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Tiago V. de V. Cavalcanti
Álvaro A. Novo

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Please address correspondence to Álvaro A. Novo, Economic Research Department, Banco de Portugal, Av. Almirante Reis nº 71, 1150-012 Lisboa, Portugal, Tel.#351-213128107; Fax#351-213107804; e-mail:anovo@bportugal.pt and Tiago V. de V. Cavalcanti, Faculdade de Economia, Universidade Nova de Lisboa, 1099-032 Lisboa, Tel.# 351-21-380-1640; Fax# 351-21-388-6073; e-mail:cavalcan@fe.unl.pt; available in *www.bportugal.pt*.

Institutions and Economic Development: How Strong Is the Relation?*

Tiago V. de V. Cavalcanti † Álvaro A. Novo‡

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Abstract

This paper investigates the relationship between institutions and economic development (output per worker). As in Hall and Jones (1999), we find that a 1% improvement in institutions (as we measure them) generates on average a 5% increase in output per worker. However, this relationship is not linear and the data have important heterogeneity. Countries with the same value of institutions have different levels of income per worker. We ask whether the "returns to institutions" are the same across countries conditional on the level of institutions. Using quantile regression methods, we show that for countries at the top of the conditional distribution of international incomes, the "returns to institutions" are lower (around 3.8%,) than for countries at the bottom of this distribution (around 6.2%). We show that this result is robust for different model specifications and definitions of institutions. We also provide evidence that, conditional on the level of institutional development, the distribution of output per worker tends to become less disperse as countries improve their institutional framework. In other words, better institutions are fundamental to close the output per worker gap across countries. Finally, we provide the rationale behind the results through a modified version of a Neoclassical Growth Model with time varying wedges, representing policy distortions and institutions.

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†Faculdade de Economia, Universidade NOVA de Lisboa, Campus de Campolide, 1099-032 Lisbon, Portugal, Phone: +351-21-380-1640, Fax: +351-21-388-6073, cavalcan@fe.unl.pt

‡Banco de Portugal, Department of Economic Studies, Av. Almirante Reis, $71-6^o$, 1150-012 Lisbon, Portugal, anovo@bportugal.pt.

1 Introduction

The central puzzle in economic development is to explain what accounts for differences in output per capita (inequality) across nations? This is what Lucas (1988) posited as the problem of economic development. Based on the neoclassical production function, differences in output per capita can be attributed to differences in physical capital, human capital and total factor productivity (TFP). Chari, Kehoe and McGrattan (1997) argue that observed differences in output per capita can be explained by differences in factors of production (e.g., physical and human capital). However, Hall and Jones (hereafter HJ, 1999), and Parente and Prescott (1999, 2000) show that difference in TFP is the key determinant of differences in international incomes. Thus, to be able to answer Lucas's question, first we must answer the question: What explains international differences in TFP? Recently, considerable attention has been given to the role of institutions in explaining not only differences in productivity across countries, but also why some countries invest more in physical and human capital (North (1990), Knack and Keefer (1995), Nugent and Robinson (1998), HJ (1999), Parente and Prescott (2000), Acemoglu, Johnson, Robinson (2001), Easterly and Levine (2002), among others). By institutions, North (1990) means the formal (laws, constitutions) and informal (customs, traditions) constraints, and government policies (enforcement, punishment) that shape the interactions of economic actors[1]. For instance, countries with more secure property rights have, in general, higher productivity and therefore higher level of income per capita. According to North (1990, p.107), institutions *"are the underlying determinant of the long-run performance of economies."*

This paper follows closely the previous literature (especially HJ), studying the strength of the relationship between institutions and economic development. We use a narrow measure of economic development: the level of output per worker. Our focus is, therefore, on the level of income and not on its growth rate. This is important, since Easterly et al (1993) suggest that differences in growth rates across countries are mostly transitory, while explaining differences in levels is the important problem in economic development (Parente and Prescott (2000)). However, instead of focusing on the conditional mean of income per capita across countries,[2] we employ

[1] This is what HJ call *social infrastructure*; we use both terms interchangeably.

[2] Conditional on the level of institutions.

quantile regression methods. This is an important extension for two reasons. First, because quantile regression gives a more thorough description of how the conditional distribution of income levels depends on institutions. Second, because we can explicitly test the hypothesis that institutions affect not only the location of the conditional distribution of income per capita across countries, but also its scale. Estimates based on the conditional mean implicitly assume that institutions affect only the location of the conditional distribution of income levels, but economically (in convergence terms) this is a restrictive hypothesis.

As HJ, we also find evidence that institutions contribute significantly to more output per worker. However, we are able to extended their results by providing evidence that (i) the marginal contributions of institutions are larger at the bottom quantiles of the (conditional) distribution of output per worker, i.e., poor countries benefit the most from better institutions, and (ii) the conditional distribution of output per worker tends to become less disperse as countries reach higher levels of institutional development. Therefore, institutions are not only fundamental to promote more development (output per worker), but also to promote convergence in output per worker across nations.

