Kaldor-Verdoorn's Law and Institutions: A Study of the Brazilian Economy

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Abstract

The recent literature on economic growth stresses the importance of institutions as the main determinant of productivity growth without consider the demand as source of long run performance. The Kaldor-Verdoorn law stands out that industrial activity has increasing returns of scale, which suggests a positive relation between demand growth and productivity. The goal of this work is introduce institutions, controlling human capital and physical capital, considering demand growth to estimate the determinants of industrial productivity at level of Brazilian municipalities. Besides that, it was created interactions between demand growth and institutions to capture the relation between institutions, demand growth and productivity. We used the econometric methodology ordinary last square and instrumental variable to handle with endogeneity between economic performance and institutions. The results of estimations suggested that both elements of supply side and demand growth are important to productivity growth.

Key Words

Institutions; Kaldor-Verdoorn Law; Long-Run Performance.

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1. Introduction

In the Kaldorian literature, differences in growth rates across countries are explained by their degrees of industrialization. The growth rate of GDP depends on the industrial growth rate. This is known as Kaldor's first law (Kaldor 1966, 1970). In addition, industrial productivity is determined by the growth rate of industrial demand, which is known as Kaldor-Verdoorn's law. In line with Young (1928) and Verdoorn (1949), the cornerstone of this relation is the existence of increasing returns of scale in industrial sectors.

Kaldor-Verdoorn's law indicates the existence of an important process of cumulative and circular causation (Myrdal, 1970). In economies where income and demand grow faster, productivity grows faster as well, increasing the economy's competitiveness, allowing further growth in income (Dixon and Thirlwall, 1975). In this approach, however, there is a strong emphasis on the role of initial conditions, represented by the initial growth rate of demand. According to Setterfield (1997), the timid role of historical time in this theory is not in accordance with the post-Keynesian approaches proposed by Joan Robinson (1980) and Kaldor (1970) himself. Setterfield (1997) introduced institutions in a theoretical model through the concept of *interrelatedness,* from Frankel (1950). The idea is that economic growth and institutions are endogenously related. The institutional structure as a heritage of past affects the possibility of increasing returns and, hence, the current growth (Setterfield, 1997).

In this paper, our aim is to analyze the role of institutions, along with the Kaldor-Verdoorn mechanism, in the determination of industrial productivity, in order to understand economic growth as a historical process. The aim is to estimate the Kaldor-Verdoorn law for the Brazilian economy, investigating whether historically determined institutions are an important source of industrial productivity. We argue that incorporating supply-side elements can contribute to decrease the strong emphasis in initial conditions observed in the Kaldorian literature.

The database used in this paper comprises information for 5,595 municipalities of Brazil in the year of 2010. We used two measures of institutions well established in literature: (i) the index of institutional quality (IQIM), created by the Brazilian Ministry of Planning; and (ii) a land Gini, calculated by the authors using data from the agricultural Census of 1996, used to measure the concentration of political power by small rural elites.

The empirical strategy adopted was separated into three parts. First, the direct impacts of supply-side elements (institutions, human capital and physical capital) and of demand on productivity growth were estimated separately. Second, the direct effects of all the variables were tested simultaneously, to assess which of them is still significant when they are put together. Third, the indirect effect of institutions on productivity growth was tested, using the interaction terms between the measures of this variable and the growth rate of demand, as carried out by Romero and Britto (2017) for research intensity. The regressions were estimated using two econometric methodologies: Ordinary Least Squares (OLS), and Instrumental Variables (IV). Following the literature, data on latitude, longitude, temperature, rainfall and altitude for each municipality were used as instruments to control for the simultaneity between institutions and productivity growth.

The remainder of the paper is organized as follows. In section 2, the Kaldor-Verdoorn law is discussed. In section 3, the recent literature on economic growth and institutions is discussed, presenting some works that focus on the Brazilian experience. The database and the empirical strategy is discussed in section 4, followed by the regression results. Finally, section 5 presents the concluding remarks of the paper.

2. Productivity Growth and Demand: Kaldor-Verdoorn's Law

Demand has always been considered an important determinant of productivity. Adam Smith (1988) explicitly stressed that the size of the marked determines the degree of division of labour, therefore affecting the level of productivity of each economy. Several years later, Young (1928) emphasized the dynamic aspect of this relationship, stressing that demand growth fosters technical progress and productivity growth. The empirical assessment of this relationship, however, was carried out by Verdoorn (1949) and Kaldor (1966), and is called Kaldor-Verdoorn's law.

Verdoorn (1949) used the simple relationship between output growth and productivity growth to assess the importance of demand growth for technical progress:

$$\hat{Q} = \rho + \lambda\hat{Y} \tag{1}$$

where *Q* and *Y* are manufacturing productivity and output, respectively, and the circumflex over the variables indicates growth rates. Moreover, r is autonomous productivity growth and l is the elasticity of productivity with respect to demand growth, or the Verdoorn coefficient[1]. Verdoorn (1949) estimated this relationship for a sample of 13 OECD countries and found the coefficient of output growth equal to 0.573 and statistically significant. Some

[1] See McCombie (2002) for a detailed discussion of the different specifications of Kaldor-Verdoorn's Law.

years later, Kaldor (1966) proposed an alternative but equivalent formulation of the law, substituting the identity $\hat{Q} = \hat{Y} + \hat{L}$ into equation (1) to find:[2]

$$\hat{L} = -\rho + (1 - \lambda)\hat{Y} \tag{2}$$

Kaldor (1966) argued that this specification is preferable to Verdoorn's (1949), for it avoids spurious correlation resulting from the fact that output growth is used to calculate productivity growth. Kaldor (1966) tested the law using the two alternative specifications for a sample of 12 OECD countries over the period 1953-64, and found a significant coefficient of 0.484 linking productivity growth and output growth in manufacturing.

After the seminal estimates of Verdoorn (1949) and Kaldor (1966), many works sought to test Kaldor-Verdoorn's Law. Overall, grouping some works of the long empirical literature according the econometric method, it is possible to identify the following groups of works:

i- *Ordinary Least Square*: McCombie (1981); Mihcl (1985) to countries of OECD; Drakopoulos and Theodossiu (1991) to Greek economy; Wells and Thirlwall (2003) to African economies.

ii- *Spatial Econometrics (regional approach)*: McCombie and Ridder (1984) to US economy; Casetti and Tanaka (1992) to Japanese economy; Fingleton and McCombie (1998), Pons-Novell and Viladecans-Marsal (1999) and Alexiadis and Tsagdis (2010) to European economies; Alexiadis and Tsagdis (2006) to Greek economy; Iasco-Pereira and Porsse (2016) to Brazilian economy.

iii- *Panel Models (including Instrumental variables) and Hierarchical Models*: Leon-Lesdema (2010) to Spanish economy; Britto and McCombie (2016) to Brazilian economy; Romero and Britto (2016), and Romero and McCombie (2016) to OECD countries.

All these works found evidences of the validity of Kaldor-Verdoorn's law. This literature interpreted that a Verdoorn coefficient positive and significantly different from zero in equation (1) indicates the existence of increasing returns to scale (i.e. $\lambda > 0$). Analogously, an elasticity of employment growth with respect to demand growth statistically different from unity in equation (2) indicates the existence of increasing returns to scale as well (i.e. $0 < (1 - \lambda) \neq 1$).

Kaldor (1970) and Dixon and Thirlwall (1975) stressed the importance of export to growth. The competitiveness of national production is associated with productivity growth and with lower production costs, which means that economies with higher productivity will

[2] Aligned with the mainstream discussion, McCombie e Roberts (2007) get the same results of equations (1) and (2) from a Cobb Douglas production function with capital and labour.

increase its exports. This increase pushes productivity up via Kaldor-Verdoorn's mechanism, creating a process of circular and cumulative causation of increase in productivity. The dynamics of this export-led-growth model, however, depends strongly on the initial conditions. Economies that grew more in past have higher current levels of productivity and, hence, are more capable of growing more intensively in the present. Thus, in absence of shocks, the initial conditions are the only historic aspect incorporated in the process of circular and cumulative causation (Setterfield, 1995).

Setterfield (1997) points out that the circular and cumulative causation behind the model of (export) demand-led growth disregards an important aspect of the post-Keynesian theory, the idea of historical time (Robinson, 1980)[3]. Thus, in order to incorporate history into the process of circular and cumulative causation of demand-led growth, it is necessary to incorporate other elements in addition to initial conditions, such as institutions (Setterfield, 1997).

