Factors of Production, Productivity, Institutions and Development in Brazil

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Área 2: Desenvolvimento Econômico

ABSTRACT
Understanding the variables that determine income level and how they are related to each other is critical, particularly because of its importance for planning economic policies. The economic growth and development literature emphasizes that investments in technology, physical and human capital are essential to achieve high levels of development. Political and economic institutions have also been pointed out as relevant features in this process. Employing a sample of 5,507 Brazilian municipalities, this study carries out a development accounting exercise and measures the effect of institutions on *per capita* Gross Domestic Product (GDP), physical capital intensity, human capital stock and productivity. The empirical results illustrate that differences in the institutional framework are relevant to explain income disparities observed among the Brazilian municipalities. They also indicate that the effects of institutions on GDP occur mainly through human capital stock and total factor productivity and that institutions' importance is greater for larger municipalities.
Key-words: Income Level; Development Accounting; Institutions

RESUMO
Entender quais são as variáveis relevantes na determinação da renda de uma economia e de que forma essas variáveis se relacionam é fundamental, sobretudo como forma de embasar políticas futuras. A literatura ressalta que o investimento em capital físico, capital humano e tecnologia são essenciais para atingir níveis elevados de desenvolvimento. Tem-se ressaltado, também, a importância das instituições políticas e econômicas sólidas neste processo. Tendo isso em vista, este artigo realiza uma contabilidade do produto dos municípios brasileiros e procura mensurar o efeito da qualidade das instituições sobre o produto e seus componentes (intensidade de capital físico, estoque de capital humano e produtividade), pelo método de Mínimos Quadrados em Dois Estágios, a fim de evitar a possível causalidade reversa entre instituições e desenvolvimento. Os resultados empíricos indicam que as instituições são relevantes na determinação dos díspares níveis de produto *per capita* municipal e que este efeito ocorre, sobretudo, via produtividade total de fatores e via estoque de capital humano. Há evidências, também, de que o efeito positivo das instituições seja mais expressivo nos municípios mais populosos.
Palavas-chave: Nível de Produto; Fatores de Produção; Instituições.

JEL: C13; O11; O43.

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1 INTRODUCTION

Studying and understanding the main causes of economic development differences is one of the main objectives of economists. Although the concept of development has been expanded over the years in order to capture the welfare of societies in a broader sense, there is a relative agreement in the economic literature that high level of output per capita, even if not the sole social welfare determinant, enables countries, regions and municipalities to achieve a higher living standard and to promote social welfare. Understanding which are the relevant variables in determining a region income level and how these variables are related is crucial, especially to provide a framework for economic policies.

The literature that addresses the issues related to economic growth and development emphasizes that investment in physical capital, human capital and technology is essential to achieve high income levels. It has also been emphasized the importance of solid economic and political institutions in this process. By shedding light on the interactions among these variables, we can better understand the mechanisms through which institutions are able to contribute to raise societies' living standards.

The vast majority of theoretical and empirical studies in the economic growth and development literature is built upon a production function. Therefore, it is natural to imagine that the fundamental variables that affect the output per capita level of an economy operate through their impact on the accumulation of factors of production and productivity. A sum of recent studies points to institutional quality as a central variable in this analysis and finds strong evidence that institutions can account for much of the variation in per capita income across economies. However, institutions by themselves do not generate product. If institutions are able to explain a significant amount of output level variation among economies, it shall be via their effects on factors of production accumulation and productivity.

Pande and Udry (2006) investigate the relationship between institutions and development using intra-country data. They claim that, since macro institutions are constant in intra-country data study, the results are more reliable and can bring new insights. It is also important to focus the analysis in developing country case studies because institutions are more important to explain differences in developing countries income when compared to developed ones, as indicated by Eicher and Leukert (2009) and Lee and Kim (2009). Lee and Kim (2009)'s results point to the importance of institutions mainly for low to middle income countries. As a country upgrade to the high income group, factors as tertiary education and technology innovation became more relevant.

In this scenario, the present study aims to investigate the role of institutions on factors of production accumulation as well as on total factor productivity in order to understand the channels through which institutions can influence long-term economic development in the Brazilian municipalities. To perform the empirical analysis, it is considered the institutions endogeneity problem in relation to economic performance. This problem can be circumvented by employing the Two Stages Least Squares (2SLS) method by means of historical and geographical instruments that are determinants of initial institutions, as applied by previous literature (Acemoglu et. al, 2001; Cavalcanti et. al., 2008; Easterly and Levine, 2003; Eicher and Leukert, 2009; Engerman and Sokoloff, 2002; Jones and Hall, 1999; Nakabashi et. al, 2013).

The results indicate that the quality of the Brazilian municipal institutions affect their level of output per capita mainly via total factor productivity (TFP) and human capital accumulation. In addition, the institutional quality indicator has a different impact on product, human capital and TFP when distinct population size samples are considered. Institutions are relevant in all samples, but its importance increases with the municipalities' population size.

The remainder of this paper is organized as follows: section two reviews the previous literature on this subject; the following section describes the data and methodology employed; in the fourth section it is presented and discussed the empirical results; and the last section concludes.

2 INSTITUTIONS, INCOME LEVEL, AND FACTORS OF PRODUCTION

North (1991) defines institutions as the rules of the game in a society, by ensuring property rights, providing incentives for investment, better or worse wealth and income distribution, political power, human capital, promoting innovation, and efficient allocation of resources. For the author, countries' institutional framework evolution throughout history influenced the amount of productive investments, it can be regarded as crucial to their different growth trajectories.

Engermann and Sokoloff (2002) also highlight the institutional framework as a fundamental factor for economic growth and, therefore, long run income level. They propose that in more egalitarian societies with better institutions, there is greater investment in education, and the increasing levels of schooling can trigger changes that lead to economic growth, as higher labor productivity, faster technological innovation and greater participation of people in economic and political activities. The authors argue that the income level disparities among former European colonies in America are due to institutional disparities. For them, factor endowments and initial conditions - such as soil, climate, population size and density of natives - were crucial to determine the type of institutions that initially developed in these societies.

Some colonies, such as the Caribbean and Brazil, enjoyed climate and soil conditions extremely favorable to the production of crops that were highly valued in the international market and more efficiently produced on large scale plantations with slave labor (such as sugar, coffee and tobacco). Therefore, there was large influx of African slaves to these regions, enabling economies of scale in the commodities production. The widespread slavery in these regions contributed to unequal income, human capital, and political power distributions, and consequently to the development of institutions that benefited a small elite at the majority of the population expense (called extractive institutions by Acemoglu, Johnson and Robinson, 2002). Engerman and Sokoloff (2002) claim that the impact of climate and soil on income occurs exclusively via institutions, contrary to some previous studies that attribute a direct impact of geographical features and initial factor endowment on the level of development (Bloch, 1988; Lewis, 1978; Pomeranz, 2000; White, 1962; Wrigley, 1988, cited by Acemoglu et. al., 2002).

Acemoglu et al. (2001, 2002) also link initial institutions to the economic development process. As Engerman and Sokoloff (2002), they admit a possible reverse causality between institutions and income level - i.e., regions with higher income levels are more likely to promote better institutions. To address this problem, they employ instrumental variables related to the initial institutions.

The authors emphasize the institutional inertia hypothesis under which institutions tend to remain fairly constant over long periods of time. Thus, it is assumed that the factors that led to a society's initial institutions development are good instruments for the current ones. Acemoglu et al. (2002) argue that even extractive institutions - defined as those that concentrate power in the hands of a small elite, reducing investment, industrialization opportunities, and economic growth - that cause negative effects on economic development tend to persist over time. Such institutions benefit the elite who hold political power and therefore the elite has no incentive to change them. Interactions between *de jure* and *de facto* political power explains why the cluster of economic institutions remained relatively constant in Latin America even with a set of relevant changes in political institutions after independence, for example (Acemoglu and Robinson, 2008).

Based on the inertia of institutions premise, Acemoglu et al. (2001) employ the potential mortality rate of colonizers as an instrumental variable for the quality of current institutions. They believe that this rate (resulting ultimately from geographical conditions) was the major determinant of the number of European settlers in the various colonized regions. For them, the number of European settlers was decisive to the formation of initial institutions.