The remainder of the paper is organized as follows. Section 2 synthesizes the underlying economic and econometric hypotheses. In Section 3, quantile regression estimation and inference tools are briefly reviewed. Sections 4 and 5 describe the data and empirical findings, respectively. Section 6 provides a rationale for the results using a modified version of the neoclassical growth model with time varying wedges representing policy distortions and institutions. Concluding remarks are collected in Section 7.

2 Main Hypothesis and Econometric Model

Figure 1 summarizes our view of how institutions and economic development are linked. This approach, which is consistent with the neoclassical production function, implies that institutions affect economic development through physical and human capital accumulation, and improvements in productivity (TFP). Notice that in this formulation the effects of institutions on economic development might be amplified over time by the feedback of output per capita on better institutions. Rich countries have in general more resources to protect private property and law enforcement than poor countries. This figure also posits that cultural, geographical and historical factors affect economic development through the channel of institutions, but not directly.[3]

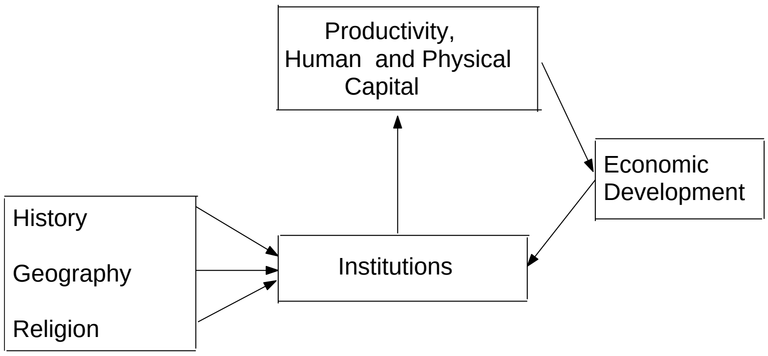

Figure 1: Economic Development and Institutions

In order to estimate the relationship between institutions and economic development we consider the same structural model as HJ, namely:

$$log(Y/L) = \alpha + \beta S + \varepsilon \quad (1)$$

$$S = \gamma + \delta log(Y/L) + \theta X + \eta, \quad (2)$$

where (Y/L) stands for output per capita, S for institutions and X is a matrix describing the other determinants of institutions. ϵ and η are error terms.

In such formulation, institutions are the key determinant to explain differences in output per worker across countries. There are several econometric issues to be considered in this model. We discuss some of them briefly, referring the reader to HJ for thorough details. Notice that this framework is consistent with Figure 1, since the variable describing institutions is endogenous. The key assumption is that the matrix X is uncorrelated with ε, $E[X'\varepsilon] = 0$. Thus, in the estimation of equation (1), any subset of X

[3]Besides HJ, this view is also shared by Nugent and Robinson (1998) and Acemoglu, Johnson and Robinson (2001). This is not the position of Gallup, Sachs and Mellinger (1999) and McArthur and Sachs (2001), who argue, for instance, that geography has many effects that work through channels other than institutions. Recently, however, Easterly and Levine (2002) found no evidence that geography and climate affect country incomes directly other than through institutions, which supports our approach.

contains valid instruments for institutions (S). Under the assumption that such useful instruments are available, it is not necessary to estimate equation (2) to quantify the effects of institutions on output per capita (β). HJ also recognize that institutions might be measured with error, however, under the appropriate set of instruments both the measurement error and endogeneity problem are addressed.

3 Quantile Regression

In the next two subsections, we describe quantile regression and a newly introduced inference technique based on the entire quantile process. We attempt to maintain a heuristic character in the presentation, for which we always try to keep it in perspective with least squares.

3.1 What Does Quantile Regression Estimate?

The least squares estimator specifies and estimates the conditional mean function, $E[Y|X = x] = x\beta$, where Y is a univariate random variable and x is a vector of covariates with the associated parameter vector β. Quantile regression, first introduced by Koenker and Bassett (1978), specifies and estimates a family of conditional quantile functions, $F_{y|x}^{-1}(\tau|x) = x\beta(\tau)$, where F is the conditional distribution function of Y given X and τ a quantile in the interval $[0, 1]$. Thus, quantile regression provides several summary statistics of the conditional distribution function, rather than just one characteristic, namely, the mean. This descriptive advantage of quantile regression allows us to characterize and distinguish the effects of covariates, for example, institutions, on the upper and lower quantiles of the distribution. Furthermore, quantile regression is also a robust technique to outliers in the dependent variable.

Koenker and Hallock (2001) and Buchinsky (1999) are excellent heuristic surveys of quantile regression, particularly the first. Technical references include Koenker and Bassett (1978), Koenker and Portnoy (1996) and, to some extent, Buchinsky (1999).