Setterfield (1997) argues that returns of scale are obtained in a specific technological regime and within institutions inherited from the past. To stress this idea, Setterfield (1997) used the concept of *interrelatedness*, from Frankel (1950), which highlights that production is based on specific machinery, social and economic relations, human capital, and institutions, creates structural and functional interconnections in the economy. In other words, each economy's *interrelatedness* is dependent on the social and economic structures inherited from the past. This heritage might affect current economic performance if it creates a "lock-in" in the social and/or economic structures. The following passage illustrates the argument:

> "(…) The faster the growth within the context of a certain technique of production, the faster interrelatedness will proliferate, and the more likely it becomes that the region will experience lock in to this specific technique. Consequently, an initial period of high relative growth may, by generating interrelatedness and lock in, impair the ability of a region to realize dynamic increasing returns based on changes in technique. Initially self-perpetuating high relative growth through cumulative causation may, therefore, endogenously create the conditions for a subsequent era of slow relative growth" (Setterfield, 1997, p. 372).

An important point raised by Setterfield (1997) is the notion that economies with higher growth rate in a specific institutional context (e.g. slavery) endogenously create the conditions for a lock-in in these (or related) institutions. This point of lock-in affects the

[3] Robinson (1980) classified time in economic theory using different typologies in relation to equilibrium's notion in economic system. The logical time corresponds to instantaneous transition to equilibrium situation, with alteration in the parameters. The future of the economic system would be pre-established, always in the direction of equilibrium (in an ergodic world). Nonetheless, the historical time assumes the irreversibility of events over time, highlighting that historical facts influence cumulatively the path of the economic system. Therefore, there is no pre-established solution.

possibility of increasing returns to scale, impacting also on the future growth rate through a cumulative and circular social process. In other words, according to Setterfield (1997), the magnitude of the Verdoorn coefficient, which indicates the magnitude of the response of productivity growth to demand growth, might be endogenous in relation to the country's institutional structure.

In order to test whether institutions affect the magnitude of the Verdoorn coefficient, the strategy proposed by Romero and Britto (2017) is adopted. Formally, assuming that the Verdoorn coefficient is partially explained by institutions can be described as:

$$\lambda = \alpha + \beta I \quad (3)$$

where I denotes institutions.

Thus, substituting equation (3) into equation (1) yields:

$$\hat{Q} = \rho + \alpha\hat{Y} + \beta I\hat{Y} \quad (4)$$

Hence, the endogeneity of the Verdoorn coefficient can be tested indirectly, by estimating equation (4), which includes an interaction term between demand growth and a measure of institutions, as well as the separate effect of demand growth on productivity growth.

3. Institutions and Economic Performance

The empiric studies related to institutions and growth are mainly associated to the New Institutional Economics (NIE), which associates well established and enforced property rights to increased transactions, technological development and economic growth (Coase, 1960; Demsetz, 1967; North, 1990). The definition of institutions used in this paper follows Douglas North's (1990, p.3) work, which defines institutions (formal and informal) as "*the rules of the game in society or, more formally, (…) the humanly devised constraints that shape human interaction*". According to North and Thomas (1973), the proximate causes of growth are innovation, capital accumulation and education, which lead to greater levels of productivity. According to them, however, the fundamental causes of economic growth are institutions, viewed as the key element explaining long run economic performance as well as actual income differences across the countries.

In the first generation of studies, the lack of data on property rights led economists to use political variables as proxies for good institutions. Scully's (1988) used the Gastil indexes on civil and political liberties as proxies for institutional quality. Through cross-country tests including 115 countries in the period 1960-80, he finds that "the institutional framework is not only a statistically significant explanation of inter-country variation in the growth rate of real per capita gross domestic product but also a phenomenon of considerable magnitude" (Scully, 1988: 658). Easterly and Levine (1997), in turn, argue that ethnic diversity, measured by ethno linguistic fractionalization, generates political instability and influence the adoption of public policies that foster rent-seeking instead of growth-promoting policies (associated to education and infrastructure).[4] As a result, countries with high fragmentation would present lower long-term growth.

Knack and Keefer (1995) investigated the impact of property rights and political variables in income per capita between 1974 and 1989. They found that "political violence and the Gastil political and civil liberties indicators are insufficient proxies for the quality of the institutions that protect property rights", while direct measures of property rights are determinants of growth and investment.[5] Moreover, even after controlling for the impact of investment they still found a significant positive impact of property rights on per capita GDP growth.

Hall and Jones' (1999) tested the impact of social infrastructure on productivity (measured by output per worker) for a sample of 127 countries over the period 1986-95. They defined social infrastructure as: "the institutions and government policies that determine the economic environment within which individuals accumulate skills, and firms accumulate capital and produce output." Hall and Jones (1999) argue that social infrastructure is the sole determinant of productivity levels across countries. They use two proxies of social infrastructure; (i) an index composed of five institutional measures taken from ICRG to period 1986-95 (law and order; bureaucratic quality; corruption; risk of expropriation; and government repudiation of contracts); and (ii) the Sachs and Warner's (1995) openness index, which embodies tariff and nontariff barriers and the black market premium.[6]

In this approach, most scholars have researched empirically the historical determinants of some particular institutions, seeking to understand their relation with long run economic performance. These studies emphasize the role of institutional inertia or path dependence for long-term growth (e.g. Engerman and Sokoloff, 1994; Acemoglu, Johnson

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[4] They also highlight the negative correlation between this variable and democracy (after 1990) and corruption.

[5] Property rights are measured through indicators provided from two different datasets, the International Country Risk Guide (ICRG) and the Business Environment Risk Intelligence (BERI), while the political variables are political and civil freedom indexes taken from the Freedom House and other indicators related to political instability. The first measure is used in a sample of 97 countries, while the second in a sample of 46 countries.

[6] Hall and Jones (1999) identify the possibility of endogeneity. Hence, assuming that distance from the equator and primary languages of Western Europe determine social infrastructure and only affect productivity through this variable, they use those measures as instruments to cope with the endogeneity problem.

and Robinson, 2001). Several works in this branch of institutional analysis have focused on investigating the determinants of long-term growth in ex-colonies. In next section, we discuss this literature focused in institutions historically determined and long run performance.

3.1. Institutions and economic performance: recent debates

In the last decades, a series of studies has sought to use historical events that are clearly associated with institutional creation or change (such as colonization or revolutions) to analyze the role of institutions in economic performance. According to Monasterio (2015), this use of historical information for institutional analysis became more prominent with the works of Engerman and Sokoloff (1994), and Acemoglu, Johnson and Robinson (2001). In general, this literature suggests that the type of colonization conditioned the shape of early institutions, and those institutions were, to a considerable degree, perpetuated though time. These institutions affect long run economic performance, so that good (bad) institutions generate higher (lower) income per capita.

Engerman and Sokoloff (1994) studied the reasons why the United States and Canada stand out when compared with other colonized economies in terms of sustained economic growth. The authors lay out that the initial endowment of land (productivity, type of crop and social concentration of land property), human capital and wealth have affected the colonial economies differently, generating specific long-run institutional and growth paths. According them, in regions where the climate and the soil conditions are propitious to crops such as sugar, cotton, coffee, rice, tobacco are more efficient when produced based on large plantations (with slave labor), the distribution of wealth and political power was considerably unequal. In societies with these traces, the wealth, human capital and the political power were concentrated in small elites of Europeans descendants. This inequality pattern has tended to perpetuate over time until nowadays. Alternatively, Engerman and Sokoloff (1994) pointed out that in regions where the climate conditioned the farming of grains based on small properties (as the North of United State and Canada), a more equal distribution of land, human capital, wealth and democratic institutions emerged. Hence, according to authors, the differences in economic performance between Americas' ex-colonies is based on the argument that the initial endowment of natural resources determined the characteristics of farming and of initial institutions, which shaped subsequent institutions and, hence, economic performance.

Acemoglu, Johnson and Robinson (2001), in contrast, proposed that the institutions of colonized economies result from the type of colonization: settlement or extractive.

According to the authors, differences in quality of property rights enforcement would explain the differences in long run performance among these ex-colonial economies. The argument of Acemoglu, Johnson and Robinson (2001) and Acemoglu, Gallego and Robinson (2014) is that "better" institutions (i.e. more secure property rights) provide better incentives for people to save more, which results in larger investments in accumulation of physical and human capital. Acemoglu, Johnson and Robinson (2001) argue that early institutions formed during the colonial period were (to a high degree) sustained through time, influencing current institutions, therefore affecting present economic dynamism.

According Acemoglu, Johnson and Robinson (2001), Europeans had two alternative strategies of colonization: (i) Neo-European settlement colonies, which would have led to including institutions (strong property rights protection); and (ii) exploratory colonies, which would have led to extractive institutions (weak property rights protection). Most importantly, Acemoglu, Johnson and Robinson (2001) proposed that the different colonization strategies (and, therefore, early institutions) were determined by the feasibility of European settlement, i.e. the rate of mortality of the first settlers affected the type of colonization. This hypothesis seemed to be confirmed by the results of their empirical investigation, which suggested that a high rate of mortality of the early settlers (soldiers, bishops and sailors) has a significant impact on early institutions in ex-colonies. Hence, the authors concluded that different colonization strategies led to different degrees of protection of property rights, which determined long-term growth performance[7].

