Journal of Institutional Economics (2016), 12: 1, 129–159

doi:10.1017/S1744137415000077
First published online 12 March 2015

Institutional development, transaction costs and economic growth: evidence from a cross-country investigation

MITJA KOVAČ*
Faculty of Economics, University of Ljubljana, Ljubljana, Slovenia

ROK SPRUK**
Department of economic and social history, Utrecht University, Utrecht, the Netherlands

Abstract: This paper seeks to quantify the impact of transaction costs on cross-country economic growth. Our evidence from a cross-country panel data regression analysis reveals a persistent and robust negative effect of increasing transaction costs on the path of economic growth. The growth-enhancing effects of lower transaction costs are confirmed after controlling for the set of conditioning variables and further demonstrated in a cross-country growth model calibration. The results provide evidence that transaction costs might indeed be central to the study of cross-country productivity differences, suggest the importance of contractual relations and indicate their significant impact on cross-country economic performance over time.

1. Introduction

Understanding why some countries grow and others fail to do so is one of the most remarkable puzzles in the modern literature on economic growth. New institutional economics has addressed precisely these fascinating issues and begun to take shape as ambitious discipline. Despite the voluminous literature on new institutional economics, a theoretical consensus on the impact of transaction costs on cross-country economic growth is still beyond reach. Previous empirical studies attempting to measure transaction costs have paved the way toward conclusive quantification. Further progress in the study of transaction costs awaits the empirical identification of their critical institutional dimensions and the impact on economic growth.

Without the concept of transaction costs it might be impossible to understand how an economic system works, analyze many of its problems and examine the effects on economic growth. Coase (1988, 1994) suggests that one should pay attention to the world of positive transaction costs where the law should

*Email: Mitja.kovac@ef.uni-lj.si
**Email: rok.spruk@uu.nl

play a crucial role in determining how resources are used and thus could have a crucial impact on growth (Coase, 1994; 1998). North (1990) states that 'the inability of societies to develop effective, low-cost enforcement of contracts is the most important source of both historical stagnation and contemporary underdevelopment in the third World'. Matthews (1986) and Williamson (1985, 1996) stress transaction costs' vital importance in long-term relationships and argue that institutions do matter and are susceptible to analysis.

Our work contributes to the new institutional economics literature by considering the interrelationships between economic growth and transaction costs generated by different legal systems. This sub-category of overall transaction costs actually represents an external fraction of transaction costs that are generated by different legal systems (e.g. administrative, procedural costs) and imposed upon the system of economic exchanges. The cross-country regression analysis that is performed offers additional evidence in support of the profound insights of Acemoglu *et al*. (2001, 2002, 2005), Acemoglu and Johnson (2005), Cheung (1969), Coase (1988), Cooter and Schäfer (2012), Demsetz (1968), Djankov *et al*. (2006), Glaeser *et al*. (2004), McCloskey and Klamer (1995), North (1990, 2005) and Williamson (1975, 1998).

Our estimates highlight negative and robust relationship between transaction costs generated by legal institutions and cross-country economic growth. The evidence suggests strong effects of rising transaction costs on economic growth. For a country with 10 basis points higher extent of transaction costs relative to those that do not increase the costs, according to our measurement, we expect it to be between 3.12-fold and 4.66-times poorer which roughly corresponds to the per capita output gap between Switzerland and Argentina. The underlying institutional framework for market exchange is possibly the key to understanding why some societies have been plagued by institutional failures and remained mired in poverty, while others have forged ahead and attained high welfare levels. Such transaction costs are also intrinsically insightful since they are common among firms within a single country but differ across countries. They represent a static reflection of the fraction of transaction costs rather than the entire spectrum of costs.

This article attempts to make several contributions to the literature. First, it incorporates the concept of transaction costs, i.e. external costs of the legal systems, generated by legal institutions, for economic exchange into the standard growth theory and provides a cross-country panel data regression analysis. Second, it attempts to estimate the effect of cross-country differences in transaction costs on economic performance over time employed in the Solow growth model. Third, in line with Coase's (1998) proposition, the article offers further empirical insights into the world of positive transaction costs, and suggests that cross-country differences in the cost of contract enforcement may be considered as some of the most important determinants of large income and welfare gaps between countries. It provides support for Coase (1988, 1998),

https://doi.org/10.1017/S1744137415000077 Published online by Cambridge University Press

North (1990) and Williamson's (1996) arguments that in the world of positive transaction costs the legal system might play a crucial role in the pursuit of efficiency and economic growth.

This empirical analysis employs a sample of 139 countries for the period 2003–2012 from World Bank Doing Business database. The fraction of transaction costs is measured by exploiting seven main categories reflecting firm-level sub-categories of transaction costs: costs of contract enforcement; time, cost of insolvency procedures, cost of property registration; costs of cross-border trading; costs of paying taxes; costs of construction permits; and costs of starting business. Although the broader spectrum of transaction costs encompasses additional categories such as the cost of getting credit, cost of getting electricity and costs of employing workers, data limitations and time framework in Doing Business reports disallow the comparative construction of time-series for these three additional categories.

Several caveats should be stated. The availability of data represents an inherent limitation on the scope of our results. Since it is impossible to acquire data on the whole spectrum of transaction costs, we focus solely on those 24 sub-categories linked to transaction costs generated by the underlying structure of the formal legal framework. This article employs data that are readily available although far from ideal and their validity have in recent years also triggered an extensive scholarly discussion (Arruñada, 2007; Djankov *et al.*, 2002; Klick, 2010; Spamann, 2010). Helland and Klick (2013) argue that statistical identification is one of the key issues in recent literature on the relationship between specific legal institutions and economic or financial development since the estimated relationships might be the result of omitted variable bias. Buchanan *et al.* (2014), Klick (2010) and Helland and Klick (2013) also observes that the empirical tools that drove the credibility revolution in applied microeconomics are simply unsuitable for making causal inferences in the context of institutions. It should also be noted that our paper is not assessing the normative content of legal rules, but merely evaluates external costs of different legal rules in their institutional setting. We provide three additional novel insights to the literature. First, our approach weighs transaction cost indicators based on the respective country-specific annual number of survey responses to address the sampling variation in each underlying indicator. This method goes beyond the distance to frontier measure adopted by World Bank since it tackles the excessive sampling variation in transaction cost indicators resulting from hugely different sample sizes across annual surveys. Second, a cross-country panel data regression analysis is employed to control for the unobserved heterogeneity in the longitudinal relationship between transaction costs and economic growth which cannot be tackled in cross-sectional regression framework. And third, it demonstrates the economic gains from lower transaction costs in the Solow growth framework by calibrating the Cobb–Douglass production function for multiple growth regimes.

This article is organized as follows. In Section 2, we provide a survey on the existing literature and elaborate on transaction costs definition. Section 3 presents the measurement of transaction costs, while Section 4 discusses data and methodology used in this study. Section 5 then discusses the results and presents our main findings and the robustness checks. Section 6 concludes.

2. Relevant literature and research hypotheses

This section identifies existing definitions of transaction costs, offers a review of previous empirical research, identifies the need for further quantitative assessment of transaction costs' impact on economic growth, and presents the set of research hypotheses.

In the original formulation by Coase (1937, 1988, 1998) and North (1990), transaction costs are defined as 'the cost of using the price mechanism' or 'the cost of carrying out a transaction by means of an exchange on the open market'. Arrow (1969), De Geest (1994), Parisi and Posner (2013) and Williamson (1996) define transaction costs as the costs of running the economic system of exchange. One should note that transaction costs are not costs like the production costs or precaution costs, but the costs of economic exchanges. Coase's (1960) definition of transaction costs encompasses *ex ante* costs (before exchange) associated with search and negotiation, and *ex post* costs (after exchange) of monitoring and enforcement. Transaction costs are hence the costs of economic exchange and are the aggregate of search, negotiation and enforcement costs (Cooter and Ulen, 2008; Goldberg, 1985; Mackaay, 2013; Parisi, 2014).

The empirical work in transaction cost economics is fruitful. A complete overview would exceed the limitations of this article. Excellent literature surveys are provided in Allen (2011, 2015), Arruñada (2013), Douma and Schreuder (2012), Klaes (2000), MacKaay (2013), Parisi (2014), Parisi and Posner (2013), Polinsky and Shavell (2007), Schäfer and Ott (2004), Trebilcock and Prado (2011), Ulen (2013), van der Beek (2011) and Williamson and Masten (1999). The empirical literature on transaction costs tests hypotheses and therefore refutes the assertion that transaction cost economics is tautological. Most empirical studies are of the comparative static variety and attempt to test transaction cost hypotheses using various proxies for asset specificity, uncertainty, measurement costs, friction and other transaction cost variables. Only few empirical studies have attempted to measure the actual level of transaction costs at the organizational (Masten *et al*., 1991) and the aggregate level (Allen, 2011; Davis, 1986, Dollery and Leong, 1998; McCloskey and Klamer, 1995; Wallis and North, 1986).