3.2 Testing for Distribution Shifts with Quantile Regression

The recourse to quantile regression is justified beyond its aforementioned descriptive advantages. The work of Koenker and Machado (1999) and, more recently, Koenker and Xiao (2002) on statistical inference based on the entire quantile regression process offers extremely appealing tools in the present context. Koenker and Xiao (2002) develop an apparatus to test the hypotheses of a *location* and/or a *location-scale* shift of the (conditional) response distribution. To motivate, in the present setting, the importance of such hypotheses testing consider the following illustrative example.

Let I_i be 1, if country i is "institutionally developed" and 0, if "institutionally less developed."[4] If output per worker, $Y/L \equiv y$, is simply regressed on an intercept and I, the resulting coefficients reflect the differences in means for the two groups[5]. Such analysis implicitly assumes that the variability of the two subsamples is identical. It's conceivable, however, that being "institutionally developed" (rather than "institutionally less developed") affects other features of the response distribution. If we choose to ignore these possibilities, by maintaining the i.i.d. error assumption, we are in fact considering regression models in which the covariates affect only the location of the conditional response distribution. There is, however, *"no compelling reason to believe that covariates must operate in this restrictive fashion"* (Koenker and Xiao (2002), p. 1585). In the economics of development, the hypothesis of a location shift, if plausible, seems to us extremely unappealing. It suggests that policy variables do not alter, for example, the scale of the distribution, making all countries *equally* "well-off" or "worse-off." On the other hand, failing to reject the location-scale shift hypothesis suggests that policy variables on the whole and/or individually are contributing to location and scale shifts in the distribution, leading to a richer understanding of economic development relationships. Rejecting both hypotheses, although not conclusive, leaves the door open to alternative distribution shifts.[6]

[4] The threshold determining the two groups is irrelevant for the illustration.

[5] In the context of treatment control literature this effect is known as "mean treatment effect." In the example, "institutionally developed" is the treatment and "institutionally less developed" the placebo.

[6] We reiterate the heuristic character of the previous model. Extending the apparatus to the model proposed by Hall and Jones (1999) should pose no difficulty, as we shall see in the next section.

To extend this analysis from mean effects to quantiles, Koenker and Xiao (2002) depart from the framework developed by Lehmann (1974) and Doksum (1974). Let $\tau = F(y)$, then, the quantile treatment effect is defined as

$$\delta(\tau) \equiv \Delta(F^{-1}(\tau)) = G^{-1}(\tau) - F^{-1}(\tau), \qquad (3)$$

where F is the distribution function of Y and G is the distribution function of $Y + \Delta Y$. Thus, the "quantile treatment effect," $\delta(\tau)$, measures the "horizontal distance" between G and F at y. $\delta(\tau)$ can be estimated with quantile regression for all choices of τ.

As discussed above, there are several ways in which two distributions may differ, but Koenker and Xiao (2002) focus on two hypotheses: *location* and *location-scale* shifts. Their framework allows us to test the hypothesis that the output per worker distribution under the "institutionally developed," G, differs from the "institutionally less developed's," F, either by a pure location shift

$$G^{-1}(\tau) = F^{-1}(\tau) + \delta_0, \qquad \tau \in [0,1], \qquad \delta_0 \in \Re, \qquad (4)$$

or by a location-scale shift

$$G^{-1}(\tau) = \delta_1 F^{-1}(\tau) + \delta_0, \qquad \tau \in [0,1], \qquad \delta_0, \delta_1 \in \Re. \qquad (5)$$

A full description of the steps involved in testing these hypotheses, as well as an empirical application into the effects of unemployment benefits in the duration of unemployment spells, can be found in Koenker and Xiao (2002). The next sections extend previous empirical analysis using the just described quantile regression estimation and inference techniques.

4 Data

It is important to make our estimates comparable with previous results in the literature. In order to accomplish this, we use the same model specification and data as HJ. The choice of HJ is justified for the following reasons. First, we view the link between institutions and economic development in a similar fashion. Secondly, HJ's results are a benchmark in the subject. Finally, recent studies have indeed confirmed Hall and Jones hypothesis about institutions and economic development (see Easterly and Levine (2002)). Data[7]

[7] The data are available at http://emlab.berkeley.edu/users/chad/datasets.html. The details of how this data set was constructed can be found in the original paper.

are for 1988 and output per worker across countries are built from the Penn World Tables Mark 5.6 (Revision of Summers and Heston (1991)), Barro and Lee (1993) and Psachropoulos (1994).

The proxy for institutions is based on two indexes. The first index measures the risk of confiscation and expropriation of private investments, and government repudiation of contracts (*GADP*). Built on data collected by the Political Risk Services, it is a standard index used in the literature (see Knack and Keefer (1995), and Acemoglu, Johnson and Robinson (2002)). The second index, compiled by Sachs and Warner (1995), is based on the openness (*Open*) of a country to international trade. International trade agreements enhance competition, constituting an efficient way to prevent insiders to block new and better technologies (Parente and Prescott (2000)). The variable institutions (S) is an average of these two indexes.