In spite of the interesting combination of historical analysis and econometric evidence provided by Acemoglu, Johnson and Robinson (2001), Glaeser *et al* (2004) have provided a powerful critique of their argument that the type of colonization determined long-run economic performance via the quality of the institutions created by the settlers. According them, the human capital that the settlers brought with them from Europe was the factor that led to higher growth, not the institutions they created. Based on Lipset (1960), the argument is that human capital is the starting point to understand why economic performance differs between countries. Many works have already explored the relationship between human capital and economic growth (e.g. Barro, 1991; Kruegel and Lindahl, 2001;

[7] In empiric terms, it is important highlight that scholars sought the problem of endogeneity between economic performance and institutions using variable instrumental regression (IV). Hall and Jones (1999) used latitude and the share of the population that speak Western European Language as instrument to institutions. However, Acemoglu, Johnson and Robinson (2001) sought to solve this problem using settler mortality. In other line, Berggren and Jordahl (2006), Faria and Montesinos (2009) used the legal tradition of civil law. Benett *et al* (2017) used an unusual instrument to institutions, represented by the population density in 1500 interacted with a dummy equal to one if the colonizer was from England. These works found out that used instruments are valid and a positive relationship between institutions and economic growth.

Hanushek and Woessmann, 2007; Barro and Lee, 2013). Yet, it is still open to debate whether it is in fact institutions that lead to the accumulation of higher human capital, of if it is actually higher human capital and growth that leads to improvements in institutions (e.g. Chang, 2002).

Following the idea of Engerman and Sokoloff (1994) that the differences in the economic performance of the New World are related to differences in resource endowments, Engerman *et al* (2009) showed that the performances of the United State and Canada stand out due to the social investments in education in the early stages of the colonial period, which were much larger than the investments observed in the other colonies. Educational institutions were more inclusive in these countries, as they aimed to attend to the general population, free of taxes and fees. The point raised by the authors is that the initial educational inequality is the cornerstone of economic dynamics over time. In societies where inequality was high, the educational institutions tended to advantage the elite groups, maintaining and re-enforcing the initial inequality. Human capital, in this case, was historically concentrated in the elite groups. However, when inequality is low, institutions tended to create opportunities of access to human capital for the general population.

This approach, therefore, calls attention to the importance of taking into account the specific history of each country to understand economic performance. It is crucial to note, however, that the discussion about what are "good" or "bad" institutions is a much more complex subject, which is largely disregarded in this literature. Moreover, although there is an agreement about the importance of human capital for economic growth, there is still a debate about what caused the investments in human capital in the first place: income/political inequality or institutions (understood as property rights, in this approach).

3.2. Institutions and economic performance: the case of Brazil

The international literature has been focused on the cross-countries analyses concerning institutions and growth. It is obvious that this macro literature makes some generalizations about historic mechanisms of causality. However, in a country of continental dimensions such as Brazil, with strong heterogeneity in social formation, assuming that its institutions operate homogeneously throughout the whole country is a clear oversimplification. Pande and Udry (2006) stressed that the advantage of using within-country databases is the homogeneity of institutions in relation to cross-country database. Yet, using municipality-level data allows us to capture the local specificities observed across Brazilian regions.

Most recently, based on the institutional approach discussed in the previous section, some works have tried to explore the relationship between institutions and economic performance for the case of Brazil.

Menezes-Filho *et all* (2006) estimated a regression for Brazilian States connecting the effects of geographic aspects to institutions. The authors' measure institutions through the enforcement of labor legislation, represented by the ratio of companies with lawsuits in the labor court. The instruments used were the percentage of illiterate population of 1872; percentage of population of 1910 that vote; percentage of immigrant of 1920; and latitude. They found that current institutions are not explained by slavery, while human capital and European immigration were very important explanatory variables. Moreover, latitude was the variable that stood out in the estimations as the main explanatory variable of institutions.

Naritomi *et al* (2012) studied the relation between current institutions and the distribution of resource endowments in Brazilian municipalities, related to cycles of sugar cane and gold during the colonial period. They used two variables to measure local political power: (i) land concentration; and (ii) persistency of families in power. They also used two variables to measure institutional quality: (i) an index elaborated by the Ministry of Planning (IQIM); and (ii) a measure of access to the justice system. The set of instruments used were latitude, longitude, sunshine, rainfall, altitude, temperature and dummies for soil quality. The conclusions reached are that institutions affect economic performance, while geographic factors are related to the different historical experiences of Brazilian regions.

In a similar fashion, Funari (2014) calculated a land Gini using the Census of 1920 as a measure of political concentration in the municipalities of the states of São Paulo, Minas Gerais, Pernambuco and Rio Grande do Sul. The author used the percentage of eligible voters to explain the differences in long-run economic performance of Brazilian municipalities in the year of 2000. He found a positive relationship between land Gini and economic performance for Minas Gerais and São Paulo (both states from the Southeast region of Brazil), while this relationship was not significant for Pernambuco (Northeast region), and negative for Rio Grande do Sul (South region).

In sum, the works discussed above provide evidence that institutions created within a specific historical context affect long-run economic performance. The literature discussed above, however, seeks to explain long-term growth only by supply-side factors, such as institutions and human capital. In contrast with such an approach, in this paper, we present an initial effort to introduce industrial demand along with human capital and institutions to explain differences in long-term economic performance, in line with the Kaldorian literature.

4. Data Description and Econometric Methods

The data used in this paper are described in Tables A1 and A2, and Graphs A1 and A2 of the Appendix. We used the logarithm of industrial GDP per capita to 5,595 Brazilian municipalities in the year of 2010 as a proxy for industrial productivity. This database is from the Brazilian Institute of Geography and Statistics (IBGE).

The industrial aggregated value of 2010 is contained on GDP of 2010 by construction, which implies in endogeneity between those variables. One way to solve this problem is using industrial aggregated value of 2009 to capture the industrial demand. In this way, the causality is from industrial aggregated to industrial GDP.

We used two variables to measure institutions; (i) the index of institutional quality (IQIM), from the Brazilian Planning Minister; and (ii) the Gini coefficient of the land concentration, calculated by the authors using data from the Brazilian Agricultural Census of 1996. The IQIM was constructed considering three dimensions. First, the degree of participation of the population in the public administration, considering capacity of decision, equality, deliberating and influence in resource allocation. Second, the financial capacity of each municipality, which means the degree to which the funds are generated in the local economic activity without federal transfers of resources. Third, the management capacity of local public government. The IQIM was normalized to stay between 0 and 1. The closest to 1 the index is, the better the institutions are. According to Naritomi *et al* (2012, p. 405) "*it captures the efficiency of the local executive in terms of administrative capacity, as reflected by its ability to provide public goods and its potential responsiveness to demand of the local population*".

According to Assunção (2008), the distribution of land is narrowly related to the Portuguese colonization of the Brazilian territory. The colonial state used the distribution of land to promote settlement and production (Assunção, 2008). This strategy sought to guarantee that the white minority elite would maintain social control. Hence, land distribution expressed the coercive and extractive colonial institutions (Frankema, 2006). Therefore, it is argued that the current distribution of land reflects the early distribution, which was promoted by extractive institutions of the Portuguese State.[8] In sociological perspective, Leal (1960) shows how this colonial heritage impacts on the local political power of small elites, called "Coronéis". The "coronelism" represents a mix between public power and interests of elites in order to maintain the social *status quo*. In this line, Naritomi (2012) points out that this political power manifests in different ways: (i) through the formal absence

[8] Naritomi (2012) showed that municipalities that were part of sugar cane cycle during the colonial period have higher degree of land concentration until the present.

of the State in these areas; (ii) though the control of the political system by the elites; or (iii) through the overruling of state power by the economic power of the elites. Taking this approach into account, in this paper we use the Gini coefficient of land concentration[9] as a proxy of political power of local elites, or political institutions, as highlighted by Leal (1960), Lipset (1968), Engerman and Sokoloff (1994), Acemoglu, Johnson and Robinson (2001) and Naritomi (2012).

The accumulation of capital is an important source of long-run economic performance (Kaldor, 1956, 1957). Yet, data on capital stocks is not available at the municipality level. To cope with this problem, some scholars have used the residential stock of capital available for 1970, 1980, 1991 and 2000 to capture the stock of capital of each municipality (e.g. Nakabashi *et al*, 2013; Barros *et al*, 2013; Lima and Neto, 2015). Lima and Neto (2015) synthesize the discussion about the better proxy for capital stock calculating the correlation between this variable and other variables available at more aggregate levels of analysis (see Table A3 in the Appendix). The results showed that this proxy for the capital stock is highly correlated to other common proxies. Therefore, the variable used in this paper to measure physical capital is the residential stock of capital of 2000, offered by the IBGE.

In this paper, human capital was controlled for using the educational dimension of the human development index[10] of 2000, so that the causality is from human capital to economic performance.

