Land inequality and economic growth in Brazil

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Abstract

This paper examines the relationship between economic growth and wealth distribution in Brazilian minimum comparable areas, measured by land inequality. The empirical investigation developed here is based on a growth regression to examine the determinants of the long-run economic performance. To deal with the endogeneity problem regarding the relationship between economic growth and inequality, we use an instrumental variable 2SLS approach, with the percentage of non-whites and the percentage of non-African immigrants in the 1872 Brazilian population Census as the exogenous instrument for the land Gini index in 1970. We find evidence of a negative relationship between the land Gini index and economic growth between 1970 - 2010. From a normative perspective, the results suggest that public policies that reduce land concentration may positively affect long-run economic growth.

Keywords: Income conditional convergence; Land Gini Index; Economic growth; Growth regression.

JEL Codes: O10; D30; C26.

Área – Economia

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1. Introduction

In the last few decades, the economic growth literature has been evolved to understand the fundamental economic growth causes. Besides the causes pointed by Solow (1956) and the vast literature related to the neoclassical growth model (e.g., technical change, physical and human capital accumulation) works like Acemoglu et al. (2001), Acemoglu et al. (2002) and Acemoglu & Robinson (2008) have explored why some countries and regions failed to accumulate physical and human capital, as well as failed to improve their productivity. Most of this literature has pointed the institutions as the very long-run development cause.

Institutions can drive development by affecting the agents' incentives to accumulate capital, spend time acquiring skills, or innovate. On the other hand, bad institutions can obstruct the incentives, creating different sorts of distortions. Usually, the expression institution refers to the game's rules, like freedom, the business environment, and the existence of democracy. Nevertheless, different elements of the social life are tightly linked to the institutions, also shape the incentives, and could be considered part of the institutional framework itself. The wealth distribution is one of these elements that potentially shape incentives and, especially, constraints.

As pointed by Bowles (2004), lack of wealth can affect the incentives by precluding the poor from acquiring assets, affecting the credit market, and, in the last instance, the allocative efficiency. One limitation regarding the empirical literature connecting growth and wealth inequality is the relative absence of data on the distribution of wealth. That is why some of the seminal works in this literature, like Bénabou (1996), have used income inequality data rather than wealth distribution data.

Alesina & Rodrik (1994) was one of the seminal works to link economic growth to wealth inequality. They found a negative association between economic growth and land inequality using a growth regression approach. The theoretical rationale described by these authors links economic growth and wealth inequality by a political economy mechanism. According to their model, greater wealth inequality drives higher tax rates and lower economic growth.

Although the land is not the only source of wealth inequality, this is a key variable regarding the sustainability of development, affecting growth and institutions, as pointed out by Cipollina et al. (2018). The meta-analysis provided by Cipollina et al. (2018) reviews the econometric findings estimating the nexus between land inequality and economic growth. The authors show that land inequality negatively affects growth, especially in the long run.

Starting from the motivation we previously described, our main goal in this paper is to investigate the relationship between economic growth and land inequality in Brazilian municipalities grouped by minimal comparable areas. To the best of our knowledge, this paper is the first work to address the linkage between economic growth and land inequality using subnational data with this level of disaggregation. Like Alesina & Rodrik (1994), and Brueckner & Lederman (2018), we base our empirical analysis on a conventional Barro & Sala-i-Martin (1992) growth regression.

Additionally, by doing so, we can also study the beta convergence process among Brazilian municipalities, considering the land inequality issue. The use of a growth regression raises an additional issue, the endogeneity problem. Since wealth inequality is part of the institutional framework, this is an endogenous variable that drives economic growth but is also driven by this. We choose an instrumental variable approach to deal with this problem. Using data from the Brazilian 1872 census, we tested different instruments to overcome the endogeneity problem. As pointed by Ehrl (2017), since the imperial era in Brazil, the number of municipalities raised continuously, then, to implement a growth regression using any instrument from the 1872 census, we first had to reshape our data to Minimum Comparable Areas (MCA) for the period 1872-2010.

We used per capita income data from the 2010 and 1970 Brazilian census, which is also the source of human capital in our regression. Finally, we calculate the land Gini index (our land inequality variable) using municipal land ownership data from the Brazilian census of agriculture. Both censuses are elaborated by the Brazilian Institute of Geography and Statistics (IBGE). The following section briefly reviews the literature that associates economic growth and inequality.

2. Literature review

In the economic thought modern era, the first attempt to link economic growth and inequality is usually attributed to Kuznets (1955), who described the relationship between economic growth and inequality in an inverted U-shaped curve. According to the now known as the Kuznets curve, in the first stages of development, growth drives inequality and then, after some turning point, starts to improve income distribution. As pointed by Chen & Ravallion (2021), the Kuznets hypothesis theoretical argument is based on the idea that most economies are rural and not very unequal in the early stages of development. When this sort of economy starts to develop, the structural change patterns occur so that the resources are re-allocated to urban sectors, richer but more unequal. This is a macroeconomic theoretical rationale, with no attempt to describe the microeconomics mechanisms generating incentives toward a more equal or unequal economy. The empirical literature has found mixed results regarding the Kuznets hypothesis. Barro (2000), for example, found evidence in favor of the Kuznets hypothesis. In contrast, Huang et al. (2012) found no evidence of an inverted U-shaped curve for the relationship between income and inequality in the United States.

Regarding the incentives mechanisms linking economic growth and inequality, two are the most common theoretical arguments: The political economy approach and the credit constraints approach. Alesina & Rodrik (1994) is one of the seminal papers linking economic growth and wealth inequality through the political economy channel. They derive their rationale from a simple endogenous growth model in which the median voter has the power to impose progressive taxation. Their aggregate production function has capital, labor, and government spending as arguments; capital is the only accumulated factor, and the government finances its public services by taxing the capital. In this model, the distributive conflict among agents with different endowments of capital and labor affects economic growth. The median voter preferences lead the government taxation toward redistribution, affecting capital accumulation and generating a negative interplay between growth and inequality. To test their theory, Alesina & Rodrik (1994) used a growth regression approach with country level data for a set of developing and developed countries. Their regression has the economic growth as depend variable (as usual) and, as explanatory variables, the initial level of per capita income, the primary school enrollment ration as a measure for the initial level of human capital and the Gini coefficient of land ownership as a proxy of wealth distribution. They found evidence of a negative association between land inequality and economic growth.