The instrumental variables must be chosen such that they are correlated with institutions (S) and uncorrelated with the error term, ε. HJ consider variables based on history and geography, namely, the absolute value of latitude in a 0 to 1 scale; the fraction of population speaking English at birth; the fraction of population speaking a Western European language at birth; and the Frankel and Romer (1996) predicted trade share.

5 Institutions and Economic Development

5.1 Basic Results

In the empirical analysis of HJ the main econometric specification is

$$log(Y/L) = \alpha + \beta\tilde{S} + \varepsilon, \tag{6}$$

where $\tilde{S}$ is the projection of S on the full set of instruments described in section 4. Instrumental variables estimation yielded a point estimate of 5.14 for β, implying that a "difference of .01 in our measure of social infrastructure is associated with a 5.14 percent difference in output per worker" (HJ, p. 104). If this result were to hold true for all percentiles of $log(Y/L)$, rather than just "on average" ($E[Y|X]$), the output per worker gap among nations would tend to widen.[8] Quantile regression provides the appropriate tools to determine whether there are different marginal responses of output per worker to

[8] A 5% increase in the United States output per worker corresponds to over $1,800, while Mali would see an increase of only around $60.

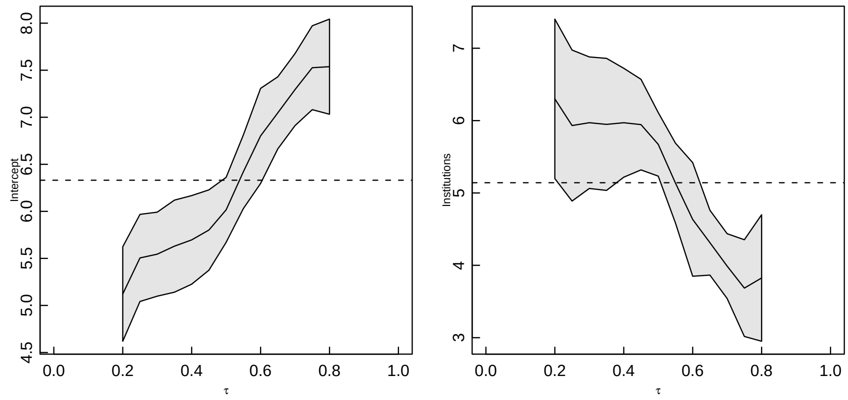

Figure 2: Quantile Regression Estimates $\sim \log(Y/L) = \alpha + \beta\tilde{S} + \varepsilon$

changes in institutions. In Figure 2, we depict the IV estimates (horizontal dashed lines) along with the corresponding quantile regression estimates.[9] The shaded areas represent 90% confidence intervals; at all estimated quantiles, institutions are statistically and foremost economically significant. As expected, at higher quantiles (τ) the return for each additional "unit" of institutions decreases relatively to lower conditional quantiles of output per worker. Returns vary from approximately 6.2 to 3.8 as τ increases. This first difference relatively to HJ, as a result of applying a more robust and descriptive methodology as quantile regression, reinforces the importance attributed to institutions in promoting not only development, but also in closing differences in output per worker across nations.[10]

In view of Figure 3, left-panel, these results might not be too surprising. The data display important heterogeneity – there are countries with significant differences in output per worker, but with comparable levels of observed social infrastructure, e.g., Argentina and Kenya, Brazil and Gambia, Israel and Jamaica, and Japan and Thailand.

[9]We use two stages quantile regression to estimate a family of "returns to institutions." The first stage is the same as in HJ, including the econometric estimation method. Then, the institutions projected on the space spanned by the instruments are used as the independent variable in the quantile regression estimation process. Figure 2 depicts, for each choice of τ, a quantile point estimate for α and β.

[10]We will return to this point by testing formally with quantile regression inference tools.

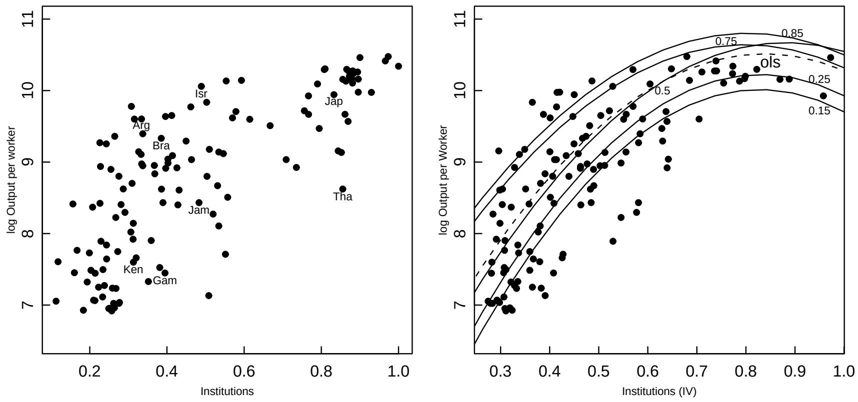

Figure 3: Institutions and Output Per Worker.