Our focus emphasizes transaction costs which are imposed upon economic exchange and generated by different legal systems. Transaction costs are primarily affected by the functioning and efficiency of legal institutions. In this respect, Djankov *et al*. (2006) introduce a new measure of institutional quality, develop an aggregate index of business regulations and argue that countries with better business regulations tend to grow faster (Aghion *et al*., 2009; Barseghyan, 2008; Bose *et al*., 2012; Crafts, 2008; Dawson and Seater, 2013; Freund and Bolaki, 2008; Herrendorf and Teixeira, 2011; Johnson *et al*., 2002). Acemoglu and Johnson (2005) exploited exogenous variation in both types of institutions driven by colonial history and document strong first-stage relationships between security of property rights, European colonization strategy and contracting institutions. They confirm that property rights institutions have a first-order effect on long-run economic growth and financial development (Acemoglu *et al*., 2001, 2002, 2005, 2011; Easterly and Levine, 2003; Hall and Jones, 1999; Rodrik *et al*., 2004; Torstensson, 1994). Some authors argue that public land and company registries strengthen property rights, reduce transaction costs and facilitate economic growth (Arruñada, 2013; Arruñada and Garoupa, 2005; Miceli and Kieyah, 2003) whereas others argue that human capital is a more basic source of wealth than institutions are (Glaeser *et al*., 2004).

Our work follows the previous transaction costs literature and employs the original Coase's (1937) definition of transaction costs as the costs of running the economic system of exchanges. Due to the lack of all-encompassing transaction costs data, we focus solely on a fraction of overall transaction costs representing the external costs of legal institutions (e.g. administration, procedural costs) that are imposed upon the system of economic exchanges. Since it is impossible to acquire data on the whole spectrum of transaction costs, we focus solely on those 24 sub-categories that are available and generated by the underlying structure of the legal institutional framework.

Given the importance of institutions for economic growth and the allocation of resources, transaction costs may be an important additional mechanism affecting cross-country patterns of growth. In essence, our research hypotheses can be summarized as follows:

> ***H1****: Higher transaction costs lead to lower output per capita conditional on the structural determinants of economic growth such as investment rate, human capital accumulation and population growth.*
>
> ***H2****: Rising transaction costs exacerbate socially wasteful allocation of resources and are a more important mechanism of cross-country economic growth than physical capital accumulation, proxied by investment/GDP ratio.*
>
> ***H3****: Decreasing the extent of transaction costs in high-cost countries spurs the economic resources into productive use, enhances human capital accumulation and leads to the convergence of income and welfare levels across countries.*

Anticipating our results, our investigation contributes to the existing scholarly literature by testing three hypotheses. Each of the three hypotheses is not concerned with the normative content of legal rules but with the impact of transaction costs on economic growth in the debate on the underlying cross-country output per capita difference. The first hypothesis (**H1**) tackles the nexus between economic growth and transaction costs by focusing not only on the relationship but also on the mechanisms at work through which higher costs constrain the ability of economies to achieve and sustain growth. The second hypothesis (**H2**) contests transaction costs into the candidates for the underlying causes of economic growth. Finally, the third hypothesis (**H3**) is concerned with the economic growth of poorer countries and tests whether lower extent of transaction costs can improve the subsequent path of growth and help bridge the output per capita gaps between countries.

3. Measuring cross-country transaction costs

Our attempt to measure transaction costs is based on the institutional dimensions of the costs incurred when firms participate in the market. Specifically, we focus on transaction costs driven by the underlying structure of the formal institutional framework, regulatory barriers and contract enforcement for economic exchange and market participation. Transaction costs are common among firms within a single country but differ across countries. Compared to earlier attempts to estimate the share of transaction costs in GDP, our approach emphasizes, institutional enforcement transaction costs captured by the extent of formal institutional regulations as advocated by De Soto (2003). In this respect, our approach represents an attempt to establish the extent of transaction costs across countries by employing various measures which indicate the persistence of transaction costs and respective differences between countries.

We investigate the fraction of transaction costs across countries by employing the *Doing Business Report* for the period 2003–2012 (World Bank, 2013) to measure firm-level of institutional business regulations. The costs are measured by exploiting seven different aspects of institutional, firm-level transaction costs and are presented in Table 1.

First, ease of doing business measures officially required procedures along with the time and cost borne by the entrepreneur to formally operate her commercial business. The ease of starting a business captures the institutional barriers and costs involved in starting a business and participating in the market (Djankov *et al*., 2002). Second, the ease of dealing with construction permits measures the official procedures, number of days and the cost in the construction industry to build a warehouse. Third, the ease of property registration measures the sequence of official procedures a firm needs to comply with to purchase a property from another firm and to transfer the property title to the buyer's name to be used for: (i) expanding the business; (ii) as collateral for acquiring loans; and (iii) selling the property to another firm. In addition, this indicator takes account of the cost and number of days needed to complete the property registration procedure.

Fourth, the ease and administrative burden of paying taxes measures the difficulty of paying taxes and mandatory contributions for firms. This indicator

Table 1. Transaction costs

1. Starting a business		
# Procedures to start a business	# Days to start a business	
Cost of starting a business (% per capita income)	Paid-in minimum capital (% per capita income)	
2. Dealing with construction permits		
# Procedures to deal with	# Days to deal with procedures	Cost of dealing with construction permits (% per capita income)
3. Property registration		
# Procedures to register a property	# Days to register a property	Cost of property registration (% per capita income)
4. Paying taxes		
# Hours to pay taxes per year	Total tax rate (% of commercial profit)	
5. Trading across borders		
# Documents to export	# Days to export	Export cost (USD per container)
# Documents to import	# Days to import	Import cost (USD per container)
6. Contract enforcement		
# Days to enforce the contract	Cost of contract enforcement (% original claim)	# Procedures to enforce the contract
7. Resolving insolvency		
# Years to resolve insolvency procedure	Cost of resolving insolvency (% debtor's estate)	Recovery rate (cents per USD to the creditor)

considers the firm-level number of hours per year needed to prepare and pay corporate income tax, value-added tax and labor tax as well as the total tax rate in percent of commercial profit (Djankov *et al.*, 2010). Fifth, the cost of international trade encompasses the cost of international market access. The cost of trading across borders measures the time and cost associated with exporting and importing a standardized cargo container of goods by sea transport. This indicator considers the number of official import and export procedures as well as the time needed to complete the procedures and the overall cost per standardized cargo container (Djankov *et al.*, 2008).

Sixth, the ease of contract enforcement measures the efficiency of the judicial system in resolving a commercial dispute. The efficiency of the courts is decomposed into three indicators: (i) number of procedures to enforce the contract, including filing and servicing the documents, the trial and the judgment and its enforcement; (ii) number of days required to complete procedures; and (iii) cost required to complete procedures. Time to complete procedures is counted from the moment the plaintiff decides to file a lawsuit until the final payment. Cost to complete procedures excludes bribes and is measured as the percentage of the claim and consists of court costs, enforcement costs and attorney fees. The ease of contract enforcement captures the possible inefficiency of the judicial system in enforcing contracts (Djankov *et al*., 2003).

Seventh, the resolving insolvency indicator captures the time, cost and outcome of insolvency proceedings. It is derived from questionnaire responses by local practitioners of insolvency proceedings and bankruptcy systems. It takes into account the time for creditors to recover the credit expressed in the number of calendar years, and the cost of the proceedings as a percentage of the value of the debtor's estate. The total cost of insolvency proceedings consists of court fees, insolvency administrator fees, legal fees, assessor fees, auctioneer fees and other related fees. The insolvency indicator comprises the recovery rate for creditors. The recovery rate is measured as cents in the dollar recuperated by creditors through firm reorganization, liquidation or debt enforcement proceeds and denotes the present value of recovered debt. The recovery rate is calculated once the official costs of insolvency proceedings and foreclosures are deducted, including the depreciation of equipment.

The extent of transaction costs is estimated by the linear scaling transformation for each indicator through the normalization and rescaling of the observable variable:

$$\hat{\otimes}^{j}_{i,t} = \frac{\div^{j}_{i,t} - \min\limits_{i,t}\left\{\boldsymbol{\theta}^{j}_{i,t}\right\}}{\max\limits_{i,t}\left\{\boldsymbol{\theta}^{j}_{i,t}\right\} - \min\limits_{i,t}\left\{\boldsymbol{\theta}^{j}_{i,t}\right\}} \times 100, \tag{1}$$

where $\hat{\otimes}$ is the transaction cost indicator j for country i at time t, $\div$ denotes a transaction cost variable for each distinctive institutional category of transaction costs and $\boldsymbol{\theta}$ represents the vector of non-zero variable values for each indicator. A linear scaling transformation confers several advantages in estimating the extent of costs. First, specific transaction costs are denoted in a different unit across seven categories such as number of days and procedures, which hinders the concise interpretation of the transaction-cost effect on cross-country economic growth. Second, rescaling the transaction costs on a range between 0 and 100 allows us to observe the response in the outcome of interest to the change in the fraction of transaction costs. Lastly, linear-rescaling transformation allows us to observe whether different types of costs affect the outcome of interest to a different degree. This is especially important for distinguishing between specific institutional dimensions of transaction costs with respect to cross-country economic performance.

The main analytical caveat in constructing the indicator variables for the extent of transaction costs concerns the size of the sample upon which the survey data is used to infer the parameter values which can exacerbate biased and inconsistent estimates of the relationship specifically between transaction costs and various measures of economic performance. When surveys differ substantially in terms of size, transaction cost indicators can exhibit markedly higher sampling variation as an outcome of a lower probability of estimating a true parameter compared to the sampling counterpart. Non-trivial differences in the respective sample size can lead to severe selection bias since a true selection probability differs from those assumed in comparing the estimated parameters. In addition, low sample size in the respective survey can aggravate the measurement error which can lead to self-recurring bias in intertemporal variance of estimated indicators when the estimated transaction cost parameters are compared between low-size surveys and large-size surveys from two separately drawn sets of population.

