high-cost countries. Panel A reports the TFP gains from lowering minimum capital requirements. The evidence suggests that lowering paid-in minimum capital requirements to the lowest value in the sample would raise TFP level in high-cost countries between 0.5% in Niger and 3.2% in Syria. The estimated TFP gains are noticeably larger for property registration procedures as shown in Panel B. If a high-cost country such as Brazil lowered the number of property registration procedures to the lowest in-sample level, observed in Norway, our estimate suggests that its TFP would improve by 15%. If property registration procedures were reduced by a similar amount in Argentina, its TFP would increase by 8%. But if Argentina simplified property registration procedures to the lowest level in its income group, observed in Belarus, its TFP would increase considerably less, i.e. by 4.9%, respectively. We find similar TFP gains from simplified property registration procedures for high-income countries such as Greece and France, where we predict an increase in TFP by 8.2%, and 4.6% if they reduced the costs to that of Sweden, the lowest observed value in our sample.

Panel C reports TFP gains in response to lower property registration costs. If the high-cost countries reduced property registration costs to the lowest value in-sample level, our estimates predict an increase in TFP from 4.7 percent in Belgium to 23 percent in Uruguay, which is comparable with the TFP gains in response to less procedural complexity in property registration. In Panel D, we show that the countries gaining most in terms of TFP from more efficient and faster international trading are mainly Sub-Saharan African countries, where the TFP gains are in the range between 2% and 12%, respectively, depending on the observed level of this particular transaction cost.

The estimated TFP gains are noticeably larger with respect to the costs of contract enforcement. Panel E reports the TFP gains from lowering the duration of contract enforcement for selected high-cost countries. Countries with the most sizeable TFP gains from lowering the time to

enforce the contract to the benchmark level appear to be Colombia and Slovenia, for which we predict an increase in TFP by 88% and 30% if they reduced judicial delays to the lowest observed level in the sample (i.e. Singapore). If India reduced contract enforcement time to the level of Singapore, our estimates imply that its TFP would rise by 29% in the long-run. For Italy and Greece, TFP would increase by 12% and 10% if contract enforcement time were at the benchmark level of Singapore. In Panel F, similar gains are apparent for the costs of enforcing contracts. For instance, our estimates imply that if high-cost countries reduced the cost of contract enforcement, relative to the value of the claim, to the level of Iceland (i.e. lowest observed value in the sample), TFP level would increase between 12% in Indonesia, and 30% in Venezuela, respectively. The evidence confirms large and broad-based TFP gains from lowering transaction costs to the observed benchmark levels.

Table 7. Total Factor Productivity Gains from Lower Transaction Costs

Quasi-Treated High-Cost Country	**Income Group**	**Dynamic Effect** (standard error)	**Overall TFP Gain**	
			Lowest in-sample value	Lowest in-sample value in the income group
Panel A: Paid-in Minimum Capital				
Syria	Lower-middle	-.553**		3.2%
Guinea	Low	(.236)		1.9%
Niger	Low			0.5%
Panel B: # Property Registration Procedures				
Uzbekistan	Low	-.063*	6.1%	5.3%
Brazil	Upper-middle	(.034)	15%	14.3%
Algeria	Upper-middle		4.9%	4.4%
Argentina	Upper-middle		8%	4.9%
Greece	High			6.2%
France	High			4.6%
Panel C: Property Registration Cost				
Syria	Lower-middle	-.087**		8.1%
Albania	Upper-middle	(.034)		4.2%
Uruguay	Upper-middle			23%
Belgium	High			4.7%
Panel D: Import Time				
Zimbabwe	Low	-.192***	12.2%	9.6%
Mozambique	Low	(.052)	4.9%	6%
Senegal	Lower-middle		2.8%	1.8%
Panel E: Contract Enforcement Time				
Bangladesh	Low	-.133***	12%	11.6%
India	Lower-middle	(.048)	29%	26%
Colombia	Upper-middle		88%	82%
Italy	High			12%
Slovenia	High			38%
Greece	High			10%
Panel F: Contract Enforcement Cost				
Congo DR	Low	-.135***	12.6%	12%
Indonesia	Lower-middle	(.042)		11.9%
Venezuela	Upper-middle			30%

5 Conclusion

In this paper, we examine the contribution of transaction costs to total factor productivity (TFP) for 143 countries in the period 2003-2014. To this end, we construct a compact measure of TFP as a Solow residual from the augmented growth model with human capital and unobserved effects, and build a variety of transaction costs indicators (World Bank 2014). The results suggest that higher transaction costs are significantly more likely to discourage TFP. Our evidence unveils the set of policy constraints, distortions and barriers to entry, which keep the vested interests in the current production process intact. The baseline OLS effects and dynamic panel estimates suggest that higher costs of business registration, property registration, contract enforcement, and insolvency proceedings matter a great deal for TFP differences across and within countries. These policy constraints, distortions and barriers to entry tend to condemn TFP through a multitude of transmission channels such as economic specialization, R&D and innovation, trade openness and the depth of financial development. These barriers to the adoption of efficient technologies are likely one of the missing puzzles behind the large and persistent TFP gaps across countries.