Another seminal paper that have addressed the link between economic growth and inequality using a political economy approach was Bénabou (1996). This paper approaches the inequality-growth interplay with two theoretical models, exploring the role of asset market imperfections and the economic growth version of the prisoner dilemma. According to this paper is not the income inequality per se that impacts growth, but the connection between the distribution of earnings and the political power dynamics. As the groups' rent-seeking abilities and the gap between rich and poor increase, the economic performance falls.

As in Alesina & Rodrik (1994), many papers have focused on wealth inequality rather than income inequality. One important aspect of this literature is the focus on asset inequality as a barrier to the accumulation of physical and human capital (Cipollina et al., 2018). As pointed by Fort (2007), the asset inequality would impact negatively the economic performance because of the lack of property rights well established and the social polarization reducing investments in physical capital but also in human capital. In that sense, asset redistribution policies as well as educational policies could potentially improve the long run economic development. Fort (2007) explores this issue with a panel data of 30 countries between 1970 and 1990 using a growth regression approach, finding a negative relationship between economic growth and the land inequality. One additional result pointed by this author is the inefficacy of educational policies in countries with a large degree of asset inequality.

Using subnational data for the United States counties between 1890 and 1930, Ramcharan (2010) finds evidence of a negative relationship between inequality and redistribution policies. This author also found evidence of a negative impact of wealth inequality on education expenditures. These results are similar to the ones found by Galor et al. (2009), who found evidence of a negative relationship between land inequality and human capital accumulation in the US states. Although these papers are not directly testing the link between economic growth and inequality, they can help to understand some of the mechanisms operating in the background. Among the papers testing the linkage between economic development and wealth inequality in Brazil, Wegenast (2010) explores the relationship between land inequality and human capital accumulation in the Brazilian States. Using an OLS cross-section approach, this author tests the link between the average years of education, the quality of education, and the public education expenditure with land inequality (land Gini index). This author found evidence of a negative relationship between land inequality and human capital accumulation. An additional finding pointed out in this paper is the fact that States with more representatives (at a State level) who are part of landowners groups of interest tend to have lower education expenditures.

Another way to test the link between economic development and land inequality is by investigating the role of the colonial institutions in the long-run development process. One of the seminal papers in this literature is Acemoglu et al. (2008). Testing the link between economic development and inequality in a Colombian state, this author does not find evidence of a negative relationship between land inequality and development, instead, he finds evidence of political inequality negatively affecting economic development. Starting from Engerman et al. (2002) findings, Nunn (2008) investigated the role of big plantations in the United States' inequality and, consequently, in the economic development process. This author estimated the effect of the number of slaves on the land Gini index in 1860 in the US. After doing that, the author tested how the land Gini index impacts the per capita income level in US counties in 2000. This paper does not find a link between land inequality in 1860 and the 2000 per capita income in these counties. On the other hand, it points out a positive relationship between the number of slaves in 1860 and the per capita income level in 2000.

Summerhill (2010) is one of the seminal papers testing the role of the colonial institutions in the economic development of Brazil. Using microdata from 1905 at the farm level in the state of São Paulo, this author does not find evidence of a relationship between land inequality in 1905 and economic development in 2000. This author also does not find evidence of a linkage between economic development and political inequality for the same period.

Using Acemoglu & Robinson (2008) as a starting point, Funari (2017) investigates the long-run relationship between inequality and development in Brazilian states. This author points out some heterogeneous results among Brazilian states, with some states showing a positive relationship between initial inequality and economic performance, others showing a negative relationship between economic performance and initial inequality, and some others without any statistically significant link between inequality and economic performance.

After this non-extensive literature review, in the next section we present some key facts about the land distribution in Brazil.

3. Some facts about land inequality in Brazil

A significant degree of land inequality is rooted in Brazilian history, reflecting the colonization process, the long Brazilian slavery period, and persisting throughout the 20th century. Authors like Prado Junior (1979) and Smith (1990) explored some historical aspects of this issue. Colistete & Lamounier (2014) highlight the fact that even after the independence in Brazil, "both the parliament and provincial governments tended to favor land policies that preserved the large estate" (Colistete & Lamounier, 2014, p.5). According to these authors, except for the settlement of some smallholders – mostly European immigrants – by the imperial government in the provinces of the south, obstacles to the small farm expansion were the general rule during the nineteenth century.

The idea of Brazil as a country with many unsolved agrarian conflicts, in which wealth inequality shapes social relationships, is echoed in fictional literature. The recent acclaimed bestselling novel Torto Arado (Vieira Junior, 2019) pictures the lives of two sisters living in a community of descendants of African Brazilian enslaved people living in the backcountry of Brazil's northeast. An essential aspect of the main characters' journey in the book is the lack of land property rights of their families, living in a social arrangement that reverberates the era of slavery, an era finished some generations before. Despite the fact they have been living and working in these lands for generations, they cannot build permanent homes and are unpaid for their work giving most of their crop to the official owners of the farm in a very unfair sharecropper regime. These echoes of the slavery period are described by one of the sisters, called Bibiana, in the following way:

> When they gave freedom to blacks, we were still abandoned. The people wandered from land to land, asking for shelter, starving, toiling for nothing, and submitting themselves to working for having a place to stay. The same slavery as before, disguised as freedom. But what freedom? We couldn't build permanent brick houses or cultivate the land in our manner with the plants we wanted. They took whatever they could from our work. (Vieira Junior, 2019, p.163)

Using a clever storytelling strategy, the author places the novel in a time that is not precise, but some excerpts from the book sound like about the 1960's. Indeed, the real Brazil in that time was not significantly different from the one picture in the Novel. In the early sixties, a document produced by the National Council of Economics (CNE), a governmental consultative bureau for economic purposes, pointed out a set of characteristics of the Brazilian land property structure. The Overview of the economic situation in Brazil ten items list regarding the land property main features in that time (CNE, 1962, p.82-83) is reproduced below:

(a) Prevalence of extensive agricultural properties (more than half of them with an area greater than 500 hectares[4]).