The potential measurement error stemming from substantial differences in the survey sizes between countries is addressed directly by constructing the weighted mean value for each of the 24 transaction cost indicators using the size of the survey for each year in the period 2003–2012 from Doing Business report. Let the underlying weight function $\mathbf{w} = \left\{w_{1i,t}, w_{2i,t}, ...w_{ni,t}\right\}$ be a non-empty sequence of weights where each element w in the set denotes the size of the sample in a survey per for each year of the estimation period $t \in T$ where $i = 1, 2, ...n$ denotes the index for the number of countries. The weighted level of transaction costs is constructed by using the weight function and taking into account the underlying differences in the survey size to adjust for the random sampling variation:

$$\hat{\tau}_{i,t}^{\text{Weighted}} = w_{i,t} \cdot \hat{\tau}_{i,t}^{j}, \tag{2}$$

where $w_{i,t}$ is the size of the sample for country i at time t and $\hat{\tau}_{i,t}^{j}$ is the original unweighted transaction cost indicator that does not take into account the respective differences in the size of the survey upon which transaction cost indicators are inferred. The adjustment of the transaction cost indicators for the varying survey sizes ensures that countries with large sample sizes will have less sampling variation in the underlying indicators since equation (2) implies that countries with larger surveys are overweighted whereas those with smaller surveys are attached a lower weight since their transaction cost indicators are typically less reliable and characterized by greater sampling variance of each indicator. The aggregate series is constructed using the weighted mean of the respective transaction cost indicators

$$\mathrm{T}_{i,t}^{\text{Weighted}} = \sum_{j} \sum_{i=1}^{n} w_{ni,t} \cdot \hat{\tau}_{i,t}^{j}, \tag{3}$$

where $\mathrm{T}_{i,t}^{\text{Weighted}}$ is the weighted aggregate series averaged across j categories for transaction costs for ith country in year t, which can be comparable across countries and over time and potentially takes into account the cross-sectional and intertemporal measurement error. Although increasing the size of the survey can partially alleviates the differences in the sampling variation, higher size of the survey does not guarantee greater reliability of the estimated parameters since the size of the respective population is not taken into account. Even though the survey size in Brazil in a given year might be higher in absolute terms than survey size in Switzerland, this might not hold in per capita (relative) terms since the size of Switzerland's population is many times smaller than the Brazilian population. Hence, even a lower absolute number of surveys can imply greater reliability and less sampling variation in the estimated parameters if the population size is sufficiently small. In the empirical section, the potential bias in the weight function are addressed using the alternative structure of weights which takes into account per capita number of surveys, the share of country-specific surveys in the annual total and log-normally distributed per capita number of surveys to tackle the skewness of the survey size distribution across space and time.

4. Data and methodology

Empirical methods

We construct the long-run cross-country growth model with transaction costs to examine the relationship between transaction costs and economic growth across countries and over time. Controlling for unobserved heterogeneity, the long-run neoclassical growth model that takes place is as follows:

$$\ln y^*_{i,t} = \mu_i + \ln \bar{A}_{i,t} + \frac{\alpha}{1-\alpha-\beta} \ln\left(\frac{s_k}{n+g+\delta}\right) + \frac{\beta}{1-\alpha-\beta} \ln\left(\frac{s_h}{n+g+\delta}\right) + \hat{\lambda} \cdot \hat{\mathrm{T}}^{Weighted}_{i,j,t} + u_{i,t} \quad (4)$$

where $y^*_{i,t}$ is the per capita output of country i at time t, $\ln \bar{A}_{i,t}$ is the level of technology, μ_i is the unobserved heterogeneity which captures country-specific effects and allows the technology intercept to vary over time, s_k is the share of investment in the GDP, s_h is the stock of human capital, n is the population growth, g is the technological change parameter common to all countries, δ is the depreciation rate, $\hat{\mathrm{T}}^{\mathrm{Weighted}}_{i,j,t}$ is the fraction of transaction costs from jth category, corrected for the underlying differences in sampling variation, where both the aggregate and disaggregated series is considered. The set of growth determinants such as working-age population growth, investment/GDP ratio and average years of schooling which capture the contribution of demography, physical capital and human capital accumulation to the long-run growth is used as identified by Mankiw *et al.* (1992), and the term $u_{i,t}$ denotes the unobserved stochastic disturbances.

The primary coefficient of interest in equation (4) is $\hat{\lambda}$ which captures the contribution of rising transaction costs to the long-run economic growth. Our aim is to test the underlying model specification based on weighted and transaction cost indicators conditional on the effects of investment rates, human capital and population growth and taking into heterogeneity bias driven by unobserved effects. A major threat to the estimated effects of transaction costs on long-run growth is the persistence of serially correlated stochastic disturbances

https://doi.org/10.1017/S1744137415000077 Published online by Cambridge University Press

not only between countries over time but also within countries. The standard solution is to use the heteroskedasticity-robust variance matrix estimator, originally proposed by White (1980), and adjust the standard errors into country clusters using one-way clustering scheme to avoid markedly underestimated standard errors and over-rejection rates in the standard hypothesis tests as discussed at length by Bertrand *et al.* (2004), Kezdi (2004) and Moulton (1986). Relatively weak distributional assumptions for the stochastic disturbances can persist even with one-way clustering of standard errors since the size of the country-specific surveys differs across years as some countries might experience lower sampling variation in transaction cost indicators whereas for some countries the sampling variance can increase over time as a result of less reliable surveys in comparison with other countries. The measurement error in the transaction cost indicators potentially persists over time which can lead to underestimated standard errors and over-rejection in testing hypotheses on the economic effects of rising and decreasing transaction costs. We overcome the potential weakness of distributional assumptions in one-way clustering of standard errors by adopting the multiway clustering scheme from Cameron *et al.* (2011) and cluster standard errors both at country-level and year-level to control for survey design effects and the consequent potential measurement error and to allow for serially correlated disturbances both at the cross-section and temporal level.

Data

Our sample consists of 139 countries for the period 2003–2012. In Table A1, the geographical coverage of the sample is presented. The data on real PPP-adjusted per capita GDP at 2005 constant prices is from *Economic Research Service*. The variable investment/GDP ratio captures the contribution of physical capital stock to output per capita. The share of investment in GDP is constructed using the data on gross fixed capital formation from the *World Bank*. The contribution of human capital formation to output per capita growth is captured by the average years of education variable. The data on average years of education are from Van Leeuwen *et al.* (2013). Average years of education encompasses the total population aged 15 and above. The variable is calculated, using perpetual inventory method by Barro and Lee (1993), separately to remedy existing methodologies such as those found in Barro and Lee (2013) and Cohen and Soto (2007). The data on working-age population are from the *International Labor Organization* working-age population comprises economically active people aged 15 and above who supply labor for the production of goods and services during a specified period. In Table 2, descriptive statistics is presented for each variable. Cross-country income per capita differences in our sample are unequivocally large, ranging from the highest level observed in Norway to the lowest level in Zimbabwe. A similar pattern is observed in the distribution of

Table 2. Descriptive statistics for the baseline variables

	Obs	Mean	Overall SD	Between SD	Within SD	Min	Max
Panel A: The dependent variable							
Real GDP per capita	1,390	10,119	14,564	14,581	942.94	28.42	70,541
Panel B: Standard growth determinants							
Average years of education	1,390	8.612	3.301	3.277	0.479	0.611	15.968
Investment/GDP ratio	1,390	23.384	7.363	6.324	4.309	2.00	75.63
Working-age population growth	1,390	1.909	1.838	1.493	1.079	– 5.074	17.426
Panel C: Transaction cost variables							
Transaction cost variable (unweighted)	1,390	22.114	7.647	7.444	1.866	5.00	45.80

Notes: the table presents the key descriptive statistics for the core dependent and independent variables in the panel. Mean and standard deviation for transaction costs is presented for both unweighted data and weighted data where the share of country-specific sample size in the total size is used as a finite-sample real-valued weight function.

average years of education, investment/GDP ratio and the rate of working-age population growth.

The variable on transaction costs is constructed through equation (1) using the indicators from Table 1. The measures of transaction costs are derived simultaneously using indicators such as the cost of starting a business, cost of dealing with construction permits, cost of property registration, cost of paying taxes, cost of contract enforcement and cost of resolving insolvency. Each indicator is normalized between 0 and 100, where higher values indicate a higher amount of transaction costs. In Table 3, descriptive statistics are presented for the level of specific transaction costs across the seven categories. The frequency of firm-level observations is used as a criteria for the number of observations in the survey design which differs from the number of country-level observations. The estimated parameters of our sample indicate that mean levels of transaction costs suggest a substantial cross-country variation in the extent of transaction costs. Peculiar differences are observed not only across transaction cost categories but also within individual categories.