Still in Figure 3, but now in the right panel, for selected quantiles, the estimated quantile regression lines are plotted for the model

$$log(Y/L) = \alpha + \beta\tilde{S} + \gamma\tilde{S}^2 + \varepsilon, \qquad (7)$$

where all the variables are as above. This specification extends the work of HJ by including the quadratic term, S^2, which if negative, captures diminishing returns to institutions as the countries' social infrastructure improves. Indeed, the associated coefficient, γ, is negative for all estimated quantiles, reflected in the concave shape of the solid lines[11].

5.2 Robustness

As HJ, we proceed by scrutinizing the robustness of the results to different functional form specifications. Always based on model specifications (6) and (7), the following changes and extensions are introduced:

[11] The quantile lines should not intersect each other, but there are only few data points at the upper quantiles. It is, however, important to highlight that quantile regression does not segment the dependent variables into subsets and then estimates least squares regression on these subsets. *"In general, such strategies are doomed to failure for all the reasons carefully laid out in Heckman (1979). It is worth emphasizing that even in the extreme quantiles all the sample observations are actively in play in the process of quantile regression fitting." (Koenker and Hallock (2001, p.5)).*

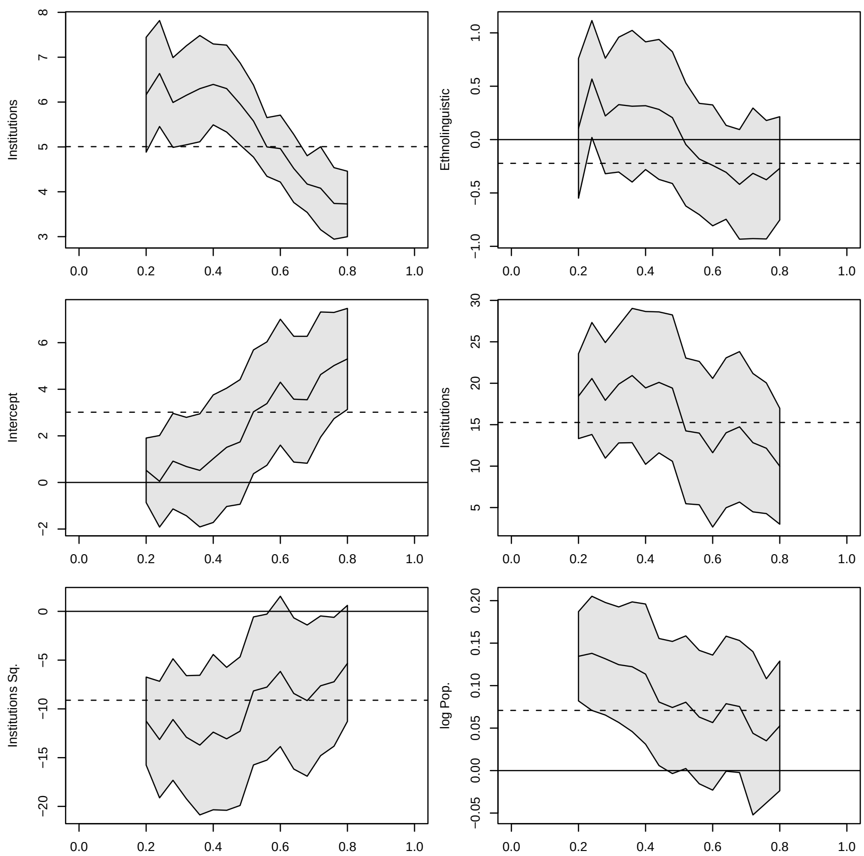

Figure 4: Institutions and Output Per Worker.

(i) set S equal to each one of its components, $GADP$ and $Open$, rather than equal to their average.

(ii) add, one at a time, the following additional exogenous variables: distance from the equator; ethnolinguistic fractionalization (ELF) index computed by Taylor and Hudson (1972), which measures the probability that any two people chosen at random will belong to different ethnic or linguistic groups; religious affiliation, which measures the fraction of a country's catholics, muslims, protestants and hindus; log of population; a measure of the density of economic activity constructed by Ciccone and Hall (1996); and, finally, an indicator variable categorizing countries as capitalist (value 1) or mixed-capitalist (Finn (1994)).

Qualitatively, the additional 16 specifications yielded comparable results in terms of the importance of institutions. Since the results are similar we report only two specifications[12]. Figure 4 plots can, therefore, be seen as representative. The first row plots the quantile regression estimates for β and λ in the model $\log(Y/L) = \alpha + \beta\tilde{S} + \lambda ELF + \varepsilon$, while the last four panels depict the coefficient point estimates for the model $\log(Y/L) = \alpha + \beta\tilde{S} + \gamma\tilde{S}^2 + \lambda\log(Pop) + \varepsilon$.