Following Romero and Britto (2017), the interaction term between our measures of institutions and the growth rate of demand (Interaction I using IQIM, and Interaction II using land Gini) to analyze whether better institutions lead to a higher response of productivity in relation to demand growth. The interpretation concerning these interaction terms can be summarized as follows:

i- *Interaction I*: Taking institutions as given, the better the institutions are the closest to one the institutional measure will be, which means that the impact of demand growth on productivity growth is higher in municipalities with better institutions. Analogously, taking demand growth as given, an improvement in municipality institutions means that demand growth will increase more intensively industrial productivity.

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[9] The land Gini was calculated by the authors using data from the Agricultural Census of 1996 - IBGE.

[10] The educational dimension of human development index was done taking in to account two dimensions of schooling. First, the schooling of adult population (18 years or more), represented by the percentage of it with full elementary education. Second, the schooling of young population (less than 18 years), represented by four variables: (i) percentage of young children between 5 and 6 years in school; (ii) percentage of adolescents between 11 and 13 years in the right level of schooling; (iii) percentage of adolescents between 15 and 17 years with elementary school; and (iv) percentage of young people between 18 and 19 years with full secondary school. As our database is dated from 2010, we do not have endogeneity between these two variables.

ii- *Interaction II*: Taking institutions as given, the stronger is the heritage of colonial institutions represented by land concentration, the closest to one will be the land Gini. This suggests that municipalities with high land Gini will have smaller improvements in industrial productivity in response to increases in demand.

The empirical strategy consists in estimating three specifications, using OLS and IV regressions. First, only the supply-side elements are tested. Second, introducing demand growth in to specification. Third, the interaction terms are introduced together with supply-side elements. These specifications are summarized in the equations bellow:

Model 1: $p = b_0 + \alpha \text{ institutions} + \Omega \text{ human capital} + \varepsilon$

Model 2: $p = b_0 + \alpha \text{ institutions} + \Omega \text{ human capital} + \beta \text{ demand} + \varepsilon$

Model 3: $p = b_0 + \alpha \text{ institutions} + \Omega \text{ human capital} + \beta \text{ demand} + \mu \text{ interactions} + \varepsilon$

The endogeneity between institutions and economic performance was resolved using instruments based on geographic factors: latitude, longitude, altitude, rainfall and temperature. Graphs A3 and A4 (see Appendix) present the relationships between our instruments and the measures of institutions.

5. Empirical Results

5.1- Baseline OLS Regressions

The OLS regressions are presented in Table 1. Separately, all supply-side variables are significant at 1% level, with the expected signs for the parameters. When variables are estimated together without industrial demand (columns 8 and 11), the results are similar, but the magnitude of Human Capital is higher in contrast to Physical Capital and Institutions. An increase of 1% in Human Capital raises nearly 1% industrial productivity, while an increase of same magnitude in Physical Capital and IQIM increase productivity by 0.34% and 0.51%, respectively. It is important to note that the coefficient of land Gini has no direct interpretation. The negative sign means that the greater the political power of local elites, the lower is the growth of industrial productivity. Thus, a municipality with an average elite power of 0.28 in terms of land Gini has a 0.31% lower growth in industrial productivity.

The introduction of demand (columns 9 and 12) decreased the magnitude of the parameters of the supply-side factors. The parameters of IQIM and land Gini were respectively 0.17 and -0.50, but the first one was not significant at the 1% level. In both specifications, the parameter of human capital kept significant with value nearly to 1, while the physical capital was around 0.24. The Kaldor-Verdoorn coefficient was significant and value close to 0.18, which suggests robustness in estimations.

Introducing the interaction terms (columns 10 and 13), the supply-side factors kept unchanged. Yet, the signal of interaction terms was not the expected. The signal of interaction term of IQIM was negative (-0.13) and interaction of land Gini was positive (0.10) and non-significative at 5% level. It should be highlighted that a positive parameter to Kaldor-Verdoorn-Institutions, using land Gini as measure, suggests that how greater is the land concentration, higher is the increase in industrial productivity induced by grows in demand. In same line, a negative parameter to IQIM interacted means that better institutions reduces the industrial productivity. These results show the importance of solve the endogeneity between institutions and economic performance, once this problem can generate bias in estimations (Greene 2007; Wooldrige, 2011).

Table 1 - OLS Regressions

	1	2	3	4	5	6	7	8	9	10	11	12	13
Log of IQIM	3.01							0.51	0.17	1.35			
	[0.00]							[0.00]	[0.04]	[0.00]			
Land Gini		-1.33									-0.31	-0.50	-1.56
		[0.00]									[0.00]	[0.00]	[0.01]
Log of Human Capital in 2000			2.13					1.03	0.98	0.97	1.07	1.00	0.99
			[0.00]					[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Log of Physical Capital				0.53				0.34	0.23	0.23	0.35	0.24	0.24
				[0.00]				[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Log of Industrial Demand in 2009					0.40				0.17	0.32		0.18	0.15
					[0.00]				[0.00]	[0.00]		[0.00]	[0.00]
Interaction Term I						0.24				-0.13			
						[0.00]				[0.00]			
Interaction Term II							0.03						0.10
							[0.00]						[0.11]
Constant	3.46	7.18	9.12	1.20	3.01	4.19	6.70	3.88	3.55	2.17	4.37	3.72	3.98
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
R^2	0.17	0.01	0.37	0.27	0.24	0.30	0.001	0.49	0.52	0.52	0.47	0.51	0.51

Obs.: The dependent variable is the Log of the Industrial GDP per capita of each municipality. Values between brackets are the p-value. Robust option was used for the variance-covariance matrix. Dummies for regions were used in specification 8-17. Interaction Term I is the Log of Industrial Demand in 2009 multiplied by the Log of IQIM. Interaction Term II is the Log of Industrial Demand in 2009 multiplied by the Land Gini.
Source: authors' elaboration.

5.2- IV Results[11]

Table 2 shows the results of IV regressions considering only supply-side factors. When IQIM is instrumentalized, just three specifications of instruments were satisfactory according the relevant test statistics (columns 3, 4 and 5).[12] All supply-side factors are positive and significant. The magnitude of the parameters kept constant in relation to three specifications, indicating the robustness of the results. An increase of 1% in IQIM leads to an increase of 11% in the growth rate of industrial productivity, but an equivalent increase in human capital and on physical capital increases the growth rate of productivity by 0.40% and 0.17%, respectively. When the land Gini is instrumentalized, only one specification was appropriate (column 5).[13] The three variables were positive and significant at the 1% level. Increases of 1% in human capital and in physical capital increase by 0.32% and 0.48 the growth rate of industrial productivity, respectively. Notwithstanding, a municipality with an average value of Land Gini of 0.28 has a 3.18% lower industrial productivity growth rate.

However, kaldorian literature points that industrial demand is an important source of productivity too. Table 3 presents the results of IV regressions considering the elements of supply and industrial demand as source of productivity. Results reveal that, when we are controlling institutions using IQIM[14] (column 4), the coeficient of Kaldor-Verdoorn is not significant and the coeficients of institutions, human capital and physical capital are significant and positive. Nonetheless, taking the land Gini as measure of institutions[15] (column 5), the supply side elements kept with the expected signal and the Kaldor-Verdoorn coeficient becomes significant and close to 0.25, which means that an increase of 1% in industrial demand push up productivity in 0.25%. The land Gini kept negative and significative.

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[11] In relation to the IV testes, the Sargan test was used to verify the validity of instruments. The null hypothesis is that instruments are uncorrelated with the error term. Rejection means that instruments are not valid. The Durbin-Wu-Hausman test assesses the endogeneity of the instrumentalized variables. The null hypothesis is that the variable must be considered exogenous. The presence of weak instruments was also tested, i.e. the possibility that the excluded instruments are correlated with endogenous regressors. The null hypothesis is that the instruments are weakly identified. The combinations of instruments produced satisfactory results according the test statistics (columns indicated in bold in each table).

[12] Tests of the IV regressions indicated that just three specifications were satisfactory: longitude, latitude, altitude; longitude, latitude; and latitude and altitude.

[13] Tests of the IV regressions indicated that just one specification was satisfactory: latitude and altitude.

[14] The econometric tests to IV regressions indicated that just one specification was satisfactory: longitude and latitude.

[15] The econometric tests to IV regressions indicated that just one specification was satisfactory: latitude and altitude.