(b) High and growing concentration of land property (8% of the owners control 75% of the total land area).

[4] A hectare is equal to 100 ares in the metric system.

(c) Large proportion of peasant workers without land ownership (about 10 million out of a total of 12 million).

(d) Small percentage of cultivated area (10% on average).

(e) Outdated agricultural practices.

(f) Low mechanization, fertilization, and pest control.

(g) Semi-feudal labor relations, such as sharecropping and non-paid labor.

(h) Meager agricultural income.

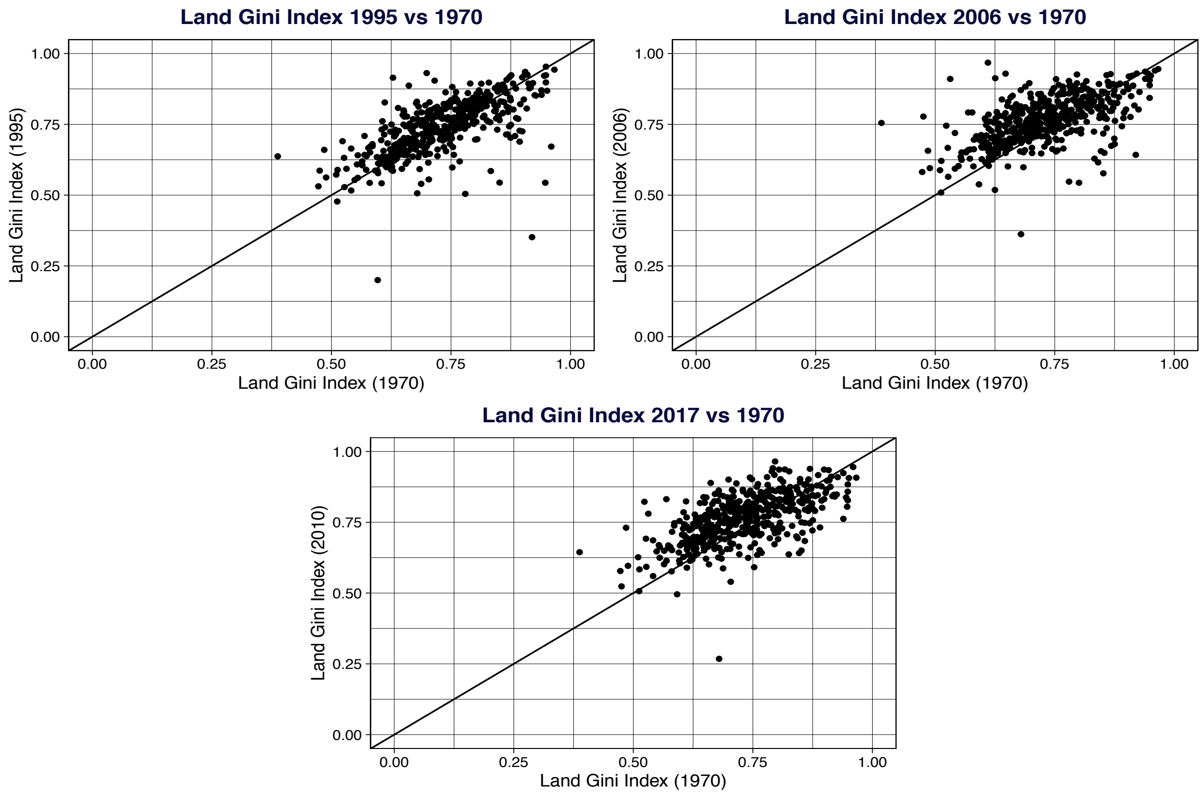
(i) Lack of guarantees and opportunities for the land workers and peasant farmers.

(j) Lack of incentives for new investments for the landowner, the peasant farmers, partners, or tenants.

Since the sixties, some of these stylized facts have changed as the agriculture sector has turned into a very modern industry in Brazil, with a significant degree of mechanization and technology use. On the other hand, the land concentration, measured by the Land Gini Index, stayed relatively unchanged from the 70's up to nowadays.

Using land property data from the IBGE's Census of Agriculture of the years 1970, 1995-1996, 2006, and 2017 we managed to calculate the Land Gini Index for Brazilian municipalities in these years. After doing that, to make it possible to analyse the evolution of the land concentration among different periods, as well as to make it possible to use an econometric instrumental variable from the 1872 population Census, we calculate the Land Gini Index for minimal comparable areas for 1970, 1995, 2006, and 2017. In 1872, Brazil had 642 municipalities; this number has increased many times since then. In 1970, for example, there were 3959 municipalities in Brazil. Finally, the number of municipalities was 5568 in 2017, our last analysis year. Ehrl (2017) has developed a routine to make it possible to generate time-consistent minimum comparable areas, covering the period of our research, using the 1872 census as the starting point reference. We get a data set of 482 minimum comparable areas contenting all our interest variables using this routine.