Based on data of 332 regions in 16 countries in the Americas, Bruhn and Gallego (2012) find that the regions more densely populated in the pre-colonial period and that were colonized with bad colonial activities have a lower level of economic development.[1] Easterly and Levine (2003) also found a statistically significant impact of institutions on output level. Their cross-country results do not give support to the geography hypothesis. Factor endowments as well as government policies have no direct influence on economic performance when taking into consideration the effect of institutions.

Arbiaa et. al. (2010) obtain results for the Europeans countries indicating that institutions and geography are important variables to explain the variations in their productivity, but their results also indicate that institutions play a dominant role over geographic characteristics, what is consistent with the findings of Rodrik et. al. (2004) for a worldwide sample of countries.

Some studies that address the relationship between institutions and product level in Brazil are those performed by Menezes-Filho et al. (2006), Nakabashi et al. (2013), Naritomi (2007), and Naritomi et al. (2009). Menezes-Filho et al. (2006) find evidences that institutions indeed have an important role in explaining disparities among the Brazilian states' GDP per capita. As a proxy for current institutions' quality, Menezes-Filho et al. (2006) use a measure of labor laws enforcement. The authors utilize as proxies for past institutions a number of past variables that have a strong correlation with current institutions' quality: the proportion of illiterates, the proportion of voters and the proportion of foreigners. As the southernmost states had a lower proportion of illiterates, larger number of electoral colleges and a greater proportion of foreign immigrants, latitude is the most strongly correlated variable with these past institutional proxies. They used this variable as an instrument to avoid the reverse causality problem.

To expand the sample size and, consequently, achieve more reliable results from a statistical perspective, Naritomi (2007) employs a Brazilian municipalities' database. The author emphasizes the fact that there is uniformity in the municipalities' macro-institutions - they have the same political system, speak the same language - so the achieved results can bring new perspectives. In the empirical analysis, Naritomi (2007) uses variables such as land distribution, concentration of political power, management capability, and access to justice to measure institutional quality. She considers two historical episodes as exogenous sources of institutional variation: the cycles of sugar cane and gold. Thus, the author attempts to identify the effects of local institutions on economic performance without incurring on the endogeneity problem. The 2SLS results indicate an important and robust role of institutions - instrumented by historical variables - in determining the Brazilian municipalities' GDP per capita. However, taking these historical episodes as instruments can be a limitation because it is assigned the same institutional index value for the municipalities that have not integrated these cycles.

The direct use of tools such as latitude, temperature and ethnic fragmentation may provide a clearer picture of initial institutions developed in each municipality, as proposed by the majority of empirical analyses that address this subject (Acemoglu et .al., 2005, 2002, 2001; Easterly and Levine, 2003; Eicher and Leukert, 2009; Engerman and Sokoloff, 2002; Hall and Jones, 1999).

Nakabashi et al. (2013) also make use of a database composed by the Brazilian municipalities. They adopt as instrumental variables geographical and historical features such as latitude, climate and ethnic fragmentation. The authors find a positive and significant impact of institutional quality - measured by the Municipal Institutional Quality Index (*MIQI*) - on the Brazilian municipalities' GDP.

Cavalcanti et al. (2008) consider data from different institutional features to build an institutional quality index for a cross-section of countries with emphasis on the Brazilian economy in the empirical analysis. Their index is based on regulatory costs of "doing private business", and their results indicate that these kind of institutions are relevant to determine income per capita.

[1] Bad colonial activities are agriculture plantations involving slavery and other forms of coerced labor such as sugar, cotton, rice and tobacco. They measure economic development based on current income level and on poverty rates.

A central study relating institutions and economic development was developed by Hall and Jones (1999). They employ a sample of 127 countries and attempt to explain the observed difference in their levels of output per worker. They assert that countries reach high levels of production when they have high rates of investment in physical and human capital and when they use these inputs productively. Among the above mentioned studies, this is the first one that evaluates the influence of institutions on income level through their effects on the factors of production and productivity. Rodrik et al. (2004) also investigate the effects of institutions on income level, factors of production (physical and human capital) and total factor productivity in a cross-country sample. The 2SLS regressions denote that geography has at best weak direct effects on GDP per capita. The results suggest that the great influence of geography on the income level is via institutional quality, and the impact of institutions on physical capital accumulation is more expressive than on human capital.

Although there are a significant number of studies that relate institutions and income level, there are still scarce studies that address this relationship within a country and that underline the possible transmission channels through which institutions affect income level. The present paper analyzes the interaction between the two above cited variables in the case of the Brazilian municipalities as in Nakabashi et al. (2013), and it goes further attempting to identify and to measure the importance of the indirect effects that institutions have on income per capita through factors of production accumulation and higher productivity.

3 METHODOLOGY AND DATA

This empirical analysis is based on Hall and Jones (1999)'s methodology. The income level differences among Brazilian municipalities are decomposed into their factors of production and productivity. Then, it is estimated the impact of municipal institutions on GDP per capita and its components. Assume a Cobb-Douglas production function with constant returns to scale:

$$Y_i = K_i^{\alpha}(A_iH_i)^{1-\alpha} \quad (1)$$

where Y_i, A_i, K_i and H_i denote, respectively, the level of output, Harrod-neutral productivity, physical capital stock, and human capital stock in the municipality i. Dividing both sides of equation (1) by L_i - labor force in municipality i -, we obtain on its left side, GDP per worker. Considering that $Y = Y^{\alpha} Y^{(1-\alpha)}$ and dividing both sides of equation (1) by $L^{(1-\alpha)}$, facilitates the algebraic manipulation:

$$\mathrm{Y_i^{\alpha} \times Y_i^{(1-\alpha)}/L_i^{(1-\alpha)} = K_i^{\alpha} \times (A_i \times H^i)^{(1-\alpha)}/L_i^{(1-\alpha)}} \quad (2)$$

Using lowercase letters to represent the variables in per capita terms[2] and rearranging equation (2), it becomes:

$$y_i^{(1-\alpha)} = (K_i/Y_i)^{\alpha} \times (A_i \times h_i)^{(1-\alpha)} \quad (3)$$

where

$$y \equiv Y/L; \quad k \equiv K/L; \quad h \equiv H/L \quad (4)$$

Raising both sides of equation (3) to the $1/(1-\alpha)$ power:

$$y_i = (K_i/Y_i)^{(\alpha/(1-\alpha)} \times (A_i \times h_i)^{(1-\alpha)} \quad (5)$$

Equation (5) decomposes output per capita into the three mentioned components. Hall and Jones (1999) indicate that it is better to use capital-output ratio instead of capital-labor ratio because if there is an exogenous increase in productivity, the K/L ratio will grow over time. In other words, if we used capital-labor ratio in the product decomposition, its growth reflecting increases in productivity

[2] In the empirical analysis, the municipalities' population will be used as a proxy for their workforce. Therefore, the term per worker is replaced by per capita hereafter.

would be erroneously attributed to capital accumulation. From equation (5), it is possible to decompose Brazilian municipalities' output per capita into productivity, capital intensity and human capital per capita. This decomposition was performed based on a municipal database for 2000.

Data commonly used as proxies for physical capital stock at the Brazilian state level - as the consumption of non-residential electricity - are not available to all municipalities, so we used urban residential capital stock as a physical capital proxy. To measure human capital, it was employed the human capital stock variable from the Brazilian Institute of Applied Economic Research (IPEA). Productivity is calculated from equation (5) as a residual, as usually done in the development accounting literature. For the parameter of income share of physical capital, this paper assumes the value of $\alpha = 0.4$, as in previous studies using national data (Gomes et. al., 2003; Coelho and Figueiredo, 2007). Taking the natural logarithm of both sides of equation (5), it can be expressed as:

$$\ln y_i = \alpha/(1-\alpha) \times \ln K_i/Y_i + \ln h_i + \ln Ai \quad (6)$$

To avoid the endogeneity problem, it is adopted a variety of geographical and historical variables as exogenous instruments for municipal institutions and the equations are estimated by the Two Stages Least Squares (2SLS) method, such as the international and national literature in this area. This method also mitigates measurement error and relevant variables omission problems.