5. Results

Baseline results

In Table 4 , weighted cross-country regressions of per capita output on transaction costs are presented using survey size per country and year to weigh transaction cost indicators based on equation (2) and excluding conditioning growth variables. In column (1), the cost of starting business indicators are

Table 3. Descriptive statistics for transaction costs

	Obs	Mean	Overall SD	Between SD	Within SD	Min	Max
Cost of starting a business							
# Procedures to a start business	48,932	41.663	19.261	16.809	9.499	0	100
# Days to start a business	48,932	17.284	16.620	14.215	8.687	0	100
Cost of starting a business	48,932	1.041	3.486	2.175	2.729	0	100
Paid-in minimum capital	48,932	0.348	2.831	1.171	2.579	0	100
Cost of dealing with construction permits							
# Procedures in dealing with construction permits	48,932	19.184	13.359	12.891	3.654	0	100
# Days to deal with construction permits	48,932	16.335	12.216	11.693	3.659	0	100
Cost of dealing with construction permits	48,932	4.410	9.201	8.448	3.718	0	100
Cost of property registration							
# Procedures to register a property	48,932	35.664	17.482	17.006	4.276	0	100
# Days to register a property	48,932	7.231	9.555	8.044	5.198	0	100
Cost of property registration	48,932	20.400	17.912	17.216	5.134	0	100
Cost of paying taxes							
# Annual hours to pay taxes	48,932	12.469	11.727	11.234	3.487	0	100
Total tax rate	48,932	12.174	10.383	9.702	3.779	0	100
Cost of international trade							
# Documents to export	48,932	32.251	12.166	13.580	6.838	0	100
# Days to export	48,932	22.569	18.635	18.023	4.952	0	100
Cost to export	48,932c	16.502	15.210	14.723	4.000	0	100
# Documents to import	48,932	32.251	12.167	13.580	6.838	0	100
# Days to import	48,932	23.683	19.103	18.211	5.954	0	100
Cost to import	48,932	14.603	12.598	11.987	3.991	0	100
Cost of contract enforcement							
# Days to enforce contract	48,932	33.654	19.843	19.709	2.792	0	100
Cost of contract enforcement	48,932	19.024	18.889	18.760	2.674	0	100

Table 3. Continued.

	Obs	Mean	Overall SD	Between SD	Within SD	Min	Max
# Procedures to complete contract enforcement	48,932	46.496	17.936	17.908	1.752	0	100
Cost of resolving insolvency							
# Years to resolve insolvency procedure	48,932	25.640	14.721	14.265	3.815	0	100
Cost of resolving insolvency	48,932	20.165	15.704	15.676	1.570	0	100
Recovery rate	48,932	61.895	25.652	25.367	4.328	0	100

assessed against per capita output. The estimates display the negative effect of higher cost of establishing business on per capita output. In column (2), the effects of dealing with construction permits on per capita output are examined and the evidence confirms the negative effect of the complexity of dealing with permits and growth. Column (3) invokes the relationship between the costs of property registration and cross-country economic growth. The results clearly suggest that countries with costlier property registration procedures in proportion to per capita income endure persistently lower rate of economic growth. In column (4), the results suggest that higher cost of paying taxes in terms of higher tax rate is associated with a markedly lower growth whereas the increase in the number of hours to pay taxes is not. Column (5) considers the cost of international trade and demonstrates persistently negative impact of the administrative restrictions on exports on economic growth. The positive effect of export cost is not surprising since it is less costly to export a standardized cargo container in both absolute and relative terms from lower-income countries than high-income countries. The second sub-set of coefficients on administrative import restrictions clearly indicates persistently downward effect on growth.

In columns (6) and (7), the effects of contract enforcement and efficiency debt enforcement regimes on per capita output differences across countries are examined in more detail. In column (6), rising costs and number of procedures in enforcing contracts is associated with a substantial loss of economic growth, as indicated by the underlying coefficients that 10 additional procedures in enforcing contracts is associated with 3.1% decline in per capita output. The estimates in column (6) indicate that 10% point increase in enforcement costs is associated with 3.7% reduction in per capita output and is significant at 1%. The estimated coefficients clearly suggest that even seemingly trivial differences in the cost of contract enforcement can lead to persistent gaps in output per capita across countries. The estimates in column (6) imply that a country with 20 percentage points higher cost of contract enforcement relative to the

Table 4. Weighted basic OLS regression for transaction costs and economic growth

	Cost of starting a business (1)	Dealing with construction permits (2)	Costs of property registration (3)	Cost of paying taxes (4)	Cost of international trade (5)	Cost of contract enforcement (6)	Cost of resolving insolvency (7)
# Procedures to start a business	−0.126* (0.658)						
# Days to start a business	−0.155 (0.102)						
Cost of starting a business	−.111** (0.051)						
Paid-in minimum capital	−0.221* (0.119)						
# Procedures in obtaining construction permits		−0.006 (0.737)					
# Days in dealing with construction permits		−0.025*** (0.771)					
Cost of dealing with construction permits		−0.085*** (0.011)					
# Procedures in registering property			−0.010 (0.638)				
# Days to register a property			−0.015 (0.012)				
Cost of property registration			−0.032*** (0.006)				
# Hours to pay taxes				−0.016 (0.013)			
Total tax rate (%)				−0.017** (0.781)			
# Documents to export					−0.031*** (0.001)		
# Days to export					−0.017 (0.023)		
Cost to export					0.074*** (0.016)		
#Documents to import					−0.063*** (0.007)		
# Days to import					−0.032 (0.021)		
Cost to import					−0.065*** (0.022)		

Table 4. Continued.

	Cost of starting a business (1)	Dealing with construction permits (2)	Costs of property registration (3)	Cost of paying taxes (4)	Cost of international trade (5)	Cost of contract enforcement (6)	Cost of resolving insolvency (7)
# Days to enforce contract						−0.026 (0.052)	
# Procedures to enforce contract						−0.037*** (0.006)	
Cost of contract enforcement						−0.031*** (0.005)	
# Years to resolve insolvency							0.016** (0.007)
Cost of resolving insolvency							−0.002 (0.007)
Recovery rate							−0.052*** (0.005)
Constant term	9.108*** (0.259)	9.101*** (0.240)	9.297*** (0.281)	8.693*** (0.210)	9.930*** (0.221)	10.464*** (0.282)	11.027*** (0.135)
#Country-level observations	1,390	1,390	1,390	1,390	1,390	1,390	1,390
# Firm-level observations	48,932	48,932	48,932	48,932	48,932	48,932	48,932
Wald χ^2 test (Prob> χ^2)	0.000	0.000	0.000	0.016	0.000	0.000	0.000
Theil R^2	0.161	0.232	0.160	0.041	0.462	0.367	0.586

Notes: the dependent variable is the natural log of real GDP per capita at 2005 constant prices in US$. Standard errors are adjusted for within-country serially correlated disturbances and heteroskedastic distribution of random error variance into 139 country-specific clusters and 10 time-specific clusters using Gelbach, Cameron and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function and cluster-robust coefficient inference to remove the inconsistencies arising from biased OLS covariance matrix estimator and serially correlated residuals. 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.

outstanding value of the claim compared to another one should experience 47% [= exp(−0.037)*20] lower PPP-adjusted per capita output which roughly corresponds to the output per capita differential between Germany and Czech Republic. The estimated effects of contract enforcement on the path of economic growth in weighted OLS regression framework clearly imply that rising transaction costs impede economic growth. In column (7), the quality and efficiency of debt enforcement is assessed against per capita output. The results clearly advocate persistently negative effect of lower recovery rate on per capita output. The estimated coefficient on the recovery rate in column (7) suggests that each additional cent relative to the US dollar lost by the creditor in the insolvent firm translates into 5.2% drop in per capita output which clearly substantiates the importance of debt enforcement efficiency in resolving insolvent firms in accounting for output per capita disparities across countries. Transaction costs associated with debt enforcement efficiency and quality indicatively account for about 60% of the cross-country variation in per capita output. Countries with a more prudent and efficient debt enforcement mechanism tend to experience higher rate of growth. In essence, substantial evidence is found in cross-country growth regressions in support of hypothesis H1.

One possible objection to the results obtained under weighted cross-country regression is the notion that the negative effect of rising transaction costs on the path of economic growth can be driven by an omitted variable that affects output per capita only through transaction costs. Such challenge would necessitate the instrumental variable strategy to tackle the omitted variable bias and address the possibility of either upward or downward bias in the nexus between transaction costs and cross-country economic growth that is driven by the omitted factor. However, Helland and Klick (2013) and Klick (2010) highlighted the near impossibility of statistical identification of the causal effect of a given dimension of institutional development on economic outcomes. Institutions tend to change very slowly over time and a variety of exogenous shocks that would allow for a quasi-natural experiment tends to simultaneously affect other observable social and economic outcomes which precludes the effective isolation of transaction costs' effect on economic growth from other the effects driven by other factors that jointly affect economic growth.

The near impossibility of identifying the causal relationship between transaction costs and economic growth does not imply that rising transaction costs are not associated with varying differences in the cross-country economic performance. It advocates that a hypothetical drop in the extent of costs simultaneously affects other outcomes which disallow the identification of causal effect in the spirit of the credibility tools from empirical microeconomics (Angrist and Pischke, 2010) to tackle the potential endogeneity and reverse causality. Notwithstanding the near identification impossibility and simultaneity, our estimate clearly indicates the potential of transaction costs to shape economic growth over time. The main dilemma possibly pervading weighted regression estimates from Table 5 is the significance of one sub-set of coefficients and the insignificance of the other set of coefficients which can cast doubt on the robustness of the relationship. Following Klick (2010), we assess the robustness of the relationship between output per capita and transaction costs by focusing on conditioning the estimated effects on other variables that might confound the negative effect of rising costs on output per capita. In addition to this kind of robustness check, we also change the underlying weight function in equation (2) using different structural assumptions in weighting transaction data to adjust transaction cost indicators for respective differences in sample size.