Figure 1: Land inequality in different years
(Brazilian minimal comparable areas)

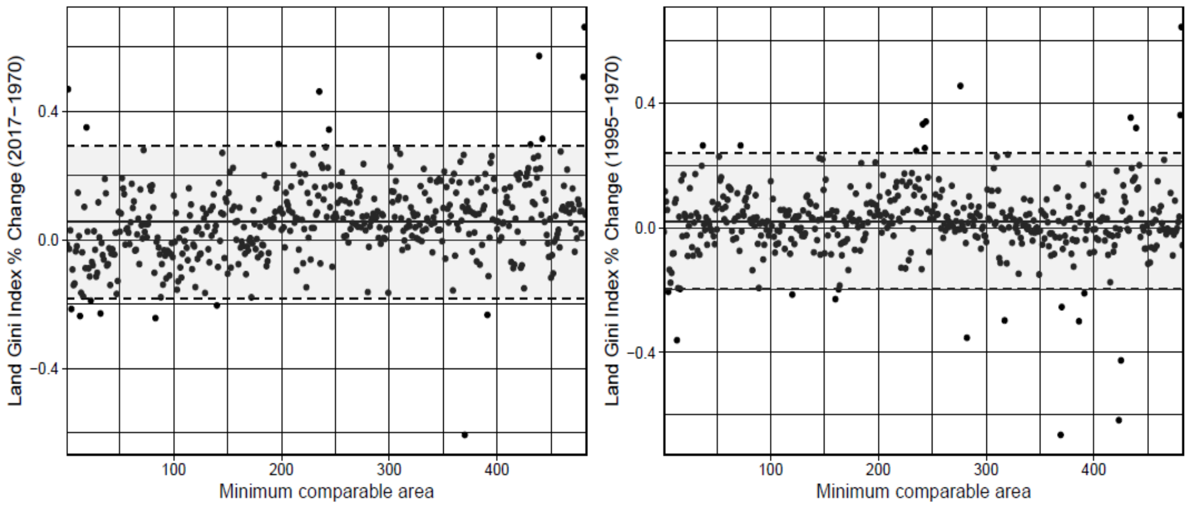


Source: Authors' calculation using IBGE's data.

Figure 1 plots the relationship between the minimum comparable areas Land Gini Index in these different years with a 45-degree line. As the plots show, the Land Gini Index stayed relatively stable and concentrated at the top right quadrant of the plots.

Using a simple procedure, we also analyze the percentage change of the Land Gini Index between 1970 and 1995 and 1970 and 2017 for the minimal comparable areas and plot it in Figure 2. The solid lines are the mean percentage changes (equal to 5.5% for 2017-1970 and 2% for 1995-1970). The dashed lines are a 95% confidence interval. The central message is that the land concentration does not change substantially in this interval. Surely this fact could be different if we take another spatial reference, for example, the municipality data level. We do something like that in Figure A1, in the Appendix, plotting the Land Gini Index in a map in different periods at a municipality level. A simple visual inspection does not show a significantly different big picture, nevertheless. Despite some improvement in terms of land inequality, especially in the North region of Brazil, in all these years, a high level of land concentration, as measured by the Gini index, prevailed.

Figure 2: Land Gini Index % Change (Brazilian minimal comparable areas)



Source: Authors' calculation using IBGE's data

In Table 1, we calculate the land distribution by the size of the properties in hectares. Taking the country as a whole (BR), the big picture about land distribution did not change significantly throughout the years, despite the increase of bigger than 1000 hectares properties between 1970 and 2017. On the other hand, among the regions, the number of big properties has increased more significantly in the North (N) and the Center-West (CW) regions. In particular, during these decades, there is a remarkable increase in the number of bigger than 1000 hectares properties in the Center-West, which is a region with a considerable presence of extensive cattle farming and large-scale soybean production.

Table 1: Farm size distribution among Brazilian regions

Area (Ha.)	Year	BR	N	NE	SE	S	CW
$A \leq 10$	1970	2,519,630	109,435	1,499,625	310,205	538,865	37,144
	1975	2,601,860	153,224	1,641,931	277,485	460,724	68,496
	1980	2,598,019	149,600	1,654,841	290,196	451,860	51,519
	1985	3,064,822	167,804	1,971,391	355,873	502,675	67,079
	1995	2,402,374	134,803	1,570,510	286,872	377,761	32,427
	2006	2,477,151	126,532	1,498,395	393,459	406,498	52,267
	2017	2,543,681	201,557	1,510,018	422,411	340,811	68,884
$10 < A \leq 100$	1970	1,934,392	122,690	560,893	484 775	674 185	69,470
	1975	1,898,949	150,185	567,033	459 961	630 591	91,381
	1980	2,016,774	204,450	637,263	458 805	624 181	92,075
	1985	2,160,340	264,705	667,491	494,263	625,123	108,758
	1995	1,916,487	217,097	604,261	428,912	555,246	110,971
	2006	1,971,600	229,105	650,865	411,438	515,460	164,732
	2017	1,980,684	270,236	645,158	441,203	444,669	179,418
$100 < A \leq 1000$	1970	414,746	56,995	126,124	125,833	55,462	41,935
	1975	446,170	69,590	131,045	131,738	58,820	54,977
	1980	488,521	88,078	141,134	131,408	62,973	64,928
	1985	517,431	102,022	143,965	133,294	64,419	73,731
	1995	469,964	83,647	125,406	118,080	64,390	78,441
	2006	424,288	80,518	115,484	91,727	59,927	76,632
	2017	420,719	89,880	99,096	95,284	59,733	76,726
$A > 1000$	1970	36,874	4,386	8,660	7,746	4,790	6,385
	1975	41,468	5,700	9,120	8,663	5,202	12,782
	1980	47,841	7,597	10,235	8,585	5,550	15,876
	1985	50,411	8,412	10,552	8,364	5,448	17,635
	1995	49,358	8,023	8,907	7,017	5,030	20,380
	2006	47,578	8,467	8,212	5,956	4,507	20,436
	2017	51,203	9,940	7,329	6,731	5,690	21,513

Source: Author’s calculation with data from IBGE’s data.

After this brief presentation of some facts about land distribution in Brazil, we will present our econometric specification and the database.

4. Econometric specification and data

We build up our analysis on a conventional growth regression using data from Brazilian municipal units and minimum comparable areas. Besides the OLS estimation, we also provide a Two-Stage Least Squares (2SLS) instrumental variable estimation to address the endogeneity issue. Next, we discuss our econometric specification and briefly present the data.

4.1 Economic growth and econometric specification

Despite the microfoundation revolution and the fact that the *Ramsey-Cass-Koopmans*[5]model has become a cornerstone of macroeconomic dynamics modeling, the Solow (1956) growth model is still a popular *workhorse* to address empirical questions.