Table 2 - IV Regressions: supply-side factors

Specification	1[1]	2[2]	3[3]	4[4]	5[5]	1[1]	2[2]	3[3]	4[4]	5[5]
Instrumentalized Variable	IQIM					Land Gini				
IQIM	6.55	7.11	**11.10**	**10.77**	**11.45**					
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**					
Land Gini						-3.44	-4.34	-4.61	-4.21	**-11.38**
						[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Human Capital	0.80	0.78	**0.44**	**0.46**	**0.42**	0.86	0.80	0.78	0.80	**0.32**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.05]**
Physical Capital	0.25	0.24	**0.17**	**0.18**	**0.17**	0.39	0.40	0.40	0.40	**0.48**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Constant	-1.45	-1.95	**-5.51**	**-5.21**	**-5.21**	4.86	5.00	5.04	4.98	**6.10**
	[0.16]	[0.10]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
R^2	0.06	-0.01	**-0.84**	**-0.76**	**-0.93**	0.39	0.33	0.31	0.34	**-0.62**
J-Hansen	36.93	32.87	**6.03**	**1.44**	**3.92**	63.50	50.87	47.73	41.70	**0.33**
	[0.00]	[0.00]	**[0.04]**	**[0.23]**	**[0.04]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.56]**
Wu-Hausman	55.95	48.17	**31.88**	**30.96**	**30.15**	263.44	181.15	156.30	149.21	**49.18**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Stock Yogo [20% and 10%]	12.35	12.52	**10.91**	**19.24**	**19.07**	64.58	51.64	63.59	90.95	**28.65**
	[6.77; 10.37]	[6.71; 10.27]	**[6.46; 9.08]**	**[8.75; 19.93]**	**[8.75; 19.93]**	[6.77; 10.83]	[6.71; 10.27]	[6.46; 9.08]	[8.75; 19.93]	**[8.75; 19.93]**

Obs.: The dependent variable is the Log of the Industrial GDP per capita of each municipality. Values between brackets are the p-value. Robust option was used for the variance-covariance matrix. Dummies for regions were used in specification 8-17. Interaction Term I is the Log of Industrial Demand in 2009 multiplied by the Log of IQIM. Interaction Term II is the Log of Industrial Demand in 2009 multiplied by the Land Gini. In relation to instruments: 1- longitude, latitude, rainfall, temperature, altitude; 2- longitude, latitude, temperature, altitude; 3- longitude, latitude, altitude; 4- longitude, latitude; and 5- latitude and altitude. Dummies for the regions of Brazil were employed in all the regressions.
Source: authors' elaboration.

Table 3 - IV Regressions: supply-side factors and demand growth

Specification	1[1]	2[2]	3[3]	4[4]	5[5]	1[1]	2[2]	3[3]	4[4]	5[5]
Instrumentalized Variable	IQIM					Land Gini				
IQIM	4.70	5.10	10.18	**11.39**	-6.84					
	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.18]					
Land Gini						-2.36	-3.38	3.85	-1.21	**-8.45**
						[0.00]	[0.00]	[0.00]	[0.07]	**[0.00]**
Human Capital	0.86	0.85	0.51	**0.46**	1.31	0.87	0.80	0.76	0.95	**0.43**
	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Physical Capital	0.23	0.23	0.22	**0.21**	0.25	0.25	0.26	0.26	0.24	**0.29**
	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Kaldor-Verdoorn	0.68	0.06	-0.04	**-0.07**	0.32	0.20	0.21	0.21	0.19	**0.25**
	[0.05]	[0.12]	[0.43]	**[0.26]**	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Constant	-0.08	-0.39	-4.52	**-5.50**	9.21	3.95	4.08	4.14	3.81	**4.72**
	[0.94]	[0.74]	[0.03]	**[0.01]**	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
R^2	0.28	0.24	-0.62	**-0.91**	-0.03	0.48	0.44	0.41	0.51	**-0.04**
J-Hansen	47.62	43.82	8.98	**1.43**	0.32	57.44	41.84	33.146	4.90	**0.10**
	[0.00]	[0.00]	[0.01]	**[0.23]**	[0.57]	[0.00]	[0.00]	[0.00]	[0.02]	**[0.74]**
Wu-Hausman	33.76	29.97	20.49	**19.97**	3.66	290.53	201.0	170.39	97.96	**59.97**
	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.16]	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Stock Yogo [20% and 10%]	6.94	7.72	8.44	**12.17**	1.75	73.66	57.65	69.76	60.79	**35.45**
	[6.77; 10.83]	[6.71; 10.27]	[6.46; 9.08]	**[8.75; 19.93]**	[8.75; 19.93]	[6.77; 10.83]	[6.71; 10.27]	[6.46; 9.08]	[8.75; 19.93]	**[11.59; 19.93]**

Obs.: The dependent variable is the Log of the Industrial GDP per capita of each municipality. Values between brackets are the p-value. Robust option was used for the variance-covariance matrix. Dummies for regions were used in specification 8-17. Interaction Term I is the Log of Industrial Demand in 2009 multiplied by the Log of IQIM. Interaction Term II is the Log of Industrial Demand in 2009 multiplied by the Land Gini. In relation to instruments: 1- longitude, latitude, rainfall, temperature, altitude; 2- longitude, latitude, temperature, altitude; 3- longitude, latitude, altitude; 4- longitude, latitude; and 5- latitude and altitude. Dummies for the regions of Brazil were employed in all the regressions.
Source: authors' elaboration

Table 4 presents the estimations with interaction terms between industrial demand and institutions. When the interaction between IQIM and industrial demand is instrumentalized[16] (columns 3, 4 and 5), the coefficient of supply side factors are significant with the expected signal according the literature. The coefficients of human capital and physical capital are close to, respectively, 0.50 and 0.24. The interacted term of IQIM was positive and significant at 1% level, with values close to 1.30, which suggests that an increase of 1% in demand lead to an increase of 1.3% in productivity through the interaction between institutions and demand. The coefficient of Kaldor-Verdoorn law was significant at 1% level and negative.

When the endogeneity between the interacted term between demand growth and land Gini and economic performance is handled using IV regressions, one set of instruments respected the preconditions of this method[17] (column 5). The parameters of supply side was positive and significant at 1% level. The coefficient of human capital and physical capital were 0.48 and 0.30 respectively. The interacted term of land Gini and demand was negative (-0.84), suggesting that economies with strong heritage from past, represented by concentration of political power in small rural elite, have more difficulty to obtain increasing returns of scale through the interaction between institutions and demand growth. In contrast to latter results, the Kaldor-Verdoorn mechanism was significant and positive, the parameter with value of 0.48 indicates that an increase of 1% in demand increase the productivity in 0.48%.

The negative coefficient of Kaldor-Verdoorn parameter in estimations with interacted term of IQIM and demand growth is not the expected result according the literature. It is important highlight that our measure of demand is strongly correlated to interacted term of IQIM[18]. In econometric terms, this means colinearity and, so, a larger variance of errors. In turn, a larger variance makes the inference not trusted. In addition, the measurement of GDP by IBGE[19] is a prediction to municipality economies from the national accounts, when we introduced the interaction term I we may can create some kind of vies in our estimations. Taking this in account, we estimated an alternative specification with just the interactions terms, without the Kaldor-Verdoorn[20].

[16] The econometric tests to IV regressions indicated that just three specifications were satisfactory: longitude, latitude, altitude; longitude, latitude; and latitude and altitude.

[17] The econometric tests to IV regressions indicated that just one specification was satisfactory: latitude and altitude.

[18] An OLS regression between the demand growth and interacted term showed a R^2 equals to 0.72, and a parameter significative at 1% level with the value close to 1.51.

[19] IBGE is the public agency responsible for the calculus of GDP to Brazilian economy.

[20] This means that equation (3) becomes $\lambda = \beta\, I$ and, hence, the equation (4) is $\hat{Q} = \rho + \beta\, I\hat{Y}$.

Table 5 presents the estimations with interaction terms between industrial demand and institutions. When the interaction between IQIM and industrial demand is instrumentalized just three specifications of instruments produced satisfactory results accordingly the econometric tests[21] (columns 3, 4 and 5). The coefficient of interaction term is significant and close to 0.5, suggesting that 1% of grow in demand push up 0.5% the productivity. 'The supply elements were constant, with the expected signal.

When the endogeneity between institutions represented by land Gini and economic performance is handled using IV regressions, one set of instruments respected the preconditions of this method[22] (column 5). The Kaldor-Verdoorn interacted was significant and negative, with a value around -1.54. While human capital is not significant, physical capital is significant with positive signal close to 0.78. Although, this result is aligned with international empiric literature on institutions and development, it does not make sense if we think in terms of Kaldor-Verdoorn law because a negative parameter to Interaction II means that a demand growth of 1% will reduce the industrial productivity in 1.54%. But, if the demand growth is taken as given, this result suggests that land concentration interacted with industrial demand has a negative relation with productivity, i.e., how greater (lower) is the political power of agrarian elite, lesser (bigger) is industrial productivity by demand growth.

Table 5 presents the results when the two interacted terms are introduced in the same specification. Only one set of instruments passed in econometric tests[23] (column 3). The supply side elements were significative with the expected signal, except for physical capital that was not significant. Both interactions were significant, while the coefficient of Interaction I was 0.46, the coefficient of Interaction II was -0.22. This result suggests that, on an average, a growth of 1% in demand push the productivity up around 0.24% to Brazilian municipality's economy through the interaction between demand growth and institutions.