Relatively to the first row, and comparing with Figure 2, there are no significant changes in the point estimates associated with institutions[13]. The coefficient for the ELF variable is quite small and statistically insignificant, with positive contributes at conditional quantiles of output per worker below the median and negative thereafter. Relatively to the latter model, population (bottom right) plays a positive role in promoting development, decreasing in importance from low to high quantiles. Although the effect is positive, it is not statistically important in explaining differences in income per capita. This confirms the hypothesis raised by North (1990), and later investigated by HJ, that institutions are the main determinant of economic performance.

5.3 Conditional Distributional Shifts

Hitherto, quantile regression addressed the question of different marginal contributions of institutions to the different levels of output per worker. Next, with appropriate inference tools, we study shifts in the conditional distribution. This allows us to investigate the hypothesis that, for instance, as institutions improve, the distribution of output per worker becomes less dispersed. In the convergence literature, this would mean that differences across countries in output per worker narrow down *not only* when poor countries close the "institutions gap" with rich countries, *but also* even when institutions are equally improved – the larger effects (coefficients) at lower quan-

[12]The additional estimations are available from the authors upon request.

[13]The range is still approximately between 3.8 and 6.2. For the other models, the ranges are approximately: (i) $[3.9, 6.6]$ and $[3.4, 5.3]$ when S is replaced with $GADP$ and $Open$, respectively; and, when the regression further includes (ii) latitude $[3.8, 5.8]$; (iii) the religion variables $[3.8, 5.2]$; (iv) population $[3.6, 6.3]$; (v) density of economic activity $[3.8, 6.2]$; and, finally, (vi) when the variable capitalism is included the range is $[4.5, 7.5]$. Regardless of the specific range, we should retain the idea that all regressions yield *economically* significant estimates associated with institutions.

tiles promote more wealth for the same marginal institutional improvement for countries at the bottom of the income distribution. We can place an approximate numerical value in such facts, but not without first issuing a caveat emptor. Conclusions will be based on the (strong) assumption that *the marginal effects (coefficients) do not change as the conditional variables (e.g., institutions) change.* With this in mind, if inferences were based only on the least squares procedure, this would imply that if Argentina and Kenya improve in the same amount their institutions, their output per worker would still differ by a factor of 8. Instead, the results based on quantile regression imply that differences in income between Argentina and Kenya would drop to a factor of approximately 3. Despite the caveat, we see these results as more plausible and economically appealing, than those based on least squares.

Koenker and Xiao (2002) developed an inference procedure based on the entire quantile regression process to test for two distributional shifts: (i) a pure location shift and (ii) a location and scale shift. The pure location shift hypothesis implies that as institutions improve, output per worker levels increase but the output gap among this set of countries remains the same (evidence in favor of the least squares procedure). Consequently, rejecting the pure location hypothesis is fundamental to suggest that as countries develop their institutions, the output per worker gap narrows down. Rejecting the pure location and scale shift implies that institutions might change other features of the conditional distribution of the output per worker (e.g., skewness and kurtosis) besides its location and scale. However, the methodology of Koenker and Xiao (2002) does not allows us to identify what are the other specific features of the conditional distribution of output per worker that are affected by the institutional level. With this in mind, Table 1 reports the test statistics for all estimated models and for the two null hypotheses.

Analysis of Table 1 reveals the following noteworthy observations: (i) the location shift null hypothesis is *always* rejected; (ii) the location and scale shift hypothesis is also rejected with the exception of the regressions of Model II that include as additional regressors the religious affiliation and the population (bold values); and (iii) by combining observations (i) and (ii) we cannot reject the hypothesis that the output per worker gap conditional on the institutional level narrows down as institutions improve.

Table 1: Location (L) and Location-scale (LS) Shift Test Statistics

Model I: $log(Y/L) = \alpha + \beta\tilde{S} + \lambda X + \varepsilon$

Model II: $log(Y/L) = \alpha + \beta\tilde{S} + \gamma\tilde{S}^2 + \lambda X + \varepsilon$

	Model	I	Model	II	I[(4)]	c.v.'s	II[(4)]	c.v.'s
X's	L	LS	L	LS	5%	10%	5%	10%
–	8.32	12.40	16.88	21.39	1.92	1.66	3.00	2.69
–[(1)]	5.69	8.37	17.48	10.30	1.92	1.66	3.00	2.69
–[(2)]	8.12	8.90	9.37	11.06	1.92	1.66	3.00	2.69
Dist. Equator	9.66	19.28	11.29	15.46	3.00	2.69	4.02	3.63
Ethnolinguistic	8.27	8.50	7.76	7.75	3.00	2.69	4.02	3.63
Religion[(3)]	9.23	11.74	11.39	**6.23**	5.85	5.41	6.76	6.24
log(Pop'tion)	7.39	17.78	7.37	**3.30**	3.00	2.69	4.02	3.63
log(C-H Dens.)	9.63	11.36	13.70	16.01	3.00	2.69	4.02	3.63
Capitalism	8.79	8.79	8.73	14.07	3.00	2.69	4.02	3.63

[(1)] $S = GADP$; [(2)] $S = Open$; [(3)] Includes 4 variables representing the proportion of each religion in the total population; [(4)] Critical values (c.v.'s), see Koenker and Xiao (2002).