The econometric specification is:

i) First stage: $$\ln I_i = \alpha_0 + \boldsymbol{Z'_i\lambda} + \boldsymbol{X'_i\delta} + \mu_i \quad (7)$$

ii) Second stage: $$\ln y_i = \theta_0 + \theta_1 \ln \mathrm{I_i}(\mathrm{hat}) + \boldsymbol{X'_i\beta} + \varepsilon_{(1,i)} \quad (8)$$

$$\alpha/(1-\alpha) \times \ln K_i/Y_i = \theta_2 + \theta_3 \ln I_i(\mathrm{hat}) + X'_i\,\gamma + \varepsilon_{(2,i)} \quad (9)$$

$$\ln h_i = \theta_4 + \theta_5 \ln I_i(\mathrm{hat}) + X'_i\,\varphi + \varepsilon_{(3,i)} \quad (10)$$

$$\ln A_i = \theta_6 + \theta_7 \ln I_i(\mathrm{hat}) + X'_i\,\vartheta + \varepsilon_{(4,i)} \quad (11)$$

where y_i is GDP per capita of the municipality i, I_i is a proxy for institutional quality, k_i is a proxy for physical capital per capita, h_i is a proxy for human capital per capita, A_i is Total Factor Productivity (TFP), μ_i and ε_i are the error terms, $\boldsymbol{Z_i}$ is a vector of instrumental variables, and $\boldsymbol{X_i}$ is a vector of other exogenous control variables (included to test the robustness of the institutional quality proxy coefficient). To estimate equations (8) to (11) by 2SLS, it is necessary that the instruments in $\boldsymbol{Z}$ vector from equation (7) exhibit the desirable properties: to have high correlation with the endogenous explanatory variables and to be orthogonal to the error terms.

We adopt geographical features as instruments for institutions such as latitude and climate (considered determinants of initial institutions), ethnic fractionalization and proportion of whites (as proxies for the type of colonization that occurred in each municipality, affecting initial institutions). It is also assumed that institutions are persistent through time as argued by Acemoglu and Robinson (2008, 2006). In this scenario, variables that are related to the establishment of initial institutions capture the effect of current institutions on income and factors of production accumulation, avoiding the endogeneity problem.

There is a significant correlation between latitude and current institutional proxy, which is probably due to the fact that the establishment of Brazilian municipalities' initial institutions was related to the type of colonization and to the initial economic activities. In the north of the country, which is warmer and more suitable for sugar cane cultivation, for example, there was a predominance of large-scale plantations with slavery, and the production was directed to foreign markets. The literature emphasizes that this system of production is historically linked to the emergence of institutions unfavorable to subsequent economic development (Engerman and Sokoloff, 2002).

Following this reasoning, another candidate for the municipalities' instrumental variables is the proportion of people of European descent. Many authors employ variables that reflect the influence of Western Europe - considered the birthplace of "good institutions" - as instruments for institutional quality. Hall and Jones (1999), for example, use as instrumental variables linguistic aspects of the population to capture the extent to which countries have been influenced by Western Europe, the first region in the world to implement a social infrastructure favorable to production. The reasoning of Acemoglu et al. (2002) is similar. The authors assert that in regions where European settlers established in greater numbers, it was more likely to be developed the so-called private property institutions that favored industrialization and the development process, unlike the extractive institutions, which favor the concentration of power in the hands of small elite and reduce the economic growth opportunities. In the present paper, based on this reasoning, it is used as a proxy for the presence of good institutions the proportion of whites in each of the Brazilian municipalities.

In fact, among the potential instruments, the two variables that presented higher correlations with the institutional quality indicator were the distance from the equator (0.59) and the proportion of whites (0.54). These variables are in the ***Z*** vector in equation (7) in most of the estimated regressions to circumvent the reverse causality problem between institutions and economic performance. For comparison purposes, we have used temperature and the ethnic fractionalization index as instruments in some of the first stage regressions. They have correlations of -0.51 and -0.26, respectively, with the institutional quality index. Alesina et al. (2003) find a negative correlation between their ethnic fractionalization index and institutions. The ethnic fragmentation index was calculated following Mauro's (1995) methodology, with data from the Brazilian Census (IBGE). The index is constructed according to:

$$frac = 1 - \sum(n_j/N)^2 \qquad (12)$$

where n_j is the number of individuals belonging to group j and $N \equiv \sum n_j$ is the total number of individuals. The five categories are: white (European descendants), mixed (*pardos*), black (African descendants), yellow (East Asian descendants) and indigenous (natives). As this indicator increases, the municipality's ethnic fractionalization rises.

To measure institutional quality, it is employed the Municipal Institutional Quality Index (*MIQI*) elaborated by the Brazilian Ministry of Planning, Budget and Management in 2005, based on the Survey of Basic Municipal Information of 1999 from the Brazilian Bureau of Statistics (IBGE), Appendix A provides a full description of this index. Besides the institutional index, some regressions include control variables as the Gini inequality index, the municipalities' degree of urbanization, the municipality's age, the distance from the state capital, and altitude. Appendix B provides a detailed description of the variables used in the empirical analysis and their data sources.

4 EMPIRICAL RESULTS

Initially, we present the estimated results employing the Brazilian municipalities' full sample, and the results that exclude the municipalities considered to be outliers. Then, municipalities are divided into samples according to their population size. The first table in this section displays the effects of the institutional quality indicator on the log of per capita GDP and on its components - the three additive terms of equation (6). Thus, the sum of columns (2), (3), and (4) coefficients yields the first column coefficient, and the sum of columns (6), (7), and (8) coefficients yields column (5) coefficient. Regressions from (1) to (4) are based on the municipalities' full sample, while the estimates from columns (5) through (8) are based on the sample without the outliers[3].

TABLE 1: 2SLS Estimates (instruments: llat lpropwhite)

	Whole Sample				Without Outliers			
	Explained Variable				Explained Variable			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln*y*	$\alpha/(1-\alpha) \times$ ln*k/y*	ln*h*	ln*A*	ln*y*	$\alpha/(1-\alpha) \times$ ln*k/y*	Ln*h*	ln*A*
ln $MIQI$	4.3275 (0.0998)***	0.1349 (0.0561)**	1.3792 (0.0317)***	2.8133 (0.1124)***	4.3092 (0.0979)***	0.1431 (0.0555)***	1.3793 (0.0318)***	2.7868 (0.1088)***
const.	-3.5910 (0.1119)***	-0.3552 (0.0616)***	1.6611 (0.0354)***	-4.8969 (0.1251)***	-3.5827 (0.1098)***	-0.3571 (0.0606)***	1.6608 (0.0354)***	-4.8864 (0.1211)***
Obser.	5503	5503	5503	5503	5470	5470	5470	5470
F	1880.63	5.74	1889.29	626.24	1937.31	6.65	1886.48	656.27
Prob>F	0.000	0.016	0.000	0.000	0.000	0.010	0.000	0.000
DWH [a]	943.451	11.072	897.768	269.635	1021.182	10.030	896.189	306.258
(p-value)	0.0000	0.0009	0.0000	0.0000	0.0000	0.0015	0.0000	0.0000
Hansen J [b]	1.855	6.389	0.405	0.022	1.146	9.434	0.468	0.454
(p-value)	0.1732	0.0115	0.5245	0.8827	0.2844	0.0021	0.4938	0.5004
ACC LR [c]	2231.219	2231.219	2231.219	2231.219	2226.644	2226.644	2226.644	2226.644
(p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S.Y. [d]	1374.958	1374.958	1374.958	1374.958	1373.314	1373.314	1373.314	1373.314
Ho a 10 %	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Source: Authors' elaboration.