In Table 5, the effects of transaction costs on cross-country economic growth are examined in the neoclassical Solow growth model based on the underlying model specification in equation (4) where we allow for the investment rates, technological change and population growth to affect the path of economic growth. The aggregate measure of weighted transaction costs is used based on weighted mean of 24 transaction indicators as shown in equation (3). Each model specification is broken down into textbook Solow model and augmented Solow model. In column (1) and (2), the weight function based on annual country-specific sample sizes in Doing Business reports is used. The estimates indicate the pivotal role of transaction costs and human capital accumulation in shaping per capita output differences across countries which also trump the contribution of investment/GDP ratio. Our preferred specification in column (2) implies that for a country with 10 basis points higher extent of transaction costs, we expect it to be roughly three times poorer [$= \exp(-0.144)\times 10$] than a low-cost country which roughly corresponds to the output per capita difference between the Netherlands and Romania.

In columns (3) and (4), the log of country-specific sample size from Doing Business surveys is used to weigh observations and address the sampling variation in transaction cost data. Rescaling the weight function with the log of sample size disallows potentially high-leverage observations from excessive influence on growth effects. The weights based on the frequency of survey responses can impose disproportionate weight on large countries and underestimate the indicators of countries with smaller population even though they might exhibit less sampling variation in the data. The results in column (3) confirm the negative effect of rising transaction costs on cross-country economic growth in both models alike. In columns (5) and (6), the share of country-specific surveys is used to weight the panel data series on transaction costs which still allows us to tackle sampling variation from the underlying indicators but prevent large countries from over-leveraging the observations. The evidence confirms the negative effects of higher transaction costs on the per capita output. In column (7) and (8), the weighing function is rearranged by dividing the absolute number of surveys by the population size assuming that small per capita frequency of survey responses is a source of excessive sampling variation in the underlying indicators. Under such setting, more leverage is imposed on the smaller countries

https://doi.org/10.1017/S1744137415000077 Published online by Cambridge University Press

Table 5. Effect of transaction costs on economic growth in neoclassical Solow model of cross-country growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Frequency weights		Analytic weights							
	# Survey responses		Log survey responses		Country share of survey responses		# Survey responses per capita		Log normal distribution of survey responses	
Weight structure	Textbook Solow model	Augmented Solow model	Textbook Solow model	Augmented Solow model	Textbook Solow model	Augmented Solow model	Textbook Solow model	Augmented Solow model	Textbook Solow model	Augmented Solow model
$\ln(n+g+\times)$	− 0.205***	− 0.117	− 0.199***	− 0.114	− 0.201***	− 0.114	0.218	0.236	− 0.190**	− 0.110
	(0.079)	(0.083)	(0.077)	(0.078)	(0.074)	(0.077)	(0.237)	(0.236)	(0.076)	(0.077)
$\ln s_k$	− 0.317	− 0.318	− 0.202	− 0.288	− 0.261	− 0.307	− 0.741	− 0.851*	− 0.205	− 0.301
	(0.253)	(0.218)	(0.252)	(0.233)	(0.264)	(0.237)	(0.491)	(0.487)	(0.250)	(0.234)
$\ln s_h$		0.986***		0.846***		0.989***		0.480		0.812***
		(0.199)		(0.157)		(0.196)		(0.329)		(0.153)
Transaction costs	− 0.144***	− 0.114***	− 0.151***	− 0.126***	− 0.146***	− 0.115***	− 0.164***	− 0.154***	− 0.152***	− 0.129***
	(0.017)	(0.019)	(0.013)	(0.014)	(0.016)	(0.018)	(0.022)	(0.024)	(0.012)	(0.013)
Constant term	12.393***	9.678***	12.140***	10.082	12.295***	9.702***	13.407***	12.488***	12.164***	10.234***
	(0.714)	(0.738)	(0.768)	(0.719)	(0.760)	(0.772)	(1.421)	(1.370)	(0.766)	(0.722)
# Observations	43,061	43,061	1,223	1,223	1,232	1,232	1,232	1,232	1,223	1,223
# Country clusters	137	137	137	137	137	137	137	137	137	137
# Time clusters	10	10	10	10	10	10	10	10	10	10
Wald χ^2 test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Theil R2	0.5067	0.5664	0.5326	0.5782	0.5165	0.5771	0.4759	0.4830	0.5369	0.5,783

Notes: the table presents the effects of transaction costs on cross-country per capita output after controlling for possible effects of physical capital and human capital accumulation in the textbook and augmented Solow growth model using the framework from Mankiw *et al.* (1992). Standard errors are adjusted into country-specific and temporal clusters to allow for arbitrary heteroskedasticity and serially correlated stochastic disturbances within countries using Gelbach, Cameron and Miller (2011) non-nested multi-way clustering scheme for finite-sample adjustment of the empirical distribution function and cluster-robust coefficient inference to remove the inconsistencies arising from biased OLS covariance matrix estimator and serially correlated residuals both over time, between- and within-countries. 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.

where lower variation is more likely. The evidence confirms a robust negative effect of higher transaction costs on per capita output. In columns (9) and (10) log-normal distribution of survey responses is constructed by using the ratio of the log of absolute number of survey responses and the log of population size to address the possible skewness in the distribution of survey responses. The results reaffirm the negative relationship between per capita output and transaction costs when alternative weighing function is used and after controlling for the set of conditioning variables. Thus, our results provide a confirmatory answer for research hypothesis H2.

Transaction costs and cross-country convergence: model calibration

The evidence based on weighted OLS regressions suggests large economic gains from lower transaction costs. The context of negative effects of rising transaction costs on the path of economic growth invokes the robustness of the results to demonstrate the credibility of obtained estimates. Given the near impossibility of distinguishing correlation from causation, a quasi-natural experiment for such a large number of countries where a certain exogenous shock is related to the outcome of interest between treatment group and the control group is likely to be driven by omitted variable bias resulting from the influence of cultural factors, history, political system, income redistribution, and geography that affect transaction costs both directly and indirectly.

Our attempt to address the near impossibility of identifying the relationship between transaction costs and economic growth is based on examining whether lower transaction costs can lead to cross-country convergence of output per capita. Rather than asking whether the effect appears causal, our approach sets to ask whether a relatively poor country with high transaction costs such as Indonesia can expect to converge to the income and welfare level of the Netherlands if Indonesia's transaction costs decreases over time. Such an approach relies on the set of reasonably strong assumptions from the cross-country convergence literature which attempts to examine whether the convergence of output per capita levels across countries (Barro and Sala-i-Marin, 1995; Caselli, 1996; Howitt, 2000; Temple, 1999) can be associated with human capital (Benhabib and Spiegel, 1994; Henderson and Russell, 2005; Mankiw *et al.*, 1992), total factor productivity (Bernard and Jones, 1996; De La Fuente, 2002; Miller and Upadhyay, 2002; Parente and Prescott, 2002) modernization (Barro, 1999; Papaioannou and Siourounis, 2008; Przeworski and Limongi, 1997) or institutions (Acemoglu *et al.*, 2009; Hall and Jones, 1999; Knack and Keefer, 1997; Levine, 1999) among the candidate variables that potentially account for income and output gaps across countries.

We follow the original framework proposed by Durlauf and Johnson (2006) and assume that persistent differences in the extent of transaction costs can be translated into multiple regimes for economic growth. Each regime corresponds to the independent neoclassical Cobb–Douglass production function used to describe the link between output per capita, transaction costs, population growth and factor accumulation variables. The estimated parameters in the production function can be used to calibrate the model and inspect whether the estimated effects predict the per capita output across countries. Such an assumption implies that low-cost institutional framework is more growth-enhancing than high-cost framework since higher rate of economic growth can be achieved over time by sustaining low transaction costs. The essential dilemma boils down to the question whether the convergence of cross-country output per capita results from lowering the extent of transaction costs conditional on the rate of capital accumulation. Such model calibration can shed a critical light on whether differences in the extent of transaction costs can account for per capita output gaps.

We perform a cross-sectional regression of output per capita on population growth, the investment/GDP ratio and human capital accumulation as advocated by Mankiw *et al.* (1992) and add our transaction costs variable to the baseline model specification. In Table 6, an augmented Solow growth model is estimated. Panel A exhibits the baseline cross-country regression. The evidence through columns (1) to (3) demonstrates that a higher income level results from human capital accumulation and low transaction costs. Panel B exhibits a restricted cross-sectional augmented Solow model. Since the effect of the investment/GDP ratio is not statistically different from zero, the focus is on the effect of human capital accumulation and transaction costs.

In the next step, the regression parameters from column (1) are considered to perform the model calibration. We first consider the baseline level of technology ($\ln \bar{A}$) which is denoted by the constant term. Multiple growth regimes are constructed by assuming that initial differences in the extent of transaction costs translate into different level of technology. Based on the negative effect of higher transaction costs, high-cost countries possess a lower level of technology whereas low-cost countries enjoy better technology. In the next step, our aim is to examine whether a lower extent of transaction costs in the high-cost country can push the output per capita frontier outward.