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[21] The econometric tests to IV regressions indicated that just three specifications were satisfactory: longitude, latitude, altitude; longitude, latitude; and latitude and altitude.

[22] The econometric tests to IV regressions indicated that just one specification was satisfactory: latitude and altitude.

[23] The econometric tests to IV regressions indicated that just three specifications were satisfactory: longitude, latitude and altitude.

Table 4 - IV Regressions: endogenous Verdoorn coefficient (Kaldor-Verdoorn and Interacted Terms)

Specification	1[1]	2[2]	3[3]	4[4]	5[5]	1[1]	2[2]	3[3]	4[4]	5[5]
Instrumentalized Variable	IQIM interacted with Aggregated Value of Industrial Product					Land Gini interacted with Aggregated Value of Industrial Product				
Kaldor-Verdoorn-Institutions	0.61	0.62	**1.25**	**1.34**	**1.31**					
(IQIM)	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**					
Kaldor-Verdoorn-Institutions						-0.24	-0.35	-0.41	-0.38	**-0.84**
(land Gini)						[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Kaldor-Verdoorn	-0.67	-0.70	**-1.55**	**-1.68**	**-1.63**	0.26	0.80	0.32	0.31	**0.48**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Human Capital	0.83	0.83	**0.52**	**0.49**	**0.50**	0.87	0.80	0.76	0.78	**0.48**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Physical Capital	0.24	0.24	**0.24**	**0.24**	**0.24**	0.26	0.26	0.27	0.27	**0.30**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Constant	5.72	5.77	**7.74**	**8.02**	**7.93**	3.31	3.17	3.09	3.12	**2.52**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
R^2	0.96	0.96	**0.91**	**0.90**	**0.90**	0.97	0.97	0.97	0.97	**0.95**
J-Hansen	38.624	37.345	**5.503**	**1.132**	**3.833**	56.282	40.161	30.183	29.485	**0.193**
	[0.00]	[0.00]	**[0.06]**	**[0.28]**	**[0.05]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.66]**
Wu-Hausman	27.973	26.405	**17.767**	**17.522**	**16.931**	273.529	193.631	168.119	160.534	**60.875**
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**
Stock Yogo	5.74	6.843	**6.970**	**10.259**	**10.217**	70.584	54.317	64.902	89.674	**35.773**
[20% and 10%]	[6.77; 10.83]	[6.71; 10.27]	**[6.46; 13.91]**	**[8.75; 19.93]**	**[8.75; 19.93]**	[6.77; 10.83]	[6.71; 10.27]	[6.46; 13.91]	[8.75; 19.93]	**[8.75; 30.468]**

Obs.: The dependent variable is the Log of the Industrial GDP per capita of each municipality. Values between brackets are the p-value. Robust option was used for the variance-covariance matrix. Dummies for regions were used in specification 8-17. Interaction Term I is the Log of Industrial Demand in 2009 multiplied by the Log of IQIM. Interaction Term II is the Log of Industrial Demand in 2009 multiplied by the Land Gini. In relation to instruments: 1- longitude, latitude, rainfall, temperature, altitude; 2- longitude, latitude, temperature, altitude; 3- longitude, latitude, altitude; 4- longitude, latitude; and 5- latitude and altitude. Dummies for the regions of Brazil were employed in all the regressions.
Source: authors' elaboration

Table 5 - IV Regressions: endogenous Verdoorn coefficient (Just Interacted terms)

Specification	1[1]	2[2]	3[3]	4[4]	5[5]	1[1]	2[2]	3[3]	4[4]	5[5]	1[1]	2[2]	3[3]	4[4]	5[5]
Instrumentalized Variable	IQIM interacted with Aggregated Value of Industrial Product					Land Gini interacted with Aggregated Value of Industrial Product					Both Interactions				
Kaldor-Verdoorn-Institutions (IQIM)	0.29	0.34	**0.46**	**0.52**	**0.46**						0.26	0.29	**0.46**	0.51	0.34
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**						[0.00]	[0.00]	**[0.00]**	[0.00]	[0.02]
Kaldor-Verdoorn-Institutions (l. Gini)						-0.38	-0.45	-0.47	-0.44	**-1.54**	-0.14	-0.24	**-0.22**	-0.20	-0.63
						[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.03]	[0.00]	**[0.01]**	[0.03]	[0.00]
Human Capital	0.85	0.81	**0.64**	**0.58**	**0.64**	0.90	0.84	0.84	0.85	**0.25**	0.81	0.73	**0.61**	0.58	0.48
	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.27]**	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]
Physical Capital	0.10	0.05	**-0.04**	**-0.09**	**-0.04**	0.46	0.48	0.48	0.47	**0.78**	0.17	0.17	**0.01**	-0.02	0.24
	[0.01]	[0.20]	**[0.00]**	**[0.13]**	**[0.38]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]	**[0.82]**	[0.76]	[0.32]
Constant	3.78	3.68	**3.49**	**3.38**	**3.49**	4.28	4.28	4.28	4.28	**4.21**	3.84	3.77	**3.47**	3.38	3.66
	[0.00	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]
R^2	0.37	0.29	**0.09**	**-0.05**	**0.08**	0.31	0.24	0.22	0.25	**-2.03**	0.42	0.37	**0.10**	-0.006	0.08
J-Hansen	47.11	35.83	**3.65**	**1.01**	**2.56**	64.36	54.73	53.45	43.38	**1.56**	43.07	28.88	**0.95**	0.00	0.00
	[0.00]	[0.00]	**[0.16]**	**[0.31]**	**[0.11]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.21]**	[0.00]	[0.00]	**[0.32]**	E.E.I	E.E.I
Wu-Hausman	111.63	99.48	**91.09**	**70.04**	**91.08**	171.64	117.41	109.43	109	**23.71**	48.15	47.92	**39.13**	28.90	2.96
	[0.00	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	[0.00]	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.00]	**[0.00]**	[0.00]	[0.08]
Stock Yogo [20% and 10%]	31.77	29.70	**33.22**	**33.44**	**49.84**	38.61	31.94	40.69	60.38	**12.85**	10.65	13.33	**14.30**	15.26	1.45
	[6.77; 10.83]	[6.71; 10.27]	**[6.46; 9.08]**	**[19.93; 8.75]**	**[8.75; 19.93]**	[6.77; 10.83]	[6.71; 10.27]	[6.46; 9.08]	[8.75; 19.93]	**[8.75; 19.93]**	[5.91; 8.78]	[5.57; 7.56]	**[13.43; 6.40]**	[3.95; 7.03]	[3.95; 7.03]

Notes: The *p-valor* is between brackets. We used the robust matrix of variance-covariance. 1- longitude, latitude, rainfall, temperature, altitude; 2- longitude, latitude, temperature, altitude; 3- longitude, latitude, altitude; 4- longitude, latitude; and 5- latitude and altitude. We used dummies to regions.

Obs:: The dependent variable is the Log of the Industrial GDP per capita of each municipality. Values between brackets are the p-value. Robust option was used for the variance-covariance matrix. Dummies for regions were used in specification 8-17. Interaction Term I is the Log of Industrial Demand in 2009 multiplied by the Log of IQIM. Interaction Term II is the Log of Industrial Demand in 2009 multiplied by the Land Gini. In relation to instruments: 1- longitude, latitude, rainfall, temperature, altitude; 2- longitude, latitude, temperature, altitude; 3- longitude, latitude, altitude; 4- longitude, latitude; and 5- latitude and altitude. Dummies for the regions of Brazil were employed in all the regressions.

Source: authors' elaboration

Our argument is that the heritage from institutions formed during the colonial times represents a historical point of "lock in". A stronger heritage from colonial period suggests more difficulties to obtain increasing returns of scale as long as the *interrelatedness* of these times affects the current economic performance. In our database, as closer to 1 is the land Gini, more concentrated the land is, which means strong heritage from colonial period through the concentration of political power in rural elite. This aspect signifies smaller growth rate of industrial productivity since the parameter of interaction between land Gini and growth rate of productivity is negative in all abovementioned estimations. Therefore, economies whereby the heritage of colonial is weak or the institutions are better, the increase returns of scale tend be larger.

Concluding Remarks

The aim of this paper was introduce supply elements in Kaldorian literature. Once the Kaldor-Verdoorn law sets out that industrial productivity depends on growth rate of demand, it has been notice that the demand-led growth models (e.g. export-led-growth model represented by Kaldor, 1970 and Dixon and Thirlwall, 1975) have a great emphasis in initial conditions. Economies that grew up more in past have higher productivity in current days through Kaldor-Verdoorn mechanism. This creates a circular and cumulative process *a la* Myrdal (1970). One cornerstone of post-Keynesian theory is the idea of historic time (Robinson, 1980), Setterfield (1997) argues that the strong emphasis in initial conditions does not respect it, and for this purpose it is necessary introduce other exogenous vectors. Alternatively, the mainstream literature does not consider the demand as a source of long run growth. In this paper, we consider this gap in literature, introducing institutions and human capital, with together Kaldor-Verdoorn mechanism in the determination of industrial productivity.