Notes: Asterisks indicate statistical significance: *** significant at 1%; ** significant at 5%; * significant at 10%. Heteroskedasticity-consistent standard errors are in parentheses. *MIQI* was instrumented in the first stage by latitude and proportion of whites. a: Durbin-Wu-Hausman test for endogeneity. A rejection of H_0 indicates the *MIQI* should be treated as an endogenous variable. b: J Hansen test for the instruments quality (alternative to Sargan test when it is reported robust standard errors). The rejection of H_0 casts doubt on the instruments validity. c: Anderson Canonical Correlation test. The rejection of H_0 indicates that the equation is identified. d: Cragg-Donald F statistic and Stock and Yogo critical value. The rejection of H_0 indicates the absence of weak instruments. GDP per capita is represented by *y*, *k/y* is the capital-output ratio, *h* is a proxy for human capital per capita, *A* represents total factor productivity, and *MIQI* is the municipal institutional quality index. Const. is the intercept, Obser. is the number of observations, and F statistic tests the joint significance of the estimated coefficients.

In column (1), we observe the estimated impact of the institutional quality index on the municipalities' output per capita. The *MIQI* coefficient is positive and significant at the 1% level. Since the variables are in log, the coefficients can be interpreted as elasticities: a 1% improvement in the institutional quality corresponds to a 4.33% municipal output per capita average increase.

The last four rows of Table 1 report the tests results for endogeneity and for the validity and relevance of the instruments in the first stage regressions. In all regressions, the Durbin-Wu-Hausman tests rejected the null hypothesis of *MIQI* exogeneity, indicating that this index should be treated as endogenous, i.e. it is appropriate to use the 2SLS method to estimate de regressions. The Hansen J test - similar to the Sargan test, however for heteroskedasticity consistent standard errors - tests the joint null hypothesis that: i) the instruments are valid (uncorrelated with the error term), and ii) the excluded instruments are correctly excluded (i.e., the instrumental variables enter just in the first stage, having no direct effects on the dependent variable in the second stage). This test does not reject the null hypothesis in regression (1), indicating that latitude and proportion of whites' instruments are valid (not correlated with the residuals) and that they have no direct impact on output per capita. The Anderson Canonical Correlation statistic tests the null hypothesis that the equation is unidentified. In all regressions in Table 1, H_0 is rejected, indicating that the instruments are relevant (correlated with the endogenous regressor). It is also necessary to test whether the instruments are weak. The Cragg-Donald

[3] The list of municipalities excluded from the sample in these regressions is in Appendix C.

statistic is used to check it. In all regressions in this table, the null hypothesis that the instruments are weakly correlated with the endogenous regressor is rejected.

In column (2), the dependent variable is the first component of the production function on the right-hand side of equation (6). Because the log of physical capital intensity is multiplied by α/(1- α) and α = 0.4, to interpret the *MIQI* coefficient in the second column as elasticity, it is necessary to multiply it by a factor of 1.5. Taking this into consideration, we can observe that municipalities with 1% better institutions have, on average, 0.2% higher capital intensity, and this effect is significant at 5%. However, in addition to the small impact of institutions on capital intensity, the Hansen J statistic rejects the null hypothesis of the instruments validity, affecting the results reliability.

Column (3) reports the estimation results with log *h* as the left-hand side variable. The impacts of institutions on human capital are more substantial. The results suggest that a 1% increase in the institutional quality proxy has a positive impact of 1.38% in per capita human capital. The coefficient is significant at 1% level, and in this column, the Hansen J statistic indicates that the instruments are valid. The other tests also indicate that the instruments are not weak.

In Table 1 fourth regression, the dependent variable is the log of Total Factor Productivity (TFP). Although *MIQI* coefficient is statistically significant and has positive effects on output and on its three decomposition components, its effect on productivity is higher than on the other two product components. The estimated parameter indicates that a 1% improvement in the institutional quality indicator is related to a 2.81% average increase on TFP.

The remaining results in the four last columns of Table 1 are based in a sample reduced in 33 municipalities, which had discrepant values of product per capita (usually small municipalities that host large companies, mining companies, refineries, etc.). The results changes marginally with their exclusion. The estimated coefficients values changed slightly, and the tests results and estimated parameters statistical significance remained unchanged (the exception is the significance level of the capital intensity coefficient, which increased from 5% to 1%).

The following table has been included in order to test the results' robustness, i.e. to see what happens to the estimated coefficients and their standard deviations when other control variables are included. Again, columns (1) to (4) results are based on the full sample of Brazilian municipalities, while the remaining columns are based on the sample without the 33 above mentioned outliers.

TABLE 2: 2SLS results - control variables (instruments: llat and lpropwhite)

	Whole sample				Without outliers			
	Dependent variable				Dependent variable			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln$y$	$\alpha/(1-\alpha) \times$ lnk/y	ln$h$	ln$A$	ln$y$	$\alpha/(1-\alpha) \times$ lnk/y	ln$h$	ln$A$
ln $iqim$	3.9640 (0.1091)***	-0.6573 (0.0510)***	1.1429 (0.0305)***	3.4784 (0.1315)***	3.9611 (0.1070)***	-0.6579 (0.0490)***	1.1427 (0.0305)***	3.4763 (0.1266)***
Gini	-0.3837 (0.1852)**	-0.3627 (0.0870)***	-0.1565 (0.0512)***	0.1355 (0.2282)	-0.3624 (0.1838)**	-0.3775 (0.0854)***	-0.1585 (0.0513)***	0.1737 (0.2245)
Urban	0.7335 (0.0464)***	0.9540 (0.0242)***	0.4099 (0.0129)***	-0.6304 (0.0586)***	0.7026 (0.0453)***	0.9761 (0.0231)***	0.4113 (0.0130)***	-0.6848 (0.0558)***
Age	-0.0037 (0.0005)***	0.0054 (0.0003)***	0.0005 (0.0001)***	-0.0096 (0.0007)***	-0.0037 (0.0005)***	0.0053 (0.0002)***	0.0005 (0.0001)***	-0.0096 (0.0006)***
distcapital	-1.87e-05 (6.21e-05)	-1.44e-04 (2.94e-05)***	5.79e-06 (1.80e-05)	1.19e-04 (7.71e-05)	-4.06e-05 (6.07e-05)	-1.33e-04 (2.80e-05)***	3.84e-06 (1.81e-05)	8.90e-05 (7.37e-05)
Altitude	-4.04e-05 (3.35e-05)	1.36e-04 (1.69e-05)***	-1.14e-05 (9.35e-06)	-1.65e-04 (4.26e-05)***	-3.53e-05 (3.27e-05)	1.32e-04 (1.61e-05)***	-1.18e-05 (9.40e-06)	-1.55e-04 (4.07e-05)***
const.	-3.2516 (0.1729)***	-0.0691 (0.0799)	1.7486 (0.0498)***	-4.9310 (0.2071)***	-3.2520 (0.1710)***	-0.0654 (0.0782)	1.7499 (0.0498)***	-4.9365 (0.2027)***
Obser.	5503	5503	5503	5503	5470	5470	5470	5470
F	457.53	562.04	785.98	191.17	462.98	609.51	784.66	212.44

Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DWH [a]	828.812	40.030	943.176	339.518	897.519	51.379	939.186	389.748
(p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hansen J [b]	1.071	5.527	0.194	0.035	0.562	9.663	0.318	0.528
(p-value)	0.3006	0.0187	0.6594	0.8510	0.4534	0.0019	0.5731	0.4674
ACC LR [c]	1568.586	1568.586	1568.586	1568.586	1564.865	1564.865	1564.865	1564.865
(p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S.Y. [d]	906.175	906.175	906.175	906.175	904.509	904.509	904.509	904.509
Ho a 10 %	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Source: Authors' elaboration.

Notes: Asterisks indicate statistical significance: *** significant at 1%; ** significant at 5%; * significant at 10%. Heteroskedasticity-consistent standard errors are in parentheses. *MIQI* was instrumented in the first stage by latitude and proportion of whites. a: Durbin-Wu-Hausman test for endogeneity. A rejection of H_0 indicates the *MIQI* should be treated as an endogenous variable. b: J Hansen test for the instruments quality (alternative to Sargan test when it is reported robust standard errors). The rejection of H_0 casts doubt on the instruments validity. c: Anderson Canonical Correlation test. The rejection of H_0 indicates that the equation is identified. d: Cragg-Donald F statistic and Stock and Yogo critical value. The rejection of H_0 indicates the absence of weak instruments. GDP per capita is represented by *y*, *k/y* is the capital-output ratio, *h* is a proxy for human capital per capita, *A* represents total factor productivity, and *MIQI* is the municipal institutional quality index. Gini index of inequality is the Gini index of income inequality, urban is the degree of urbanization, age is the municipality years from its emancipation to the 2000 year, distcapital is the municipality distance from the State capital in kilometers, and altitude is the altitude in meters. Const. is the intercept, Obser. is the number of observations, and F statistic tests the joint significance of the estimated coefficients.