One popular approach to address empirical questions using Solow's model as starting point is the so-called growth regression, as in Barro & Sala-i-Martin (1992). This is also the approach adopted by Alesina & Rodrik (1994) to investigate the relationship between wealth inequality and economic growth in a cross-country context.

In Solow's model, the equilibrium output per worker (y) can be expressed as follows:

$$y(t) = A(t)f(k(t)) \tag{1}$$

where $A(t)$ is the Harrod-neutral technology labor-augmenting index and $k(t)$ is the capital per efficiency unit of labor. Using the usual set of assumptions in the model and proceeding a linear approximation, we have the following equation motion:

$$\frac{\dot{y}(t)}{y(t)} \approx g - (1 - \varepsilon(k^*))(\delta + n + g)(log\ (y(t) - log\ (y^*(t)) \tag{2}$$

where $\varepsilon(k^*)$ is the $f(.)$ elasticity with respect to $k = \frac{K(t)}{A(t)L(t)}$ (equal to a constant between 0 and 1 for a Cobb-Douglas production function); g the constant technical progress rate, δ is the capital depreciation rate and n the exogenous population growth rate and $y^*(t)$ is the steady-state output per worker.

A discrete approximation of the previous equation can be used to express the following econometric model:

$$g_{t,t-1} = \beta_0 + \beta_1 log(y_{t-1}) + u \tag{3}$$

where $\frac{log(y_t)}{log\ (y_{t-1})}$, and u is the stochastic error term. This is the so-called absolute convergence regression, in which β_1 is expected to be negative. If β_0 is not constant and the covariance it and the error term is different from zero, the absolute convergence regression is not a good econometric specification. Most of the cross-country evidence rejects absolute convergence, pointing out the existence of country-specific aspects (like the human capital level) that also explain the growth process. Taking this into consideration, we can re-write the growth regression equation as follows:

$$g_{t,t-1} = \beta_{i-1}X' + \beta_1 log(y_{t-1}) + u \tag{4}$$

where X' is the vector of additional covariate explanatory variables.

[5] See Cass (1965) and Koopmans (1963).

Using (4) as reference, we specify the following econometric model[6]:

$$g_{t,t-1} = \beta_{i-2}X' + \beta_1 log(y_{t-1}) + \beta_2 log(LGini_{t-1}) + u \quad (5)$$

where *LGini* is the land Gini index and X' is the vector of the rest of the control variables.

There are good reasons to believe that *cov*(*LGini,u*) is different from zero, such as reverse causality between economic performance and land inequality, measurement error, and omitted variable bias. In this case, the OLS estimator is not unbiased. To deal with it we proceed with a Two-Stage Least Squares (2SLS) regression using socioeconomic data from the 1872 population Brazilian census as instruments for the land inequality measured by the land Gini index. Next, we describe our data and explore some details about our instrumental variable choices.

4.2 The database

We build up the variables used in our econometric analysis with data from the 1872, 1970, and 2010 Brazilian population censuses and the 1970 Brazilian agricultural census, both provided by the Brazilian Institute of Geography and Statistics (IBGE). After calculating each variable at the municipal level, we aggregate them into 481 Minimum Comparable Areas (MCA) for the period 1872-2010 as proposed by Ehrl (2017).

Per capita income growth between 1970 and 2010 is the dependent variable. Per capita income is the per capita household income calculated as the total income of residents, divided by the number of residents in the household. Then, we deflated it to 2010 Brazilian reals and aggregate it into MCAs. An important point to mention is that, as far as we know, 1970 is the furthest year for which there are complete data to calculate our interest variables.

The explanatory variable of interest is the land inequality Gini index. As pointed by Frankema (2010), land concentration is one of the main determinants of long-run wealth and asset inequality. We construct this index using the 15 levels of size and number of properties data from the 1970 agricultural census. The 1970 agricultural census is particularly important because it portrays the period when the population became predominantly urban. In 1970, for the first time, the Brazilian rural areas had a population decrease. The percentage of the population living in urban areas, which was 45% in 1960, rose to 56% in 1970[7]. Furthermore, in the period 1970-2010, there is a constant increase in urbanization and productivity, which suggests the need to control the effect of the rural exodus on income.

Due to the endogeneity and reverse causality problem, we propose to use characteristics of the Brazilian population at the time of slavery to estimate the effect of inequality on income growth. Slavery profoundly shaped Brazilian society and land inequality is just one of the many current characteristics that have roots at that time. We used the fact that the State segregated the right to land according to the ethnic-racial characteristics of the population. From the Land Law of 1850, Europeans were encouraged to immigrate to Brazil with the promise of land, but slaves and freedmen were prevented from acquiring them. Thus, our understanding is that the inequality between whites and non-whites in land tenure was endogenously fixed, which makes the percentage of inhabitants with these characteristics in 1872 a valid instrument to uncover the causal effect of the land inequality on income growth.

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[6] In our context we are using per capita income data in place of output or output per worker.

[7] Source: Author's calculation with IBGE's data available at https://censo2010.ibge.gov.br/sinopse/index.php?dados=8.

Additional control variables are added to the specification to mitigate the omitted variable bias. As proxies for human capital stock in 1970, we pick the average years of education (the total number of years of schooling divided by the number of inhabitants aged 25 or over) and the illiteracy rate (percentage of the population aged 15 and over who cannot read or write). The last control variable is the rural population (population living in areas outside the urban areas) as a percentage of the total population. We calculated all these variables with data from the 1970 population census at a municipal level and then aggregated it into 2010-1872 MCAs.

5 Results and discussion

By doing a simple exploratory data analysis, using MCAs data, we find evidence of a negative association between economic growth and land inequality as we show in the following figure:

Figure 3: Land inequality and growth
(Brazilian minimal comparable areas)

Source: Authors' calculation using IBGE's data.

In Table 2 we report the OLS regression outcomes of our model, which we ran using MCAs level data.