The OLS results showed that supply factors are important to explain the economic performance but, when we consider the industrial demand, those elements lose explanatory power. Industrial demand has been shown an important source of industrial productivity too. Considering the interaction between institutions and demand, the OLS estimations showed that elements of supply are relevant to explain the differences of industrial productivity to Brazilian municipalities, well as the interaction between institutions and demand has been shown important to explain it too.

In relation to IV regressions, the set of full instruments (latitude, longitude, altitude, rainfall and temperature) was not satisfactory to resolve the endogeneity in both specification with iterations or not. Therefore, it has been analyzed the results from combinations of instruments that have passed in econometric testes. Yet, considering just the supply side elements (vectors human capital and institutions) were significant with the expected signal. The signal of IQIM was positive and land Gini was negative, which means that better institutions are related to higher growth rate of industrial productivity and the concentration of political power in rural small elite with lower growth rate. Introducing the demand, the results suggested that Kaldor-Verdoorn parameter is not significant when IQIM is instrumentalized, but it becomes significant when just the land Gini is instrumentalized.

The results of IV regressions instrumentalizing the interaction terms showed that higher industrial productivity through increasing returns of scale is related to better institutions measured by IQIM and small concentration of political power in rural elite. Introducing both iterations in some specification, it is been obtained that a growth of 1% in demand push up the productivity in 0.22%. In sum, such the demand and supply side elements were important to determine the industrial productivity. Economic structures with better institutions represented by IQIM have higher increasing returns. On the other hand, municipalities with strong heritage from colonial times have lesser increasing returns of scale.

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Appendix

Table A1 - Variables

Variable	Description	Unit	Year	Source
Aggregated Value of Industrial Product	Industrial Aggregated Value of each municipality	Logarithm	2009	IBGE
Industrial Productivity	Industrial GDP per capita	Logarithm	2010	IBGE
Interaction I	IQIM interacted with Aggregated Value of Industrial Product	Logarithm		Calculated by authors
Interaction II	Land Gini interacted with Aggregated Value of Industrial Product	Logarithm		Calculated by authors
Human Capital	IDH-education	Logarithm	2000	Atlas of Brazilian Human Development
Physical Capital	Stock of Residential Capital in Prices of 2000	Logarithm	2000	IPEA DATA
IQIM	Index of Institutional Quality	Logarithm	2000	Ministry of planning
Land Gini	Concentration of Land		1996	Calculated by authors
Latitude	Latitude		1998	IPEA DATA
Longitude	Longitude		1998	IPEA DATA
Altitude	Meters		1998	IPEA DATA
Rainfall	Annual Average	Millimeters	1998	IPEA DATA
Temperature	Annual Average	Celsius	1998	IPEA DATA

Source: authors' elaboration.

Table A2 - Descriptive Statistics

Variável	Average	Std. Dev.	Maximum	Minimum
Aggregated Value of Industrial Product	9.42	1.78	18.01	3.18
Interaction I	10.40	3.18	25.12	0.70
Interaction II	2.70	1.50	10.58	0.06
Industrial Productivity	6.74	1.41	12.38	4.19
Human Capital	0.35	0.12	0.74	0.04
Physical Capital	10.47	1.41	18.87	6.80
IQIM	1.08	0.19	1.59	0
Land Gini	0.28	0.14	0.74	0
Latitude	16.39	8.26	4.59	-33.69
Longitude	46.17	6.39	72.89	32.41
Altitude	412.47	293.13	1.628	0
Rainfall	116.10	36.63	282.43	28.87
Temperature	22.73	2.98	28.04	14

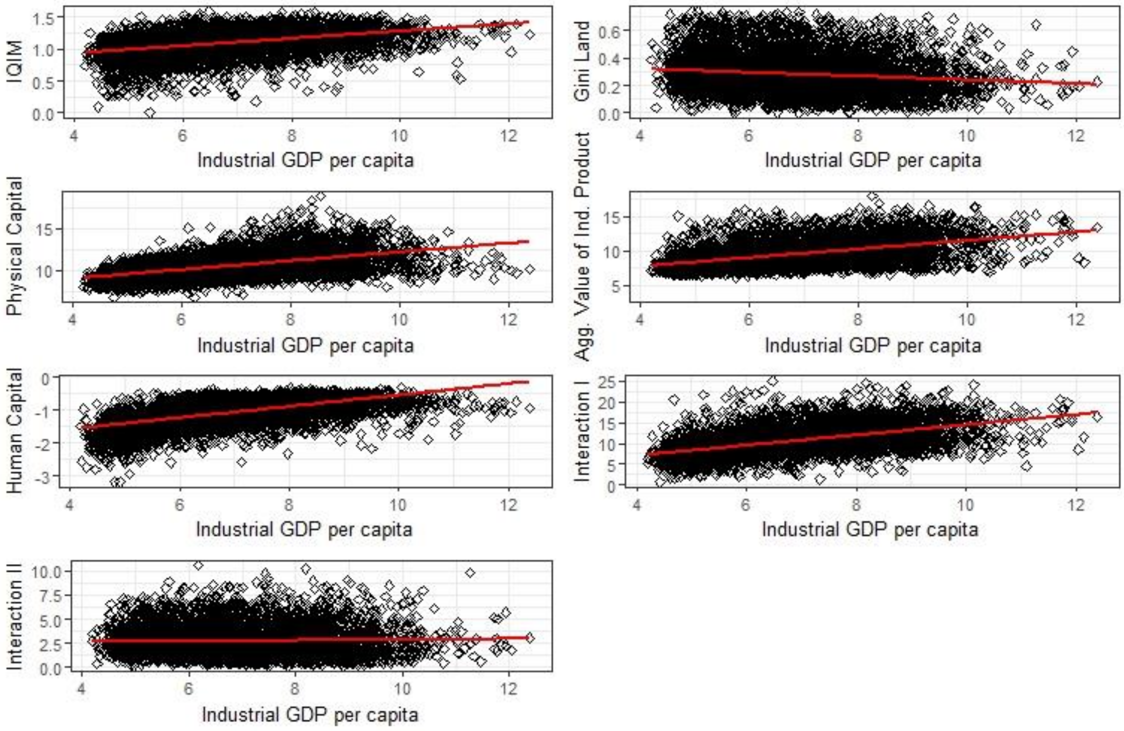
Source: authors' elaboration.

Table A3 - Correlations between residential stock of capital and common proxies for physical capital

Variable	Correlation
Gross Fixed Capital – Non-residential building	0.96
Gross Fixed Capital – Machinery and Equipment	0.84
Gross Fixed Capital – Total	0.94
Industrial Electric Power Consumption - 1970	0.93
Industrial Electric Power Consumption - 1980	0.94
Industrial Electric Power Consumption - 1991	0.93
Industrial Electric Power Consumption - 2000	0.94

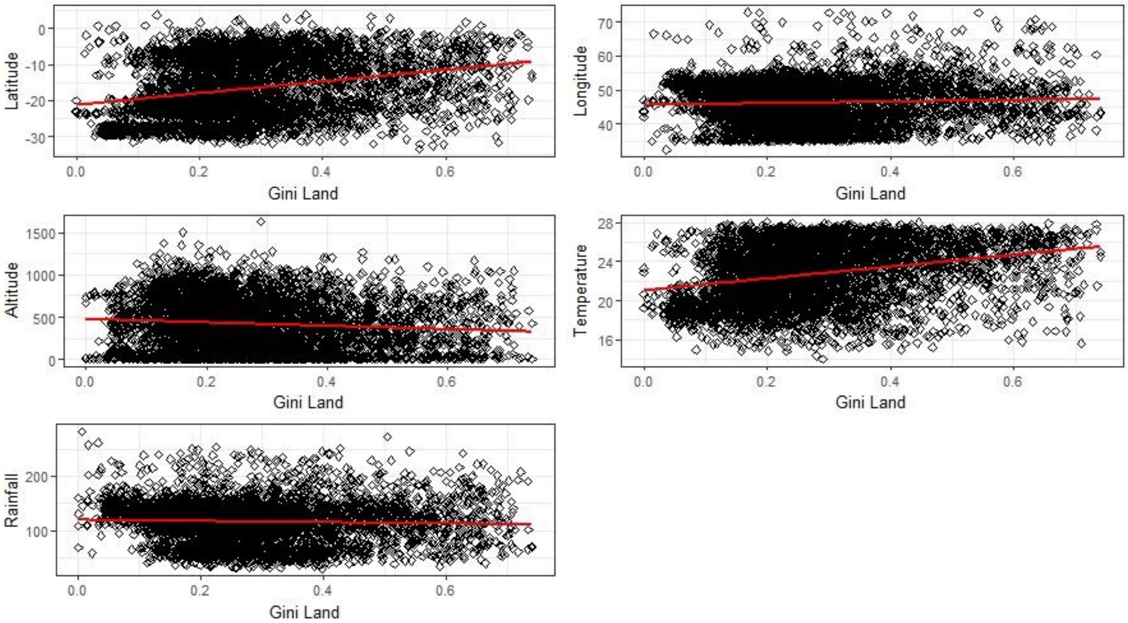
Source: Barros *et al* (2013) and Lima and Neto (2015).