Based on the cross-sectional distribution of mean transaction costs, four specific equilibria are established: (i) zero transaction cost from the Coase theorem; (ii) low transaction costs (Denmark); (iii) medium transaction costs (Greece); and (iv) high transaction costs (Brazil). Three different countries are selected into each category and none is chosen in the first category since in the world of positive transaction costs no country can be feasibly characterized by a zero transaction costs. Mean value of transaction cost variable for each country is multiplied by the regression coefficient to predict technology levels. Table 7 summarizes the differences in the extent of transaction costs and the inferred baseline technology level. Finally, per capita output is simulated based on the implied rate of return to human capital investment from the Cobb–Douglas production function. Model calibration is based on the assumption that transaction costs affect the implied technology level. In a world of zero

Table 6. Cross-section estimation of the augmented Solow growth model

	Base sample (1)	Non-oil producing sample (2)	OECD sample (3)
Panel A: Baseline cross-country regression			
$\ln(n+g+\times)$	– 0.892	– 1.421*	0.618
	(0.750)	(0.839)	(0.402)
$\ln s_k$	– 0.511	– 0.459	– 0.984
	(0.400)	(0.408)	(0.608)
$\ln s_h$	0.871***	0.778***	1.323***
	(0.169)	(0.186)	(0.457)
TC	– 0.137***	– 0.140***	– 0.084***
	(0.016)	(0.017)	(0.016)
Constant	8.442***	7.016***	12.961***
	(2.337)	(2.488)	(2.283)
Panel B: Restricted cross-country regression			
$\ln\left(\frac{s_h}{n+g+\times}\right)$	0.850	0.866***	0.187
	(0.141)	(0.147)	(0.448)
TC	– 0.137***	– 0.142***	– 0.098***
	(0.015)	(0.017)	(0.016)
Constant	6.758***	6.967***	10.548***
	(0.986)	(0.956)	(2.441)
Implied α	0.459	0.464	0.157
	(0.141)	(0.147)	(0.448)
Restriction F-Test	36.14	34.67	0.17
(Prob>F)	(0.000)	(0.000)	(0.679)
Restriction F-test on joint significance of transaction costs	81.65	70.57	33.99
(Prob>F)	(0.000)	(0.000)	(0.000)
# Countries	139	127	31
R^2	0.6682	0.7011	0.5548
F-Test	152.69	145.49	18.74
(Prob>F)	(0.000)	(0.000)	(0.000)

Notes: the dependent variable is the natural log of real GDP per capita (US$). In the baseline cross-section specification, we set $\delta = 0.05$ similar to Mankiw *et al.* (1992). Standard errors are adjusted for heteroscedasticity and serially correlated residuals using the Huber–White sandwich estimator. Standard errors are denoted in parentheses and indicate statistically significant sample coefficients at 1% (***), 5% (**) and 10% (*).

transaction costs, the implied technology level would reach its possibility frontier whilst the persistence of transaction costs leads to the sub-optimum equilibrium, lowering the output per capita.

In Figure 1a, steady-state equilibria in per capita output are presented under the assumption of varying transaction costs. The upper output curve corresponds to the zero transaction cost equilibrium. The existence of transaction costs shifts the Cobb–Douglas production function with decreasing returns to scale inward as a result of the lower technology level. Due to the difference in the

Table 7. Model calibration

	Zero transaction cost (coase theorem)	Low transaction costs	Intermediate transaction costs	High transaction costs
Country example	None	Denmark	Greece	Brazil
Mean transaction costs	0	9	23	38
Implied technology level [ln(A)]	6.758	5.641	3.902	2.039

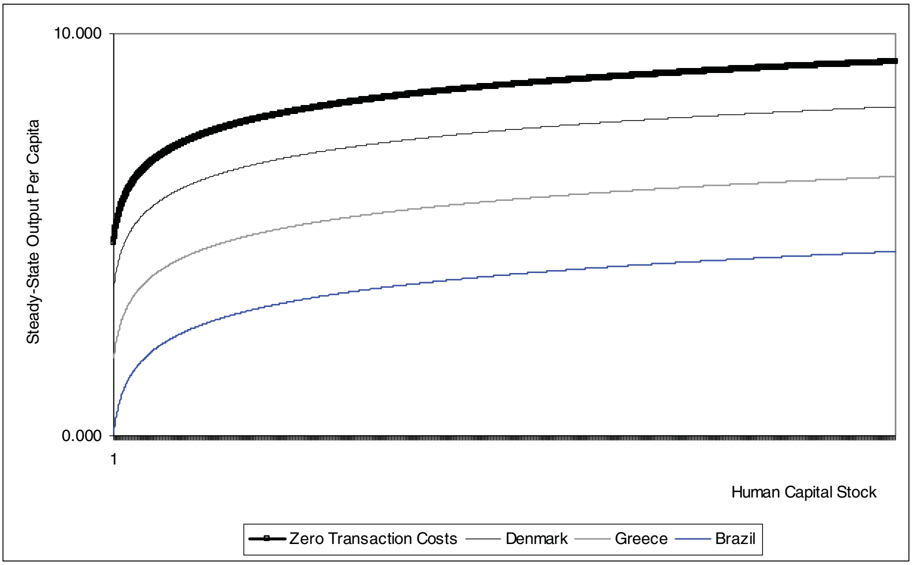
Notes: the implied technology level is based on the calibrated model from the cross-sectional growth regression. Mean transaction costs are calculated as an unweighted average of their seven sub-categories. The breakdown of countries into (i) low, (ii) intermediate and (iii) high transaction costs is based on the decomposition of the cross-country distribution into three non-zero transaction cost categories which denote the level of transaction costs.

extent of transaction costs, Denmark enjoys higher output per capita in the steady state than Greece and Brazil because of its better initial technology level which facilitates higher productivity. The key implication of the calibrated cross-country productivity differences is relatively straightforward to establish. Countries with lower transaction costs enjoy a favorable initial position with respect to the balanced growth path. When institutional differences in transaction costs persist, so does the per capita output in the steady state which accounts for persistent cross-country per capita output gaps.

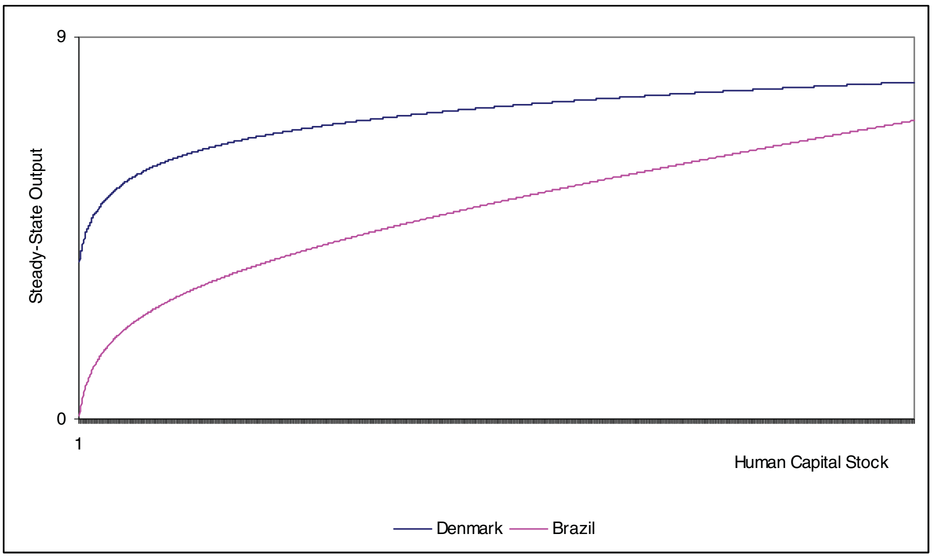
The calibrated productivity differences are used to examine whether lower transaction costs can encourage convergence in output per capita between countries. Can a country with a low income and high transaction costs (Brazil) achieve a comparable level of per capita output in the steady state to a high-income low-cost country in the long run if its transaction costs decrease over time? In Figure 1b, the baseline cross-country growth model is calibrated for a low-cost country (Denmark) and a high-cost country (Brazil). This strategy allows us to observe the spatial shapes of the two different Cobb–Douglas production functions with human capital. The model calibration points to large economic gains from lower transaction costs for the high-cost country. That high-cost country is originally impeded by lower baseline technology level. If Brazil were to reduce the extent of its transaction costs toward low-cost equilibrium, its output per capita in the steady state would gradually start to converge. The speed of the cross-country convergence depends on the implied rate of return to human capital and on the removal of institutional distortions caused by transaction costs. If both countries share the same rate of return to human capital, the speed of cross-country convergence depends on the ability of the high-cost country to reduce its transaction costs. In essence, cross-country growth calibration confirms the research hypothesis H3.

Figure 1. (Colour online) Transaction costs, steady state and cross-country convergence. (a) Steady state equilibrium with transaction costs, (b) Transaction costs and cross-country convergence.

(a) Steady State Equilibrium with Transaction Costs



(b) Transaction Costs and Cross-Country Convergence



https://doi.org/10.1017/S1744137415000077 Published online by Cambridge University Press

6. Conclusion

This paper presents an attempt to quantify the level of transaction costs generated by the formal legal institutions (e.g. administrative and procedural costs) and examine the effects of increasing transaction costs on economic growth between countries and over time. Specifically, we focus on the level of transaction costs triggered by the formal institutional framework that involves the quality of contract and property rights enforcement, costs of market participation and regulatory barriers to economic exchange. We exploit the variation in institutional indicators of cross-country transaction costs from the World Bank's Doing Business Report for the period 2003–2012 and establish specific institutional measures of transaction costs created by the legal and economic institutions for 139 countries.