The control variables insertion did not invalidate the conclusions of the *MIQI* impacts on product per capita, but the regressions with the product components as the left hand-side variable changed considerably. A 1% rise in *MIQI* is reflected in a 3.96% average GDP per capita change, with 1% level of significance. This effect is somewhat lower than that found in Table 1 (4.33%), in which *MIQI* was the only explanatory variable.

The Gini index shows a negative and significant (at 5%) effect on the explained variable, indicating that municipalities with worse income distribution (higher Gini) have lower per capita product, *ceteris paribus*. However, its effect is not substantial in quantitative terms. Since the Gini index has a standard deviation of 0.059, the estimated parameter implies that one standard deviation increase in this index reflects in a GDP per capita fall of only 0.02%.

The urbanization degree and municipality's age variables are also significant at 1% level. 1% more urbanized municipalities have, on average, 0.73% higher income per capita, *ceteris paribus*. The age variable effect is small: 100 years younger municipalities have only a 0.37% average higher income per capita, taking into consideration the other variables influence. The distance from the state capital and altitude are not statistically significant on output per capita level determination.

The most altered results after the control variables inclusion are those in which the explained variable is the physical capital intensity. In column (2) of Table 2, it is possible to note that the *MIQI* coefficient sign is reversed in relation to the results presented in the same column of Table 1. The *MIQI* coefficient suggests that better institutions are associated with lower capital intensity.[4] If, indeed, the effect of *MIQI* on capital intensity is negative, a possible explanation is that of Hall, Sobel and Crowley (2010). For the authors, where institutions are weak, a relevant part of physical capital is employed in rent-seeking and other unproductive activities. If this is the case, controlling for other variables, one can expect that where institutions are stronger, the capital stock is used more efficiently. Pritchett (2000) also stresses that poorer regions with weaker institutions are more likely to overestimate physical capital investments because part that is recorded as investment is diverted into other uses. Therefore, poorer regions have recorded higher stocks of physical capital than in reality.

Also in column (2), we can verify that the Gini index is significant and has the expected sign (municipalities with worse income distribution have lower physical capital intensity). Urbanization

[4] This result could stem from the fact that the physical capital proxy is correlated with the urbanization degree variable (correlation of 0.57), but this possibility is ruled out because estimating the same regression without the urbanization degree variable, the negative sign and significance of the coefficient remains.

degree and the municipality age have a positive influence on the capital-output ratio. The variable distance to the state capital is also significant, and its negative sign suggests that municipalities closer to the state capitals are more capital-intensive, *ceteris paribus*. Altitude has a positive and significant effect on the explained variable. However, all results in column (2) should be interpreted with caution since the Hansen J test rejects (at least at 5% significance level) the validity of the instruments.

Regression (3) dependent variable is the (log) human capital per capita stock. The *MIQI* coefficient is significant at 1% and indicates that municipalities with 1% better institutions have 1.14% higher human capital per capita. The inclusion of the controls does not alter this variable significance, but its quantitative effect is reduced to approximately 83% of its prior effect (Table 1).

The Gini index influence is negative and significant, indicating that income distribution affects the Brazilian municipalities' output per capita also via human capital accumulation. This effect is consistent with the literature that emphasizes the role of better income distribution in fostering investment in education (Engermann and Sokoloff, 2002). Urbanization degree has a positive and significant effect on the explained variable. 1% more urbanized municipalities have, on average, a 0.41% higher human capital per capita stock. Another significant variable is the municipality's age. Older municipalities have higher stocks of human capital, keeping everything else constant. Finally, the results indicate that the variables distance from the state capital and altitude are not relevant on human capital per capita determination.

In the fourth column of this table, the explained variable is log Total Factor Productivity (TFP). The log *MIQI* estimated coefficient in column (4) indicates that 1% better institutions are associated with 3% higher TFP. This result is also in line with the literature (Arbiaa, Battistib and Di Vaio, 2010). Good institutions encourage innovation. In addition, better institutions tend to allocate productive resources more efficiently. This effect of institution on TFP seems to be even more important in relation to human capital accumulation for the Brazilian municipalities.

The Gini index seems to have no effect on TFP. The sign of the urbanization degree is the opposite of the previous regressions and this effect is significant at 1% level. The municipalities' age variable has a negative and significant influence on TFP. Altitude also has a negative impact on TFP. Combining the effects of urbanization degree and altitude on TFP, we can interpret that in Brazil, predominantly rural and plane municipalities (probably based on agriculture) have relatively higher productivity, *ceteris paribus*. In the remaining results of Table 3 - columns (5) to (8) - the explanatory variables estimated coefficients are similar in magnitude and significance level to the prior results, indicating that the results almost do not change with the exclusion of the outliers.[5]

The significance and magnitude of the municipal institutions quality coefficient are not considerably altered with the use of alternative instruments instead of latitude: temperature and ethnic fragmentation index. However, the Hansen J test indicates them as not valid instruments, and therefore these results are not reported here. The tests indicate that the use of llat and lpropwhite in previous regressions were indeed the most appropriate choice.

Table 3 reports the results of estimating the institutional quality indicator influence on output per capita when the sample is separated by municipalities' population size. The objective of this procedure is to assess if the effects of institutions on output per capita level are different according to the municipalities' population size. The hypothesis is that municipalities with larger population have more coordination problems, more difficulties to solve their collective problems based on trust, and therefore institutions are more relevant in their development process. For comparison purpose, the first column of Table 3 replicates column (1) results of Table 2. Columns (2) to (6) display the estimations' results based on different samples. In the last column, the sample is composed by 224 municipalities with population over 100 thousand inhabitants.

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[5] In the next tables, the reported results are the ones based on the full sample because the results are quite similar when the outliers are excluded from the database.

TABLE 3: 2SLS results according to population size - dependent variable: ln *y*

	(1) toda a amostra	(2) <5000	(3) ≤ pop<10000	(4) ≤ pop<20000	(5) ≤ pop<50000	(6) pop ≥50000	(7) pop≥10000
ln $iqim$	3.9640	3.6649	3.8902	3.9753	4.6529	4.2638	4.9302
	(0.1091)***	(0.1984)***	(0.2133)***	(0.2169)***	(0.4403)***	(0.5317)***	(0.8133)***
Gini	-0.3837	-0.0988	0.4438	-0.5716	-0.6319	-0.0432	-0.8634
	(0.1852)**	(0.3970)	(0.4714)	(0.3532)	(0.4358)	(0.7521)	(0.9652)
Urban	0.7335	0.9004	0.6256	0.6349	0.6961	0.7711	0.7330
	(0.0464)***	(0.0946)***	(0.0990)***	(0.1048)***	(0.1746)***	(0.2701)***	(0.5573)
Age	-0.0037	-0.0011	-0.0021	-0.0018	-0.0045	-0.0055	-0.0028
	(0.0005)***	(0.0012)	(0.0012)*	(0.0011)	(0.0016)***	(0.0031)*	(0.0037)
Distcapital	-1.87e-05	6.09e-05	-9.98e-05	2.83e-05	1.16e-05	-2.25e-04	2.95e-04
	(6.21e-05)	(1.37e-04)	(1.38e-04)	(1.16e-04)	(1.46e-04)	(2.42e-04)	(3.40e-04)
Altitude	-4.04e-05	-1.47e-04	2.32e-05	-2.16e-04	-4.94e-05	1.15e-04	1.12e-04
	(3.35e-05)	(7.74e-05)*	(6.73e-05)	(7.12e-05)***	(8.67e-05)	(9.42e-05)	(1.37e-04)
const.	-3.2516	-3.1605	-3.5874	-3.1443	-3.8306	-3.8361	-4.4300
	(0.1729)***	(0.3790)***	(0.3869)***	(0.3247)***	(0.5315)***	(0.6815)***	(0.9701)***
Obser.	5503	1324	1310	1380	964	525	224
F	457.53	94.1	83.85	126.63	93.35	34.12	11.97
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DWH [a]	828.812	229.212	199.636	231.467	102.937	50.764	26.568
(p-valor)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hansen J [b]	1.071	0.230	0.028	0.108	0.309	2.742	2.387
(p-valor)	0.3006	0.6315	0.8670	0.7424	0.5783	0.0978	0.1223
ACC LR [c]	1568.586	446.542	399.352	372.917	150.111	81.197	40.169
(p-valor)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S.Y. [d]	906.175	263.932	232.03	212.842	80.541	43.237	21.212
Ho a 10 %	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Source: Authors' elaboration.