Table 2: OLS regressions. Dependent variable is the log-growth rate between 1970 and 2010, $\Delta\log(inc)$.

	(1)	(2)
LGini$_{1970}$	-0.741^{***}	-0.821^{***}
	(0.127)	(0.133)
$\log(inc)_{1970}$	-0.299^{***}	-0.386^{***}
	(0.017)	(0.032)
$\log(educ)_{1970}$		0.021
		(0.054)
ill$_{1970}$		0.048
		(0.100)
rur$_{1970}$		-0.295^{***}
		(0.100)
Constant	3.091^{***}	3.732^{***}
	(0.144)	(0.269)
Obs.	482	481
R_2	0.352	0.367
Adj. R^2	0.349	0.360
RSS	0.223($df = 479$)	0.221($df = 475$)
F statistic	129.934^{***}($df = 2;479$)	55.083^{***}($df = 5;475$)

Note: Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$ are used as the significance threshold, respectively. $(LGini)_{1970}$ is the inequality index measuring the distribution of land across the population. $\log(inc)_{1970}$ and $\log(educ)_{1970}$ are respectively the log of income and the log of the average years of education in 1970. ill_{1970} is the illiteracy rate in 1970, and rur_{1970} is the rural population as a percentage of the total population.

We report the growth regression with all the controls and also with only the land Gini index and the initial income as explanatory variable[8]. In both cases the land Gini index ($LGini_{1970}$) coefficient, and the initial income ($\log(inc)_{1970}$) coefficient are negative and statistically

[8] We do not report the absolute β convergence regression outcomes, but we find evidence of absolute convergence among MCAs with a negative and statistically significant income coefficient in the absolute convergence regression.

significant. In the model with the controls the speed of convergence increases, since the absolute value of the coefficient associated with the initial income is bigger in the model with all the controls. In the model with all control variables, coefficients associated with the initial average years of education ($\log(educ)_{1970}$), and the initial illiteracy rate ($\log(ill)_{1970}$) are not statistically significant. Finally, the initial rural population (rur_{1970}) coefficient is negative and statistically significant. This result is similar to the one found in Alesina & Rodrik (1994) in a cross-country context, with a negative association between economic growth and land inequality measured by the land Gini index. The next step in our research is to proceed with a 2SLS instrumental variable regression, in that regard we report in Table 3 the first-stage regression results of our model.

Table 3: First stage regressions. Dependent variable is the inequality index measuring distribution of land across population in 1970, $LGini_{1970}$

	(1)	(2)	(3)
nwp_{1872}	0.169***		0.155***
	(0.027)		(0.029)
nai_{1872}		−0.397***	−0.170
		(0.116)	(0.121)
Constant	0.625***	0.735***	0.636***
	(0.017)	(0.005)	(0.019)
Obs.	472	472	472
R_2	0.077	0.024	0.081
Adj. R^2	0.075	0.022	0.077
RSS	0.094(df = 470)	0.096(df = 470)	0.094(df = 469)
F Statistic	39.401***(df = 1;470)	11.683***(df = 1;470)	20.740***(df = 2;469)

Note: Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$ are used as the significance threshold, respectively. nwp_{1872} is the percentage of non-white and nai_{1872} is the percentage of non-African immigrants in the general population in 1872.

We got our instruments from the 1872's Brazilian census, where nwp_{1872} is the percentage of non-whites and nai_{1872} is the percentage of non-African immigrants, both in the general population in 1872. Our baseline assumption is the fact these variables are exogenous with respect to the economic growth in our period of analysis but shape the long-run land inequality in Brazil. According to these outcomes, there is a positive association between the percentage of non-whites in 1872 and the land Gini index in 1970, and a negative association between the percentage of non-African immigrants in 1872 and the land Gini index in 1970. Taking this into consideration, we proceed with our second stage regression using those variables as instruments for the land Gini index. In Table 4 we report the second stage regression outcomes. We run three specifications, model (1) in which the instrument for the land inequality is the percentage of non-whites in 1872, model (2) in which the instrument for the land inequality is the percentage of non-African immigrants in 1872, and, finally, model (3) in which we use both instruments. Model (1) is the best fit since the instrument pass both the Stock-Yogo criterion and the Wu-Hausman criterion concerning the instrument identification. In this model, the land inequality coefficient is negative and statistically significant, suggesting a long-run negative relationship between land inequality and growth among minimal comparable areas in Brazil. All the rest of the coefficients have the expected signal, negative for the initial income, positive for the initial level of education, negative for the initial rate of illiteracy, and negative for the percentage of the population living in rural areas. Among the control variables, only the initial level of education ($\log(educ)_{1970}$) is not statistically significant. Model (2) has similar coefficient signals but does not pass the StockYogo criterion and the Wu-Hausman criterion. Model (3) also have similar coefficient signal outcomes but pass the Stock-Yogo criterion only for the critical value equal to 15%. We can infer from these results that land inequality has an important role as one of the causes of the economic long-run performance in Brazil, impacting economic growth negatively among minimal comparable areas between 1970 and 2010.

Table 4: 2SLS regressions. Dependent variable is the log-growth rate between 1970 and 2010, $\Delta\log(inc)$.