We construct and estimate a simple empirical model of cross-country economic growth with transaction costs to examine the effects on the path of economic growth over time. Our evidence suggests that transaction costs impede the growth path through institutional channels, ranging from higher costs of starting a business, costlier dealing with construction permits, greater administrative burden of paying taxes, more expensive and inefficient contract enforcement and more inefficient debt enforcement regime. We address the measurement error and excessive sampling variation in the constructed transaction cost indicators across countries by weighing the longitudinal time series of each country based on the respective sample size of country-specific surveys in Doing Business Report on the annual basis used to address varying degrees of survey reliability and indicator accuracy stemming from differences in the number of respondents per country which inevitably drives the variation in each underlying indicator. Alternative weighing schemes are adopted to tackle the differences in both the quality and reliability of the surveys and prevent potentially high-leverage observations from exhibiting disproportionate effects on the estimated relationship between transaction costs and cross-country economic growth.

The negative effects of rising transaction costs on the path of economic growth remain robust to the alternative data weighing function and do not seem to be confounded by the structural determinants of cross-country economic growth such as human capital accumulation, physical capital stock and population growth. The negative relationship between transaction costs and economic growth does not appear to be driven by unobserved heterogeneity.

Our results emphasize the distortionary effects of persistent transaction costs on the path of economic growth over time. To this end, we calibrate the long-run growth model to investigate whether transaction costs can encourage cross-country per capita output convergence. The evidence from the model calibration suggests that decreasing transaction costs activate the cross-country convergence

https://doi.org/10.1017/S1744137415000077 Published online by Cambridge University Press

process in the long run when initially high-cost poor countries move toward lower transaction costs.

The main implication of our study sheds an additional perspective on the interaction between new institutional economics and economic growth. Poorer countries are significantly more likely to embark on a sustainable path of structural transformation if legal institutions establish lower transaction costs. The results in this study clearly suggest that addressing transaction costs can persistently improve the rate of economic growth. Legal institutions that support markets, protect private property, enforce contracts and promises, and assure the integrity of business organizations and innovation are hence the institutions that might matter most for the economic growth. Our paper attempts to answer the question whether transaction costs matter for economic growth. However, reducing those transactions costs may be easier said than done and the normative question of how countries could reduce the transactions costs associated with using their legal systems is open to future research. The institutional, historical, cultural and legal measures driving the underlying differences in the extent of transaction costs across and within countries provide a good starting point for future research to examine why and how some countries manage to establish low-cost environment whilst others do not.

Acknowledgements

The authors would like to thank Pablo Furquim Azvedo, Lee Benham, Roger van den Bergh, Nick van der Beek, Boudewijn Bouckaert, Ignacio Cofone, Giuseppe Dari-Mattiachi, Gerrit De Geest, Thomas Eger, Michael Faure, Peter Földvari, Luigi Franzoni, Matthew Golsteyn, Carmine Guerriero, Wolter Hassink, Tobias Hlobil, Jonathan Klick, Bas Van Leeuwen, Igor Lončarski, Matej Marinč, Robbert Maseland, Stephan Michel, Anthony Ogus, Alberto Ruiz Ojeda, Francesco Parisi, Janez Prašnikar, Juan S. Mora Sanguinetti, Hans-Bernd Schaefer, Enrico Santarelli, Marc Schramm, Ann-Sophie Vandenberghe, Thomas Ulen, Louis Visscher, Alexander Wulf, Jan Luiten van Zanden, Qi Zhou, to the participants of the 18th Annual EMLE Law and Economics Conference, Bologna 2014, of the VI. Annual Conference on the Future of Law and Economics in Europe, Maastricht 2014, of the 18th Annual Conference of International Society for New Institutional Economics (ISNIE), Duke University 2014, of the VII. Annual Conference of Spanish Association of Law and Economics, and of the XII. Annual Meeting of German Law and Economics Association, Ghent 2014 for their thoughtful comments, suggestions, and advice.

References

Acemoglu, D. and S. Johnson (2005), 'Unbundling Institutions', *Journal of Political Economy*, **113**: 949–995.

Acemoglu, D., D. Cantoni, S. Johnson, and J. A. Robinson (2011), 'The Consequences of Radical Reform: The French Revolution', *American Economic Review*, **101**: 3286–3307.

Acemoglu, D., S. Johnson, and J. A. Robinson (2001), 'The Colonial Origins of Comparative Development: An Empirical Investigation', *American Economic Review*, **91**: 1369–1401.

Acemoglu, D., S. Johnson, and J. A. Robinson (2002), 'Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution', *Quarterly Journal of Economics*, **117**: 1231–1294.

Acemoglu, D., S. Johnson, and J. A. Robinson (2005), 'Institutions as a Fundamental Cause of Long-Run Growth', in P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*, Amsterdam, North Holland: Elsevier.

Acemoglu, D., S. Johnson, J. A. Robinson, and P. Yared (2009), 'Reevaluating the Modernization Hypothesis', *Journal of Monetary Economics*, **56**: 1043–1058.

Aghion, P., R. Blundell, R. Griffith, P. Howitt, and S. Prantl (2009), 'The Effects of Entry on Incumbent Innovation and Productivity', *Review of Economics and Statistics*, **91**: 20–32.

Allen, D. W. (2011), 'Transaction Costs', in: B. Bouckaert and De Geest (eds.), *Encyclopedia of Law and Economics*, London: Edward Elgar Publishing.

Allen, D. W. (2015), 'Coasean Method: Lessons from the Farm', *Journal of Institutional Economics*, **11**: 93–110.

Angrist, J. D. and J. S. Pischke (2010), 'Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics', *Journal of Economic Perspectives*, **24**: 3–30.

Arrow, K. J. (1969), 'The Organization of Economic Activity: Issues Pertinent to the Choice of Market Versus Nonmarket allocation', *The Analysis and Evaluation of Public Expenditures: The PBB System, Joint Economic Committee Compendium, 91st Congress*, 1st Section, vol. 1. Government Printing Office: Washington, D.C.

Arruñada, B. (2007), 'Pitfalls to Avoid when Measuring Institutions: Is Doing Business Damaging Business?', *Journal of Comparative Economics*, **35**: 729–747.

Arruñada, B. (2013), *Institutional Foundations of Impersonal Exchange: Theory and Policy of Contractual Registries*, Chicago: University of Chicago Press.

Arruñada, B. and N. Garoupa (2005), 'The Choice of Titling System in Land', *Journal of Law and Economics*, **48**: 709–727.

Barro, R. J. (1999), 'Determinants of Democracy', *Journal of Political Economy*, **107**: 158–183.

Barro, R. J., and J. W. Lee (1993), 'International Comparisons of Educational Attainment,' *Journal of Monetary Economics*, **32**: 363–194.

Barro, R. J., and J. W. Lee (2013), 'A new data set of educational attainment in the world, 1950–2010', *Journal of Development Economics*, **104**: 184–198.

Barro, R. J. and X. I. Sala-i-Martin (1995), *Economic Growth*, 2nd edn., Cambridge, MA: MIT Press.

Barseghyan, L. (2008), 'Entry Costs and Cross-country Differences in Productivity and Output', *Journal of Economic Growth*, **13**: 145–167.

Benhabib, J. and M. M. Spiegel (1994), 'The role of Human Capital in Economic Development: Evidence from Aggregate Cross-country Data', *Journal of Monetary Economics*, **34**: 143–173.

Bernard, A. B. and C. I. Jones (1996), 'Productivity Across Industries and Countries: Time Series Theory and Evidence', *Review of Economics and Statistics*, **78**: 135–146.
Bertrand, M., E. Duflo, and S. Mullainathan (2004), 'How Much should we Trust Differences-in-differences Estimates?', *Quarterly Journal of Economics*, **119**: 249–275.
Bose, N., A. P. Murshid, and M. A. Wurm (2012), 'The Growth Effects of Property Rights: The Role of Finance,' *World Development*, **40**: 1784–1797.
Buchanan, J., D. Heesang Chai, and S. Deakin (2014), 'Empirical Analysis of Legal Institutions and Institutional Change: Multiple-methods Approaches and their Application to Corporate Governance Research,' *Journal of Institutional Economics*, **10**: 1–20.
Cameron, A. C., J. B. Gelbach, and D. L. Miller (2011), 'Robust Inference with Multiway Clustering,' *Journal of Business & Economic Statistics*, **29**: 238–249.
Caselli, F., G. Esquivel, and F. Lefort, F. (1996), 'Reopening the Convergence Debate: A new Look at Cross-country Growth Empirics', *Journal of Economic Growth*, **1**: 363–389.
Cheung, S. N. S. (1969), 'Transaction Costs, Risk Aversion and the Choice of Contractual Arrangements', *Journal of Law and Economics*, **12**(1): 23–42.
Coase, R. (1937), 'The Nature of the Firm', *Economica*, **4**: 386–405.
Coase, R. (1960), 'The Problem of Social Cost', *Journal of Law and Economics*, **3**: 1–44.
Coase, R. (1988), *The Firm, the Market and the Law*, Chicago: University of Chicago Press.
Coase, R. (1994), *Essays on Economics and Economists*, Chicago: University of Chicago Press.
Coase, R. (1998), 'The New Institutional Economics,' *American Economic Review, Papers and Proceedings*, **88**: 72–74.
Cohen, D., and M. Soto (2007), 'Growth and human capital: good data, good results,' *Journal of Economic Growth*, **12**: 51–76.
Cooter, R. and H. B. Schaefer (2012), *Solomon's Knot: How Law can End the Poverty of Nations*, New Jersey: Princeton University Press.
Cooter, R. and T. Ulen (2008), *Law and Economics*, Boston: Addison Wesley Longman.
Crafts, N. (2008), 'Regulation and Productivity Performance', *Oxford Review of Economic Policy*, **22**: 186–202.
Davis, L. (1986), 'Comment', in S. L. Engerman and R. E. Gallman (eds.), *Long-Term Factors in American Economic Growth*, Chicago: University of Chicago Press.
Dawson, J. W. and J. J. Seater (2013), 'Federal Regulation and Aggregate Economic Growth', *Journal of Economic Growth*, **18**: 137–177.
De Geest, G. (1994), *Economische Analyse van het Contracten- en Quasi-contractenrecht*, Antwerpen, Belgium: Maklu.
De La Fuente, A. (2002), 'On the Sources of Convergence: A Close Look at the Spanish Regions', *European Economic Review*, **46**: 569–599.
De Soto, H. (2003), *The Mystery of the Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else?*, New York: Basic Books.
Demsetz, H. (1968), 'The Cost of Transacting', *Quarterly Journal of Economics*, **82**: 33–53.
Djankov, S., C. McLiesh, and R. M. Ramalho (2006), 'Regulation and Growth', *Economics Letters*, **92**: 395–401.
Djankov, S., O. Hart, C. McLiesh, and A. Shleifer (2008), 'Debt Enforcement around the World', *Journal of Political Economy*, **116**: 1105–1049.
Djankov, S., R. La Porta, F. Lopez-de-Silanes, and A. Shleifer (2002), 'Regulation of Entry,' *Quarterly Journal of Economics*, **117**: 1–37.