Notes: Asterisks indicate statistical significance: *** significant at 1%; ** significant at 5%; * significant at 10%. Heteroskedasticity-consistent standard errors are in parentheses. *MIQI* was instrumented in the first stage by latitude and proportion of whites. a: Durbin-Wu-Hausman test for endogeneity. A rejection of H_0 indicates the *MIQI* should be treated as an endogenous variable. b: J Hansen test for the instruments quality (alternative to Sargan test when it is reported robust standard errors). The rejection of H_0 casts doubt on the instruments validity. c: Anderson Canonical Correlation test. The rejection of H_0 indicates that the equation is identified. d: Cragg-Donald F statistic and Stock and Yogo critical value. The rejection of H_0 indicates the absence of weak instruments. GDP per capita is represented by *y*, *k/y* is the capital-output ratio, *h* is a proxy for human capital per capita, *A* represents total factor productivity, and *MIQI* is the municipal institutional quality index. Gini index of inequality is the Gini index of income inequality, urban is the degree of urbanization, age is the municipality years from its emancipation to the 2000 year, distcapital is the municipality distance from the State capital in kilometers, and altitude is the altitude in meters. Const. is the intercept, Obser. is the number of observations, and F statistic tests the joint significance of the estimated coefficients.

It is important to stress that in all sub-samples the *MIQI* coefficients remained positive and highly significant. Other interesting result is that the magnitude of the *MIQI* coefficients increases as the municipalities' population size rises. However, not all differences are statistically significant. Wald tests were performed to test the statistical difference of the coefficients, two by two. The results are expressed in the table below:

TABLE 4: Testing *MIQI* coefficients equality in sub-samples

	pop < 5000	≤ pop<10000	≤ pop<20000	≤ pop<50000	pop ≥50000	pop≥10000
pop<5.000	NR					
5.000 ≤ pop<10.000	NR	NR				
10.000≤ pop<20.000	NR	NR	NR			
20.000≤ pop<50.000	R***	R***	R***	NR		
pop ≥50.000	R***	R*	NR	NR	NR	
pop≥100.000	R***	R***	R***	NR	NR	NR

Source: Authors' elaboration.
Notes: NR = the null hypothesis of equality between the coefficients is not rejected. R = the null hypothesis of coefficients equality is rejected. Level of significance: *** 1%; * 10%.

The Wald test does not reject the *MIQI* coefficients equality for the three sub-samples of municipalities up to 20,000 inhabitants. It also does not reject this equality in the sub-samples with more than 20,000 inhabitants. Considering these two major groups, each sub-group sample of population up to 20,000 inhabitants have an estimated coefficient that is statistically different from those of each larger population municipalities' sub-samples.[6] Therefore, there is evidence that, in Brazil, the quality of institutions is more important in determining the product in larger municipalities (with more than 20,000 inhabitants) than in small ones, and this difference is statistically significant.

It is noteworthy that, in column (7), considering the sample of the 224 largest Brazilian municipalities in terms of population, none of the control variables is significant when taking into account the effect of institutions. Only *MIQI* is significant at 1% level, and its estimated coefficient is higher (its difference is statistically significant in relation to the three samples based on municipalities with less than 20,000 inhabitants), indicating that institutions are more important for the development of the most populated municipalities.

Tables 6 and 7 show, for each sub-sample, the estimation results of the effects of *MIQI* on the components of GDP per capita, as decomposed in the development accounting exercise. Specifically, the estimates are analogous to the ones displayed in columns (2), (3) and (4) of Table 2 for each population size sample. The estimates for the three smallest population size samples are listed in Table 5. The results for the other three population size samples are listed in Table 6.

In all sub-samples, the *MIQI* indicator has a negative impact on the intensity of physical capital. According to column (1)'s results of Table 5, the effects of all the explanatory variables are significant at 1%. The Gini coefficient indicates that among small population size municipalities with less than 5,000 inhabitants, those with worse income distribution invest less in physical capital. Urbanization and proximity to the state capital seem to exert a positive effect on the capital-output ratio. The sign of the altitude coefficient is also positive and significant. The Gini index and altitude effects vary greatly among different population size municipalities, losing their significance and even altering signs, depending on the population size sample, what complicates the analysis since just a portion of the municipalities is leading the results found using the entire sample.

[6] The only exception is the test of equality between the coefficient of municipalities between 10 and 20 thousand inhabitants and municipalities over 50,000 inhabitants. In this case, the test does not reject the null hypothesis (Prob. > chi ² = 0.18).

TABLE 5: 2SLS results by municipalities' population size – production function components (three smallest population sample size)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	pop<5000			5000≤ pop<10000			1000≤ pop<20000		
	$\alpha/(1-\alpha) \times$ ln*k/y*	ln*h*	ln*A*	$\alpha/(1-\alpha) \times$ ln*k/y*	Ln*h*	ln*A*	$\alpha/(1-\alpha) \times$ ln*k/y*	ln*h*	ln*A*
ln $iqim$	-0.6807	1.0178	3.3278	-0.5907	1.0543	3.4266	-0.5718	1.0452	3.5019
	(0.0992)***	(0.0562)***	(0.2452)***	(0.0924)***	(0.0558)***	(0.2499)***	(0.1001)***	(0.0571)***	(0.2624)***
Gini	-0.5477	-0.1197	0.5686	-0.7428	-0.1984	1.3850	-0.2328	-0.2629	-0.0759
	(0.1989)***	(0.1095)	(0.5096)	(0.2100)***	(0.1188)*	(0.5696)**	(0.1690)	(0.0875)***	(0.4422)
Urban	1.0762	0.3586	-0.5345	0.9837	0.3208	-0.6789	0.9559	0.3827	-0.7037
	(0.0513)***	(0.0263)***	(0.1238)***	(0.0504)***	(0.0257)***	(0.1260)***	(0.0503)***	(0.0260)***	(0.1295)***
Age	0.0060	0.0015	-0.0086	0.0061	0.0014	-0.0096	0.0048	0.0011	-0.0077
	(0.0006)***	(0.0003)***	(0.0016)***	(0.0006)***	(0.0003)***	(0.0015)***	(0.0005)***	(0.0003)***	(0.0014)***
Distcapital	-4.06e-04	1.46e-05	4.52e-04	-2.00e-04	5.26e-06	9.48e-05	-1.21e-04	4.65e-05	1.03e-04
	(6.66e-05)***	(3.73e-05)	(1.70E-04)***	(6.57e-05)***	(3.77e-05)	(1.74e-04)	(5.26e-05)**	(3.57e-05)	(1.41e-04)
Altitude	9.76e-05	-5.39e-05	-1.91e-04	9.72e-05	-1.11e-05	-6.28e-05	1.95e-04	-4.60e-05	-3.65e-04
	(4.48e-05)**	(2.07e-05)***	(1.06e-04)*	(3.30e-05)***	(1.80e-05)	(8.38e-05)	(3.41e-05)***	(1.76e-05)***	(8.97e-05)***
const.	0.0604	1.9060	-5.1270	0.0746	1.8913	-5.5533	-0.2196	1.8926	-4.8173
	(0.1876)	(0.1081)***	(0.4722)***	(0.1666)	(0.1030)***	(0.4495)***	(0.1573)	(0.0822)***	(0.4054)***
Obser.	1324	1324	1324	1310	1310	1310	1380	1380	1380
F	193.60	121.66	77.32	131.45	170.95	48.05	113.44	222.09	36.71
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DWH [a]	34.089	231.561	117.968	11.488	232.607	93.968	11.244	251.733	97.720
(p-value)	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0008	0.0000	0.0000
Hansen J [b]	1.732	0.088	0.719	1.573	0.003	0.124	3.724	0.195	1.215
(p-value)	0.1881	0.7666	0.3965	0.2098	0.9564	0.7250	0.0536	0.6587	0.2704
ACC LR [c]	446.542	446.542	446.542	399.352	399.352	399.352	372.917	372.917	372.917
(p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S.Y. [d]	263.932	263.932	263.932	232.03	232.03	232.03	212.842	212.842	212.842
Ho a 10 %	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Source: Authors' elaboration.