6 Institutions and the Neoclassical Growth Model

Since the neoclassical growth model is the standard framework to study issues about economic development, it is important to link this theoretical framework with our empirical findings. This can shed some light on why the effects of institutions on output per capita are stronger for countries at the bottom of the conditional distribution of international incomes (CDII), than those at the top.

Notice first that countries at the bottom of the CDII have lower level of (physical and human) capital compared to those at the top. In addition, our response variable is output per worker, which captures the long run performance of the economies. Therefore, it can be argued that countries at the bottom of the CDII are more distant from the steady-state level of income per capita than those at the top. Since countries with the same level of social infrastructure will converge to the same level of output per worker, the long run effect of institutions on output per capita will be clearly stronger for countries with lower level of (physical and human) capital. However, this argument is hard to be accepted. Mainly, because it suggests that countries at the bottom of the CDII must have higher growth rates of income per capita than those at the top (since they are converging to the same level of income), which is not observed in the data (Easterly et al (1993)).

In a recent article Chari, Kehoe and McGrattan (2002) show that a large class of economic models, including those with various frictions (e.g., financial frictions, entrepreneur decisions, and credit market imperfections) are equivalent to a prototype growth model with time-varying wedges, that look like time-varying productivity, A_t, labor taxes, $1-\tau_t^n$, and capital income taxes, $1-\tau_t^k$. They call these "distortions" as the efficiency, labor and productivity wedges, respectively. In this prototype growth model, the problem of a representative agent is to choose c_t, n_t and k_{t+1} to maximize

$$U = E_t\{\sum_t \beta^t u(c_t, n_t)\}, \quad \beta \in (0,1), \tag{8}$$

subject to

$$c_t + k_{t+1} - (1-\delta)k_t = (1-\tau_t^n)w_t n_t + (1-\tau_t^k)r_t k_t + T_t, \tag{9}$$

where the notation is standard, except that T_t are lump-sum taxes.

Firms choose k_t and n_t to maximize profits,

$$A_t F(k_t, n_t) - r_t k_t - w_t n_t. \tag{10}$$

In equilibrium, the solution is summarized by the resource constraint

$$c_t + k_{t+1} = y_t + (1-\delta)k_t \text{ and } y_t = A_t F(k_t, n_t), \tag{11}$$

and the following marginal conditions:

$$\frac{u_n(t)}{u_c(t)} = -(1-\tau_n), \tag{12}$$

$$u_c(t) = \beta E_t u_c(t+1)[A_{t+1}F_K(t+1)(1-\tau_{t+1}^k) + 1 - \delta], \tag{13}$$

$$y_t = A_t F(k_t, n_t). \tag{14}$$

Institutions and policy distortions would affect the three wedges in the model, equations (12)-(14), and therefore would affect the allocations of capital and labor, and productivity. These wedges are country specific and differences in institutions would imply differences in such wedges. For instance, institutions represented by the risk of confiscation and expropriation of private investment would clearly be linked to the investment wedge (equation

(13)). Countries with more secure property rights have smaller τ_t^k compared to those where property rights are not well defined and policies are more distortional. However, Chari, Kehoe and McGrattan (2002) show that more detailed models with frictions which are linked to the investment wedge (e.g., credit market frictions) might also have some impact on the efficiency wedge, A_t.

In order to see how institutions affect the long run level of output per worker and differences in levels across countries in the Neoclassical Growth Model, let's consider a deterministic environment,[14] with preferences only over consumption and assume that population is constant. Assume also that the efficiency wedge is given by $A_t = \mu B_t^{1-\alpha}$ with $B_{t+1} = (1+\gamma)B_t$, where γ is the rate of technological growth (world knowledge), and $\mu \in (0,1]$ is country specific and can be viewed as barriers that prevent the use of a more productive technology, $\mu = 1$. In order to find an analytical solution for this model, let the time period utility be logarithm (i.e., $u(c) = \log(c)$) and the production function be Cobb-Douglas, $Y_t = A_t K_t^\alpha N_t^{1-\alpha}$ with $\alpha \in (0,1)$.