Djankov, S., R. La Porta, F. Lopez-de-Silanes, and A. Shleifer (2003), 'Courts', *Quarterly Journal of Economics*, **118**: 453–517.

Djankov, S., T. Ganser, C. McLiesh, R. Ramalho, and A. Shleifer (2010), 'The Effect of Corporate Taxes on Investment and Entrepreneurship', *American Economic Journal: Macroeconomics*, **2**: 31–64.

Dollery, B. and W. H. Leong (1998), 'Measuring the Transaction Sector in the Australian Economy, 1911–1991', *Australian Economic History Review*, **38**: 207–231.

Douma, S. and H. Schreuder (2012), *Economic Approaches to Organizations*, 5th edn., London: Pearson.

Durlauf, S. N. and P. A. Johnson (2006), 'Multiple Regimes and Cross-country Growth Behavior', *Journal of Applied Econometrics*, **10**: 365–384.

Easterly, W. and R. Levine (2003), 'Tropics, Germs and Crops: How Endowments Influence Economic Development', *Journal of Monetary Economics*, **50**: 3–39.

Freund, C. and B. Bolaky (2008), 'Trade, Regulations, and Income', *Journal of Development Economics*, **87**: 309–321.

Glaeser, E. L., R. La Porta, F. Lopez-de-Silanes, and A. Shleifer (2004), 'Do Institutions Cause Growth?', *Journal of Economic Growth*, **9**: 271–303.

Goldberg, V. (1985), 'Production Functions, Transaction Costs and the New Institutionalism', in G. R. Feiwel (ed.), *Issues in Contemporary Microeconomics and Welfare*, Albany: SUNY Press.

Hall, R. E. and C. I. Jones (1999), 'Why do some Countries Produce so much more Output per Worker than others?', *Quarterly Journal of Economics*, **114**: 83–116.

Helland, E. and J. Klick (2013), 'Legal Origins and Empirical Credibility', in M. Faure and J. Smits (eds.), *Does law matter? On Law and Economic Growth*, Cambridge: Intersentia.

Henderson, D. J. and R. R. Russell (2005), 'Human Capital and Convergence: A Production-frontier Approach', *International Economic Review*, **46**: 1167–1205.

Herrendorf, B. and A. Teixeira (2011), 'Barriers to Entry and Development', *International Economic Review*, **52**: 573–602.

Howitt, P. (2000), 'Endogenous Growth and Cross-country Income Differences', *American Economic Review*, **90**: 829–846.

Johnson, S., J. McMillan, and C. Woodruff (2002), 'Property Rights and Finance', *American Economic Review*, **92**: 1335–1356.

Kezdi, G. (2004), 'Robust Standard Error Estimation in Fixed-effects Panel Models', *Hungarian Statistical Review*, **9**: 96–116.

Klaes, M. (2000), 'The History of the Concept of Transaction Costs: Neglected Aspects', *Journal of the History of Economic Thought*, **22**: 191–216.

Klick, J. (2010), 'The Perils of Empirical Work on Institutions', *Journal of Institutional and Theoretical Economics*, **166**: 166–170.

Knack, S. and P. Keefer (1997), 'Why don't Poor Countries Catch-up? A Cross-national Test of an Institutional Explanation', *Economic Inquiry*, **35**: 590–602.

Levine, R. (1999), 'Law, Finance, and Economic Growth', *Journal of Financial Intermediation*, **8**: 8–35.

Mackaay, E. (2013), *Law and Economics for Civil Law Systems*, London: Edward Elgar.

Mankiw, N. G., D. Romer, and D. N. Weil (1992), 'A Contribution to the Empirics of Economic Growth,' *The Quarterly Journal of Economics*, **107**: 407–437.

Masten, S. E., J. W. Meehan, and E. A. Snyder (1991), 'The Cost of Organization', *Journal of Law, Economics and Organization*, **7**: 1–25.
Matthews, R. C. O. (1986), 'The Economics of Institutions and the Sources of Economic Growth', *Economic Journal*, **96**: 903–18.
McCloskey, D. and A. Klamer (1995), 'One Quarter of GDP is Persuasion', *American Economic Review*, **85**: 91–195.
Miceli, T. J. and J. Kieyah (2003), 'The Economics of Land Title Reform', *Journal of Comparative Economics*, **31**: 246–256.
Miller, S. M. and M. P. Upadhyay (2002), 'Total Factor Productivity and the Convergence Hypothesis', *Journal of Macroeconomics*, **24**: 267–286.
Moulton, B. R. (1986), 'Random Group Effects and the Precision of Regression Estimates,' *Journal of Econometrics*, **32**: 385–397.
North, D. C. (1990), *Institutions, Institutional Change and Economic Performance*, New York: Cambridge University Press.
North, D. C. (2005), *Understanding the Process of Economic Change*, New Jersey: Princeton University Press.
Papaioannou, E. and G. Siourounis (2008), 'Economic and Social Factors Driving the third Wave of Democratization', *Journal of Comparative Economics*, **36**: 365–387.
Parente, S. L. and E. C. Prescott (2002), *Barriers to Riches*, Cambridge: MIT Press.
Parisi, F. (2014), *Oxford Handbook of Law and Economics*, New York: Oxford University Press.
Parisi, F. and R. A. Posner (2013), *The Coase Theorem*, London: Edward Elgar.
Polinsky, A. M. and S. Shavell (2007), *Handbook of Law and Economics*, vol. 1, Amsterdam, North-Holland: Elsevier.
Przeworski, A. and F. Limongi (1997), 'Modernization: Theories and Facts', *World Politics*, **49**: 155–183.
Rodrik, D., A. Subramanian, and F. Trebbi (2004), 'Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development', *Journal of Economic Growth*, **9**: 131–165.
Schäfer, H. B. and C. Ott (2004), *The Economic Analysis of Civil Law*, London: Edward Elgar.
Spamann, H. (2010), 'Legal Origin, Civil Procedure and the Quality of Contract Enforcement', *Journal of Institutional and Theoretical* Economics, **166**: 171–177.
Temple, J. (1999), 'New Growth Evidence', *Journal of Economic Literature*, **37**: 112–156.
Torstensson, J. (1994), 'Property Rights and Economic Growth: An Empirical Study', *Kyklos*, **47**: 231–247.
Trebilcock, M. J. and M. Mota Prado (2011), *What Makes Poor Countries Poor? Institutional Determinants of Development*, London: Edward Elgar.
Ulen, T. S. (2013), 'The Role of Law in Economic Growth and Development', in M. Faure and J. Smits (eds.), *Does Law Matter? On Law and Economic Growth*, Cambridge: Intersentia.
van der Beek, N. (2011), 'Long-Term Contracts and Relational Contracts', in G. De Geest (ed.), *Encyclopedia of Law and Economics*, London: Edward Elgar, 281–314.
Van Leeuwen, B., J. L. van Leeuwen, and P. Földvari (2013), 'Average Years of Education', 1850–2010. Utrecht University Working Paper No. 20, Clio Infra.
Wallis, J. J. and D. C. North (1986), 'Measuring the Transaction Sector in the American Economy, 1870–1970', in S. L. Engerman, S. L. and R. E. Gallman (eds.), *Long-Term Factors in American Economic Growth*, Chicago: University of Chicago Press.

White, H. (1980), ‘A Heteroskedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity’, *Econometrica*, **48**: 817–838.

Williamson, O. (1975), *Markets and Hierarchies*, New York: Free Press.

Williamson, O. (1985), *The Economic Institutions of Capitalism*, New York: Free Press.

Williamson, O. (1996), *The Mechanisms of Governance*, New York: Oxford University Press.

Williamson, O. (1998), ‘Transaction Cost Economics: How it Works; Where it is Headed’, *De Economist*, **146**: 23–58.

Williamson, O. (2000), ‘The New Institutional Economics: Taking Stock, Looking Ahead’, *Journal of Economic Literature*, **38**: 595–613.

Williamson, O. and S. E. Masten (1999), *The Economics of Transaction Costs*, London: Edward Elgar.

World Bank (2013), *Doing Business*, 10th ed., Washington: World Bank and the International Finance Corporation.