	(1)	(2)	(3)
$LGini_{1970}$	-3.725^{***}	-1.692^{*}	-3.478^{***}
	(0.711)	(0.962)	(0.655)
$\log(inc)_{1970}$	-0.570^{***}	-0.430^{***}	-0.553^{***}

	(0.067)	(0.073)	(0.063)
$\log(educ)_{1970}$	0.087	0.036	0.080
	(0.082)	(0.059)	(0.078)
ill_{1970}	−0.271*	−0.057	−0.245
	(0.160)	(0.139)	(0.151)
rur_{1970}	−0.750***	−0.406**	−0.708***
	(0.175)	(0.184)	(0.164)
Constant	7.224***	4.717***	6.919***
	(0.929)	(1.203)	(0.858)
Obs.	471	471	471
RSS (df = 465)	0.342	0.230	0.324
CD statistic	28.14***(df = 1;465)	6.68***(df = 1;464)	14.98***(df = 2;464)
Wu-Hausman	44.71***(df = 1;465)	0.75(df = 1;464)	39.29***(df = 1;464)
Sargan	–	–	2.296
SY crit. value (0.10)	16.38	16.38	19.93
SY crit. value (0.15)	8.96	8.96	11.59

Note: Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$ are used as the significance threshold, respectively. $\log(Gini)_{1970}$ is the inequality index measuring distribution of land across population. $\Delta\log(inc)$ is the income per capital growth between 1970 and 2010. $\log(inc)_{1970}$ and $\log(h)_{1970}$ are respectively the log of income and the log of human capital in 1970. ill_{1970} is the illiteracy rate in 1970 and rur_{1970} is percentage of the rural population in 1970. CD statistic is the Cragg-Donald F-Statistic for weak instruments. SY crit. value is the Stock and Yogo's maximum rejection rate of the (true) null hypothesis.

6. Conclusion

In this paper, we investigate the impact of land inequality on economic growth among Brazilian minimal comparable areas using a growth regression approach. Despite the absence of consensus in this literature, our motivation assumption is the fact that the initial level of wealthy inequality can drive the incentives in different directions, at the same time shaping the institutional setup.

We set our growth regression with data from the Brazilian populational Census of 1970 and 2006 and from the Census of Agriculture in 1970, using the land Gini index as our wealthy inequality variable. Since the number of municipalities has increased during this period, we use a minimal comparable areas approach to make it possible to homogenize the unit of analysis. This was also useful to deal with the endogeneity problem by using an instrumental variable 2SLS approach with instrumental variables from the 1872 Brazilian Census. Both the OLS model as well as the IV estimator results suggest a negative relationship between economic growth and land inequality in the Brazilian comparable areas for the period 1970 to 2010.

This result confirms some of the historical intuition about the role of land ownership as one of the things driving the unequal development in Brazil. From a normative point of view, this means that public policies which try to mitigate land concentration could also improve the long-run economic performance.

References

Acemoglu, D. & Robinson, J. A. (2008), ‘Persistence of power, elites, and institutions’, *American Economic Review* **98**(1), 267–293.

Acemoglu, D., Bautista, M. A., Querub´ın, P. & Robinson, J. A. (2008), *Economic and Political Inequality in Development: The Case of Cundinamarca, Colombia*, 1 st ed., Harvard University Press, Cambridge, pp. 181–245.

Acemoglu, D., Johnson, S. & Robinson, J. A. (2001), ‘The colonial origins of comparative development: an empirical investigation’, *American Economic Review* **91**(5), 1369–1401.

Acemoglu, D., Johnson, S. & Robinson, J. A. (2002), ‘Reversal of fortune: geography and institutions in the making of the modern world income distribution’, *The Quarterly Journal of Economics* **117**(4), 1231–1294.

Alesina, A. & Rodrik, D. (1994), ‘Distributive politics and economic growth’, *The Quarterly Journal of Economics* **109**(2), 465–490.

Barro, R. J. (2000), ‘Inequality and growth in a panel of countries’, *Journal of Economic Growth* **5**(1), 5–32.

Barro, R. J. & Sala-i-Martin, X. (1992), ‘Convergence’, *Journal of Political Economy* **100**(2), 223–251.

Bowles, S. (2004), *Microeconomics: behavior, institutions, and evolution*, The Roundtable Series in Behavioral Economics, Princeton University Press, chapter Credit Markets, Wealth Constraints, and Allocative Inefficiency, pp. 299–330.

Brueckner, M. & Lederman, D. (2018), ‘Inequality and economic growth: the role of initial income’, *Journal of Economic Growth* **23**(3), 341–366.

Bénabou, R. (1996), Inequality and growth, *in* ‘NBER Macroeconomics Annual 1996, Volume 11’, NBER Chapters, National Bureau of Economic Research, Inc. URL https://ideas.repec.org/h/nbr/nberch/11027.html.

Cass, D. (1965), ‘Optimum growth in an aggregative model of capital accumulation’, *Review of Economic Studies* **32**(3), 233–240.

Chen, S. & Ravallion, M. (2021), ‘Reconciling the conflicting narratives on poverty in China’, *Journal of Development Economics*.

Cipollina, M., Cuffaro, N. & D‘Agostino, G. (2018), ‘Land inequality and economic growth: a meta-analysis’, *Sustainability* **10**(12), 1–20.

CNE (1962), Conselho nacional de economia. Exposição geral da situação econômica do Brasil, Technical report, CNE-Brasil.

Colistete, R. & Lamounier, M. L. (2014), Land Inequality in a Coffee Economy: São Paulo During the Early Twentieth Century, Technical report, University of São Paulo (FEAUSP).

Ehrl, P. (2017), ‘Minimum Comparable Areas for the period 1872-2010: an aggregation of Brazilian municipalities’, *Estudos Econômicos (São Paulo)* **47**, 215–229.

Engerman, S. L., Sokoloff, K. L., Urquiola, M. & Acemoglu, D. (2002), ‘Factor endowments, inequality, and paths of development among new world economies [with comments]’, *Econom´ıa* **3**(1), 41–109. URL http://www.jstor.org/stable/20065432.

Fort, R. (2007), ‘Land inequality and economic growth: a dynamic panel data approach’, *Agricultural Economics* **37**(2-3), 159–165. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1574-0862.2007.00262.x.

Frankema, E. (2010), ‘The colonial roots of land inequality: geography, factor endowments, or institutions?’, *The Economic History Review* **63**(2), 418–451.

Funari, P. P. P. (2017), *Inequality, Institutions, and Long-Term Development: A Perspective from Brazilian Regions*, Springer International Publishing, Cham, pp. 113–142. URL https://doi.org/10.1007/978-3-319-44621-9_6.