It is straightforward to show that, in the long run (i.e., balanced growth path) equilibrium, output per worker is given by

$$\begin{aligned} y_t^{BG,i} &= \mu^i B_t [\frac{\beta\alpha(1-\tau^{k,i})}{(1-\gamma)-\beta(1-\delta)}]^{\frac{\alpha}{1-\alpha}} \\ &= \mu^i (1-\tau^{k,i})^{\frac{\alpha}{1-\alpha}} B_t [\frac{\beta\alpha}{(1-\gamma)-\beta(1-\delta)}]^{\frac{\alpha}{1-\alpha}} \\ &= \pi^i B_t [\frac{\beta\alpha}{(1-\gamma)-\beta(1-\delta)}]^{\frac{\alpha}{1-\alpha}}, \quad \text{with } \pi^i = \mu^i (1-\tau^{k,i})^{\frac{\alpha}{1-\alpha}}. \end{aligned} \tag{15}$$

Since institutions affect the efficiency, μ, and investment, $(1-\tau^k)$, wedges, they have a key effect on the long run level of output per worker. Better institutions (μ close to one and/or τ^k close to zero) imply a higher level of output per worker in the long run, as the empirical findings suggest. HJ, for instance, argue that *"countries produce high levels of output per worker in the long run because they achieve high rates of investment in physical capital and human capital and because they use these inputs with a high level of productivity."* Their and our empirical results suggest that success on each of these fronts is driven by institutions, which in turn have a direct effect on such wedges. Notice that both wedges have a *qualitative* similar effect

[14]Since the focus of our analysis is the long run behavior of output per worker, we can abstract from business cycle fluctuations.

on output per worker and from the empirical point of view institutions have only one effect on output per worker, which is represented by the variable $\pi^i \in [0, 1]$. Therefore, π^i and μ^i have a similar interpretation and represent the distance of each country from the world technology frontier or the fraction of world knowledge used by each country.[15]

From (15), we have that

$$\frac{y_t^{BG,i}}{y_t^{BG,j}} = \frac{\mu^i}{\mu^j}\left(\frac{1-\tau^{k,i}}{1-\tau^{k,j}}\right)^{\frac{\alpha}{1-\alpha}} = \frac{\pi^i}{\pi^j}, \tag{16}$$

and differences in output per worker are explained by differences on the efficiency, μ, and investment, τ^k, wedges.

It is important to highlight that countries with the same level of observed institutions can have different levels of output per worker (i.e., different wedges). First, because institutions might be measured with error; second, since countries with similar institutions might have different policy distortions (e.g., tax code, and public investment in education); finally, because there are other factors (e.g., stock of human capital) which can affect, for instance, the productivity wedge besides institutions.

Mathematically, in order for the returns to institutions to be higher for countries at the bottom of the CDII, than those at the top, it is necessary that better institutions increase the variable π^i at a decreasing rate. The rationale behind this result is also straightforward: a country can increase its per capita income level by reducing its barriers to the efficient use of better technologies. Since there is a higher amount of knowledge unexploited by countries at the bottom of the CDII, than those at the top, the *potential* for rapid growth is greater the farther behind a country is from the industrial leader. The growth of rich countries are driven mainly by the growth of productive knowledge (technological progress), while for poor countries growth might be also driven by reducing the barriers to technology adoption and capital accumulation. Since better institutions reduce barriers, they are important to explain differences in output per worker across countries and their marginal effect on output per worker is higher for countries farther behind the industrial leader, i.e., those at the bottom of the CDII.

[15] In our model π^i is generated exogenously from the investment and efficiency wedges. Parente and Prescott (1999, 2000) show how these barriers are erected to protect specific groups with vested interests in the status quo from outside competition.

7 Concluding Remarks

What is the relationship between institutions and economic development? As suggested by HJ and other authors, we also find that institutions are key to explain differences in output per worker across countries. However, we show that institutions do not have the same effect on output per capita across countries. Improvements in institutions have a stronger effect on output per capita for countries at the bottom of the CDII (around 6.2%), than for countries at the top of this distribution (around 3.8%). Besides, we also provide some evidence that institutions are important in closing the output per worker gap across nations.

The puzzle is why countries do not adopt better institutional arrangements, mainly those at the bottom of the CDII, since they have higher returns from improving the level of social infrastructure. Parente and Prescott (1999, 2000) show that inside groups with vested interests explain the inefficient use of inferior technologies and institutions. But why are these inside groups particularly important in developing countries? Some progress has been made to address this question. Parente (2000), for instance, shows how landowners erect barriers to industry start up to protect their rental price of land. These barriers reduce the numbers of industries and stimulate the formation of industry insider groups that block the adoption of better industrial technologies. Kocherlakota (2000) puts forward a model which shows that the key building blocks to the formation of these barriers are inequality and limited enforcement. Finally, Acemoglu, Johnson and Robinson (2001) argue that Europeans adopted different colonization policies in different colonies, with different institutions. Despite the progress to answer this question, this is clearly an important avenue for future research and History and Geography will certainly play a key role.

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