Graph A1 - Industrial GDP per capita, Institutions, Human Capital, Physical Capital and Interaction Terms



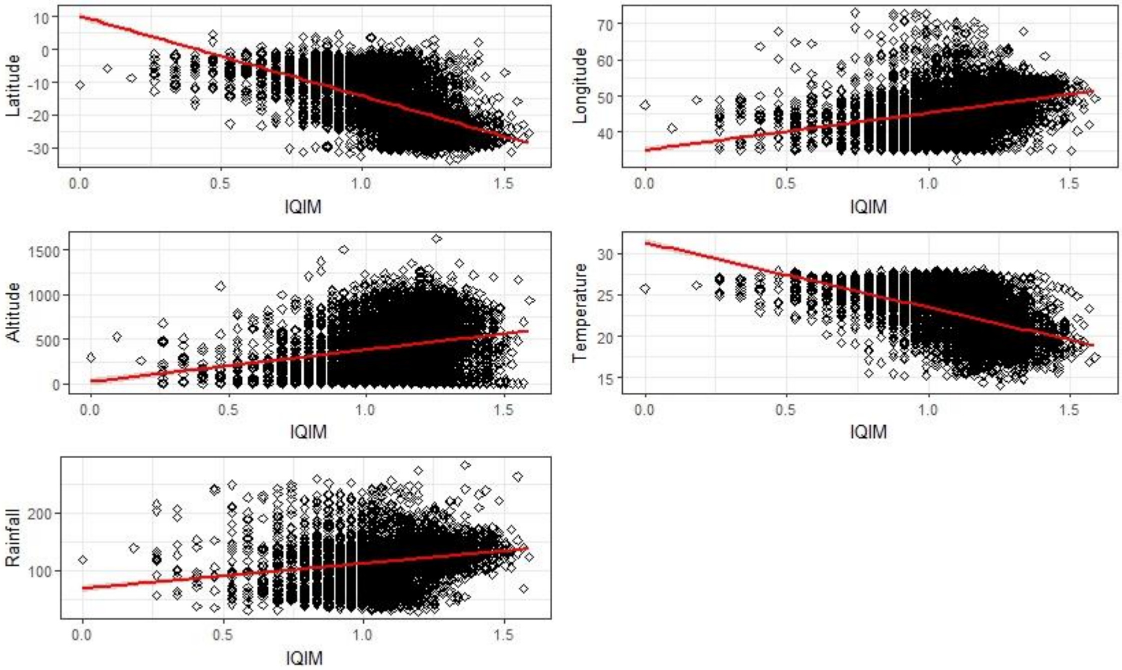
Source: authors' elaboration using package ggplot 2 from R and data described in Table A1.

Graph A2 – Land Gini and Instruments



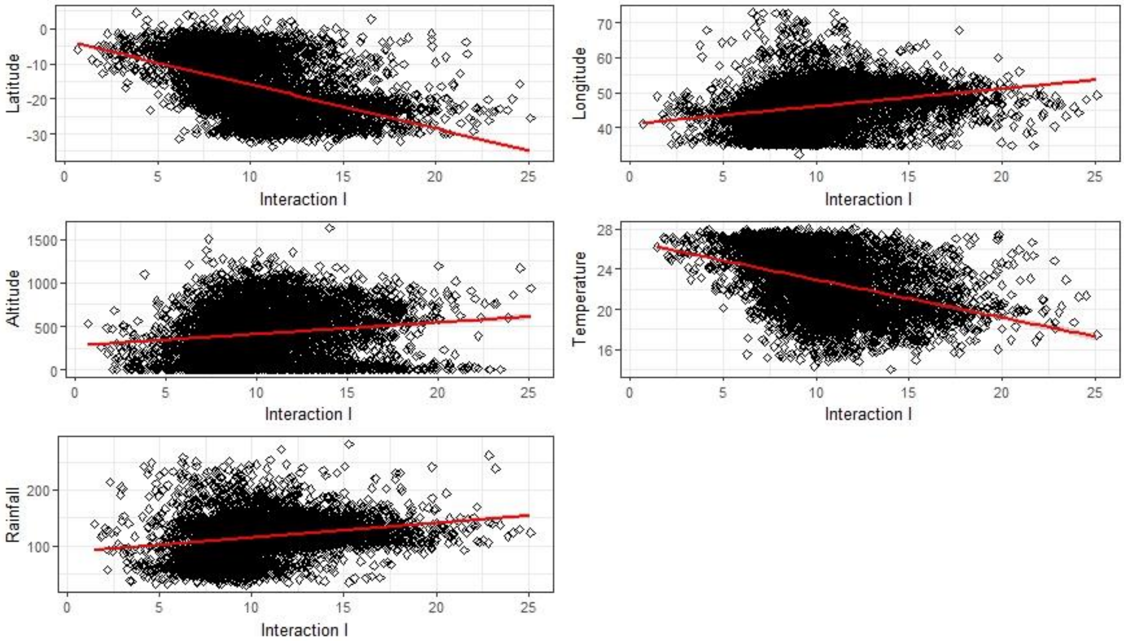
Source: authors' elaboration using package ggplot 2 from R and data described in Table A1.

Graph A3 - IQIM and Instruments



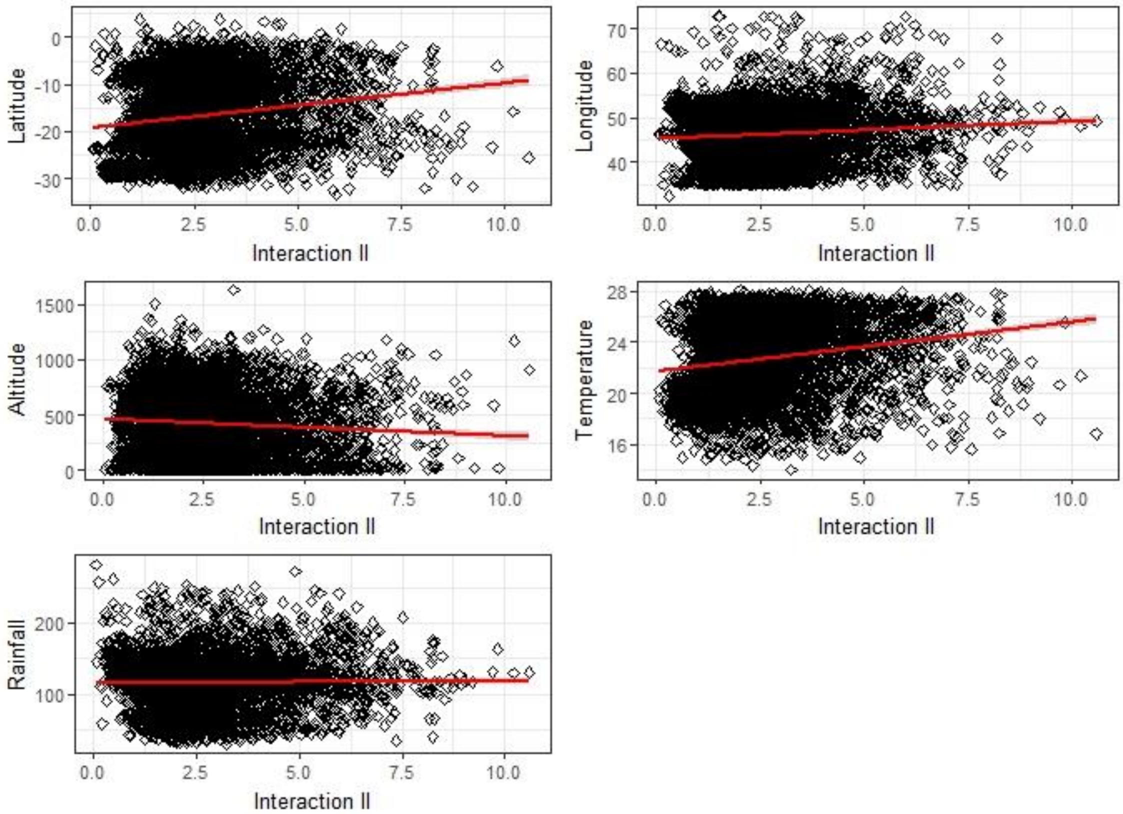
Source: authors' elaboration using package ggplot 2 from R and data described in Table A1.

Graph A4 - Interaction Term I and Instruments



Source: authors' elaboration using package ggplot 2 from R and data described in Table A1.

Graph A5 – Interaction Term II and Instruments



Source: authors' elaboration using package ggplot 2 from R and data described in Table A1.