Galor, O., Moav, O. & Vollrath, D. (2009), 'Inequality in landownership, the emergence of human-capital promoting institutions, and the great divergence', *Review of Economic Studies* **76**(1), 143–179. URL https://EconPapers.repec.org/RePEc:oup:restud:v: 76:y:2009:i:1:p:143-179.

Huang, H.-C., Lin, Y.-C. & Yeh, C.-C. (2012), 'An appropriate test of the Kuznets hypothesis', *Applied Economics Letters* **19**, 47–51.

Koopmans, T. (1963), On the concept of optimal economic growth, Cowles Foundation Discussion Papers 163, Cowles Foundation for Research in Economics, Yale University.

Kuznets, S. (1955), 'Economic growth and income inequality', *The American Economic Review* **45**(1), 1–28.

Nunn, N. (2008), *Slavery, Inequality, and Economic Development in the Americas: An Examination of the Engerman-Sokoloff Hypothesis*, Harvard University Press, Cambridge, pp. 148–180.

Prado Junior, C. (1979), *A questão agrária. São Paulo: Brasilense*, Brasilense.

Ramcharan, R. (2010), 'Inequality and redistribution: Evidence from u.s. counties and states, 1890-1930', *The Review of Economics and Statistics* **92**(4), 729–744. URL http://www.jstor.org/stable/40985790.

Smith, R. (1990), *Propriedade da Terra Transição: estudos da formação da propriedade privada da terra e transição pêra o capitalismo no Brasil*, Brasilense.

Solow, R. M. (1956), 'A contribution to the theory of economic growth', *The Quarterly Journal of Economics* **70**(1), 65–94.

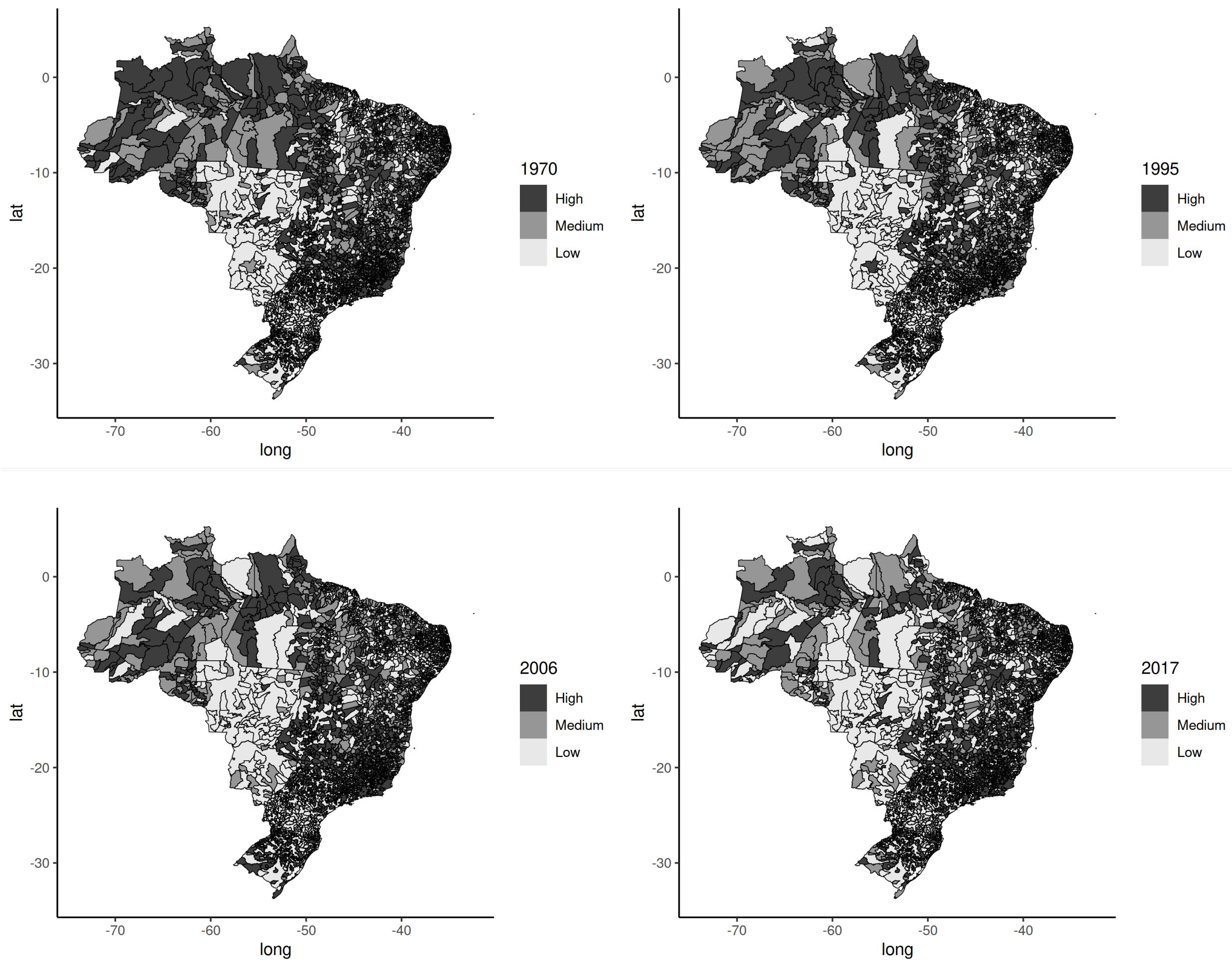
Summerhill, W. (2010), Colonial Institutions, Slavery, Inequality, and Development: Evidence from São Paulo, Brazil, MPRA Paper 22162, University Library of Munich, Germany. URL https://ideas.repec.org/p/pra/mprapa/22162.html.

Vieira Junior, I. (2019), *Torto Arado*, Todavia.

Wegenast, T. (2010), 'Cana, café, cacau: agrarian structure and educational inequalities in brazil', *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* **28**(1), 103–137.

Appendix

Figure 4: Land inequality in different years
(Brazilian minimal comparable areas for the period 1970–2010)



Source: Authors' calculation using IBGE's data.