Not all transaction costs are created equal. Our evidence shows that the costs of contract enforcement, property registration and insolvency proceedings appear to be substantially more important for explaining TFP gaps across and within countries than the costs of construction permits, costs of paying taxes, and costs of international trade. We also address the reverse causality between transaction costs and TFP to determine whether low TFP growth causes the deterioration of institutional environment or vice versa. To this end, we exploit the historical variation in urbanization rate in 1500, the variation in the disease environment, and the variation in latent cultural traits to isolate the effects of transaction costs on TFP from the potential identification threats. The evidence suggests that societies with less cooperative cultural traits, greater prevalence of toxoplasma gondii bacteria, and with higher urbanization rate in 1500 tend to have considerably higher transaction costs down to the present day. The negative effects of rising transaction costs on TFP gaps appear to be causal.

Our paper also offers a set of policy recommendation to tackle high transaction costs. We show that a well-intentioned policymaker should identify the binding constraint on growth at country-specific income level

to determine which transaction costs constrain TFP growth. We also compute the TFP-growth maximizing levels of transaction costs, and show that while costs exhibit the growth-maximizing level, others do not. In the counterfactual scenario, reducing transaction costs to the benchmark levels observed in least-cost countries is associated with large and pervasive TFP gains where the cost of contract enforcement and property registration appear to be more important for TFP than administrative transaction costs.

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Appendix

Table A.1. Static and Dynamic Panel-Level Estimates of Transaction Costs on TFP

	Cost of Starting Business		Cost of Dealing with Construction Permits		Cost of Property Registration		Cost of Paying Taxes		Cost of International Trade		Cost of Contract Enforcement		Cost of Resolving Insolvency	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	OLS with Multiway-Clustered S.E.	Arellano-Bond	OLS with Multiway-Clustered S.E.	Arellano-Bond	OLS with Multiway-Clustered S.E.	Arellano-Bond	OLS with Multiway-Clustered S.E.	Arellano-Bond	OLS with Multiway-Clustered S.E.	Arellano-Bond	OLS with Multiway-Clustered S.E.	Arellano-Bond	OLS with Multiway-Clustered S.E.	Arellano-Bond
# Procedures to start business	-.040	.055												
	(.291)	(.053)												
# Days to start business	-.862***	-.119**												
	(.290)	(.061)												
Cost of starting business (% per capita income)	-.808*	.194												
	(.452)	(.133)												
Paid-in minimum capital (% per capita income)	1.837***	-.113												
	(.652)	(.133)												
# Procedu			-.106	.073										
			(.275)	(.054)										

res to deal with construction permits				
# Days to deal with construction permits	-.774***	.055		
	(.330)	(.072)		
Cost of dealing with construction permits (% warehouse value)	-.721	.072		
	(.687)	(.108)		
# Property registration procedures			-.783***	.005
			(.289)	(.047)
# Days to complete property registration procedu			-1.092**	.091**
			(.510)	(.045)

res							
Cost of property registration (% property value)		-.303	-.059				
		(.307)	(.071)				
# Hours to pay taxes per annum				-.763	.086		
				(.584)	(.109)		
Total tax rate (% commercial profit)				-.295	.075		
				(.608)	(.089)		
# Documents to export						-.778***	-.036
						(.289)	(.085)
# Days to export						-.180	-.073
						(.721)	(.121)
Cost to Export (USD per standardized cargo container)						-.138	-.005
						(.932)	(.127)
# Docume						-.243	.070
						(.647)	(.100)

nts to import								
# Days to import			-1.355**	.057				
			(.705)	(.139)				
Cost to import (USD per standardized cargo container)			1.693*	.036				
			(.991)	(.173)				
# Procedures to enforce a contract					-.384	.054		
					(.390)	(.235)		
# Days to enforce a contract					-.111	-.103		
					(.301)	(.093)		
Contract enforcement cost (% claim)					-1.200***	-.207**		
					(.311)	*		
						(.066)		
# Years to resolve an insolvent firm							.789***	.040
							(.302)	(.048)
Cost of							-.125	.399*

resolving an insolvent firm (% estate)													(.565)	(.241)
Recovery rate (cents per USD)													-1.591*** (.240)	-.093* (.067)
Constant Term	.165 (.118)	.222 (.189)	.183* (.106)	.159 (.221)	.420*** (.124)	.416** (.197)	.126 (.124)	.417*** (.177)	.462*** (.094)	.519** (.238)	.440*** (.166)	.383* (.223)	.772*** (.087)	.381** (.205)
Obs	1,713	980	1,713	980	1,713	980	1,713	980	1,713	980	1,713	980	1,713	1,713
Adj. R2	0.04		0.02		0.06		0.01		0.15		0.09		0.21	0.20
Covariates (p-value)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)
Country-Fixed Effects (p-value)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)
Time-Fixed Effects (p-value)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)	NO	YES (0.000)
TFP Lags		1 Year		1 Year		1 Year		1 Year		1 Year		1 Year		1 Year
Wald Test (Pr>χ2)	[0.000]	[0.000]	[0.000]	[0.095]	[0.000]	[0.000]	[0.000]	[0.355]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: the dependent variables is total factor productivity (TFP) index computed from the augmented growth model with human capital as Solow residual. Standard errors are adjusted for serially correlated stochastic disturbances and heteroskedastic distribution of error variance allowing for intra-class residual

correlation into 143 country-specific clusters and 12 time-specific clusters using Cameron, Gelbach and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function allowing for cluster-robust parameter inference to remove the structural inconsistencies arising from biased OLS covariance matrix estimator. Two-way cluster-robust standard errors are denoted in the parentheses for each empirical specification. Asterisks denote statistically significant sample regression coefficients at 10% (*), 5% (**), and 1% (***), respectively.