Notes: Asterisks indicate statistical significance: *** significant at 1%; ** significant at 5%; * significant at 10%. Heteroskedasticity-consistent standard errors are in parentheses. *MIQI* was instrumented in the first stage by latitude and proportion of whites. a: Durbin-Wu-Hausman test for endogeneity. A rejection of H_0 indicates the *MIQI* should be treated as an endogenous variable. b: J Hansen test for the instruments quality (alternative to Sargan test when it is reported robust standard errors). The rejection of H_0 casts doubt on the instruments validity. c: Anderson Canonical Correlation test. The rejection of H_0 indicates that the equation is identified. d: Cragg-Donald F statistic and Stock and Yogo critical value. The rejection of H_0 indicates the absence of weak instruments. GDP per capita is represented by *y*, *k/y* is the capital-output ratio, *h* is a proxy for human capital per capita, *A* represents total factor productivity, and *MIQI* is the municipal institutional quality index. Gini index of inequality is the Gini index of income inequality, urban is the degree of urbanization, age is the municipality years from its emancipation to the 2000 year, distcapital is the municipality distance from the State capital in kilometers, and altitude is the altitude in meters. Const. is the intercept, Obser. is the number of observations, and F statistic tests the joint significance of the estimated coefficients.

TABLE 6: 2SLS Results by Municipalities' Population Size – Production Function Components (Three Largest Population Samples Size)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	20000≤ pop<50000			pop≥50000			pop≥100000		
	$\alpha/(1-\alpha) \times \ln k/y$	ln*h*	ln*A*	$\alpha/(1-\alpha) \times \ln k/y$	Ln*h*	ln*A*	$\alpha/(1-\alpha) \times \ln k/y$	ln*h*	ln*A*
ln $iqim$	-0.5836 (0.1955)***	1.3177 (0.1136)***	3.9189 (0.5322)***	-0.4731 (0.2452)*	1.5586 (0.1806)***	3.1783 (0.6310)***	-0.8431 (0.3864)**	1.6981 (0.2906)***	4.0752 (1.0053)***
Gini	0.1170 (0.1785)	-0.1305 (0.1308)	-0.6184 (0.4814)	-0.4216 (0.3355)	0.5619 (0.2251)**	-0.1835 (0.8977)	-0.6456 (0.4536)	0.5270 (0.2907)*	-0.7449 (1.2239)
Urban	0.8580 (0.0854)***	0.4420 (0.0446)***	-0.6039 (0.2195)***	0.9061 (0.1696)***	0.4677 (0.1141)***	-0.6027 (0.3100)*	0.8782 (0.2706)***	0.3388 (0.2453)	-0.4840 (0.7903)
Idade	0.0042 (0.0007)***	0.0000 (0.0004)	-0.0086 (0.0019)***	(0.0026 (0.0014)*	-0.0008 (0.0011)	-0.0073 (0.0036)**	0.0008 (0.0015)	-0.0004 (0.0013)	-0.0033 (0.0043)
Distcapital	-9.56e-05 (6.77e-05)	4.44e-05 (4.04e-05)	6.28e-05 (1.78e-04)	2.03e-05 (1.02e-04)	-2.40e-05 (7.51e-05)	-2.21e-04 (2.80e-04)	-1.60e-04 (1.44e-04)	1.26e-04 (1.07e-04)	(3.30e-04 (4.07e-04)
Altitude	1.67e-04 (3.78e-05)***	1.923-05 (2.373-05)	-2.36e-04 (1.03e-04)**	3.54e-05 (4.54e-05)	2.66e-05 (3.28e-05)	5.30e-05 (1.16e-04)	-1.68e-05 (6.05e-05)	1.61e-05 (5.16e-05)	(1.12e-04 (1.61e-04)
const.	-0.3322 (0.2135)	1.5086 (0.1508)***	-5.0071 (0.5932)***	-0.1034 (0.3336)	0.8892 (0.2277)***	-4.6219 (0.8176)***	0.6521 (0.4135)	0.8193 (0.3196)***	-5.9014 (1.2221)***
Obser.	964	964	964	525	525	525	224	224	224
F	59.00	144.50	19.30	7.31	43.01	5.49	3.78	14.10	4.09
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001
DWH [a]	1.114	150.875	34.542	0.017	86.601	10.732	0.286	43.719	6.357
(p-value)	0.2913	0.0000	0.0000	0.8955	0.0000	0.0011	0.5928	0.0000	0.0117
Hansen J [b]	0.005	0.099	0.125	0.353	0.341	1.279	0.007	0.448	1.766
(p-value)	0.9452	0.7532	0.7236	0.5527	0.5591	0.2581	0.9318	0.5035	0.1838
ACC LR [c]	150.111	150.111	150.111	81.197	81.197	81.197	40.169	40.169	40.169
(p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S.Y. [d]	80.541	80.541	80.541	43.237	43.237	43.237	21.212	21.212	21.212
Ho a 10 %	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Source: Authors' elaboration.

Notes: Asterisks indicate statistical significance: *** significant at 1%; ** significant at 5%; * significant at 10%. Heteroskedasticity-consistent standard errors are in parentheses. *MIQI* was instrumented in the first stage by latitude and proportion of whites. a: Durbin-Wu-Hausman test for endogeneity. A rejection of H_0 indicates the *MIQI* should be treated as an endogenous variable. b: J Hansen test for the instruments quality (alternative to Sargan test when it is reported robust standard errors). The rejection of H_0 casts doubt on the instruments validity. c: Anderson Canonical Correlation test. The rejection of H_0 indicates that the equation is identified. d: Cragg-Donald F statistic and Stock and Yogo critical value. The rejection of H_0 indicates the absence of weak instruments. GDP per capita is represented by *y*, *k/y* is the capital-output ratio, *h* is a proxy for human capital per capita, *A* represents total factor productivity, and *MIQI* is the municipal institutional quality index. Gini index of inequality is the Gini index of income inequality, urban is the degree of urbanization, age is the municipality years from its emancipation to the 2000 year, distcapital is the municipality distance from the State capital in kilometers, and altitude is the altitude in meters. Const. is the intercept, Obser. is the number of observations, and F statistic tests the joint significance of the estimated coefficients.

In columns (1), (4) and (7) of Table 6, there is the same signal to the institutional quality coefficient on the determination of *k/y* ratio as in columns (1), (4) and (7) of Table 5. That is, for all samples based on distinct population sizes, the institutional indicator has a negative effect on capital intensity. This effect is not statistically different among the samples in most cases, so we omit the Wald test results.

The regressions results that have human capital per capita as the explained variable, in Tables 6 and 7, corroborate that institutions are relevant to this factor of production accumulation despite municipalities' population size. Additionally, there are evidences that this positive effect is more pronounced in larger municipalities. The literature highlights that economies with stronger institutions are those that invest more in education, accumulating larger stocks of human capital. The data supports this statement for the Brazilian municipalities, and the larger the municipality's population is, the more relevant is this effect. The following table summarizes the Wald statistic results to test whether the coefficients differences are statistically significant.

TABLE 7: Testing the equality of *MIQI* coefficients in human capital for different population sample size

	<5,000	≤ pop<10,000	≤ pop<20,000	≤ pop<50,000	pop ≥50,000	pop≥100,00
pop<5,000	NR					
≤ pop<10,000	NR	NR				
≤ pop<20,000	NR	NR	NR			
≤ pop<50,000	R***	R***	R***	NR		
pop ≥50,000	R***	R***	R***	R**	NR	
pop≥100,000	R***	R***	R***	R***	NR	NR

Source: Authors' elaboration.
Notes: NR = the null hypothesis of equality between the coefficients is not rejected. R = the null hypothesis of coefficients equality is rejected. Level of significance: *** 1%; ** 5%; * 10%.

The assessment of estimated *MIQI* coefficients of each sub-sample reveals that for municipalities with more than 20,000 inhabitants, the effect of institutions on human capital per capita is statistically higher than in smaller population municipalities. Additionally, among the municipalities with population ranging from 0 to 20,000; 20,000 to 50,000; and with more than 50,000, the effects of institutions are increasing, and these differences are statistically significant at 1% or 5% level. In quantitative terms, in municipalities with less than 5,000 inhabitants, the estimates suggest that a 1% quality of institutions improvement has almost the same effect on human capital per capita accumulation (1%). In the sample of municipalities with over 100,000 inhabitants, this stimulus is almost 70% higher (the *log MIQI* coefficient is 1.698).

Looking at columns (3), (6) and (9) of Tables 6 and 7, one may assess the effects of *MIQI* on TFP. The *MIQI* coefficients are statistically higher in municipalities with populations between 20,000 and 50,000 and municipalities over 100,000, according to the Wald test results, omitted from the text to save space. For example, while in municipalities with less than 5,000 inhabitants a 1% institutional improvement has a positive effect on TFP of 3.33%, in municipalities over 100,000 inhabitants, this number is 4.07% (i.e. 22% higher).

It is interesting to note that, in the municipalities with more than 100,000 inhabitants, none of the control variables is significant. That is, for the 224 population largest municipalities in Brazil, the only variable that showed statistically significant impact on total factor productivity was the institutional quality indicator.

5 CONCLUSIONS

The results of this study employing Brazilian municipal data indicate that the quality of municipal institutions affects the level of output per capita. After decomposing the product level into its components via a Cobb-Douglas production function, it was observed that this effect is due to the positive inducement of institutional quality on total factor productivity (TFP) and on human capital per capita accumulation. Controlling for the endogeneity of institutions by the Two Stage Least Square (2SLS) method, the positive effects of institutional quality on productivity, human capital and the level of output per capita were robust to the inclusion of control variables such as income distribution, degree of urbanization, altitude and distance from the state capital.

The positive effect of institutions on capital intensity, observed initially, was not robust to the inclusion of the above mentioned control variables. In many specifications its influence was negative on physical capital accumulation. Income inequality, measured by the Gini index, presented significant negative effects on capital intensity in several specifications. The results suggest that municipalities with more egalitarian income distribution have higher physical capital investment rates.

Another relevant conclusion is that the institutional quality indicator has a different impact on product, on human capital accumulation and on TFP when it is considered distinct population size samples. In municipalities with small populations, the institutional quality is important in determining income per capita level, but this effect is quantitatively less substantial when compared to larger municipalities. This effect is due to the higher importance of institutions on TFP and, mainly, human capital determination on more populated municipalities. In particular, the results for the 224 most populated Brazilian municipalities sample (over 100,000 inhabitants), the institutional quality indicator was the only significant variable in determining the output per capita level, productivity and human capital per capita.

There are still many relationships to be explored in more depth, especially regarding the ways in which institutional quality affects output per capita level and the complex relationship among income distribution, institutions and factors of production accumulation. With evidences that, in Brazil, institutions affect the product per capita mainly via human capital accumulation and productivity, we hope that the present analysis can instigate further research in the area.

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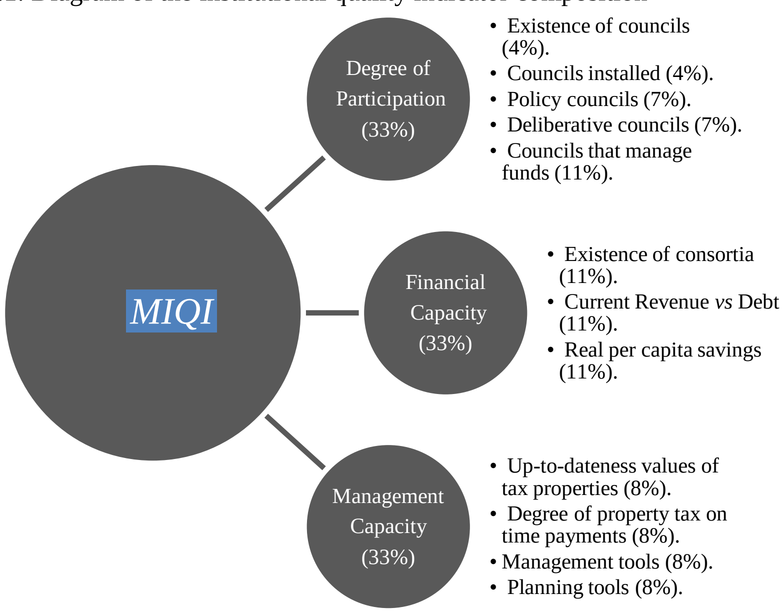
APPENDIX A - Description of the institutional quality indicator

FIGURE A.1: Diagram of the institutional quality indicator composition



SOURCE: Brazilian Ministry of Planning, Budge and Management

Notes: The degree of participation measures population participation in local government and it is based on the number of municipal councils and their characteristics. The financial capacity is based on the number of inter-municipal associations, the relationship between a municipality's debt and its current revenues, net of personnel expenses (which reflects the municipality capacity to repay its debt in time), and real per capita savings. The management capacity is based on the properties' up-to-dateness values for tax purposes, the degree of property tax on time payments, and the number of management and planning tools available to the municipal government. The management tools are: existence of district administration or administrative regions; subprefecture (it is an administrative division of a municipality that is below prefecture); master plan (strategic planning); act land; zoning law or equivalent; construction code; and code of postures. The planning tools are: the existence of government plan; strategic plan and organic law (sort of municipal constitution).

APPENDIX B - Description of variables and data source - TABLE B.1: Description of variables and data source

Variable	**Description**	**Data Source**
Y	Gross domestic product in 2000	Brazilian Bureau of Statistics (IBGE)
K	Urban residencial capital in 2000	Ipeadata
H	Human capital stock in 2000	Ipeadata
L	Total resident population in2000	Ipeadata
MIQI	Municipal Institutional Quality Indicator	The Brazilian Ministry of Planning, Budget and Management based on the Survey of Basic Municipal Information of 1999 from the Brazilian Bureau of Statistics (IBGE)
Gini	Income inequality index in 2000	Ipeadata
Urban	Urbanization degree in 2000; Ratio (urban residential population)/(total residential population)	Authors' elaboration based on data from Ipeadata
Distcapital	Distance from the State Capital (km)	Ipeadata
Altitude	Altitude in meters	Ipeadata
Age	2000 minus the municipal installation year	Authors' elaboration based on data from IBGE
Propwhite	Proportion of whites; ratio (population that has declared themselves as being white in the 2010 census) / total residential population)	Authors' elaboration based on data from 2010 IBGE census
Latitude	Distance from de equator; latitude absolute value in degrees	Ipeadata
Temp	Annual average temperature in ^{o}C	Ipeadata
Frac	Ethnic fractionalization index following the methodology of Mauro (1995)	Authors' elaboration based on data from 2010 IBGE census

APPENDIX C - Outliers - TABLE C.1: Outliers

Municipality	State	Municipality	State	Municipality	State
Barcarena	PA	São João Batista do Glória	MG	Cubatão	SP
Parauapebas	PA	José da Barra	MG	Jambeiro	SP
Ipojuca	PE	Tapira	MG	Luis Antônio	SP
Camaçari	BA	Anchieta	ES	Motuca	SP
São Francisco do Conde	BA	Carapebus	RJ	Ouroeste	SP
Arapora	MG	Porto Real	RJ	Sandovalina	SP
Betim	MG	Quissama	RJ	Taciba	SP
Fortaleza de Minas	MG	Rio das Ostras	RJ	Triunfo	RS
Fronteira	MG	Ariranha	SP	Itiquira	MT
Indianópolis	MG	Castilho	SP	Perolândia	GO
Pirajuba	MG	Colombia	SP	Sao Simão	GO