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Housing, Inequality and Economic Growth: Evidence from a Sample of Brazilian States

Vittoria Manzoli[1] | António Portugal Duarte[2] | Marta Simões[2*]

[1] Faculty of Economics, University of Coimbra, Coimbra, Portugal
[2] CeBER and Faculty of Economics, University of Coimbra, Coimbra, Portugal

ABSTRACT

This paper investigates the inequality-growth nexus using state-level data for Brazil from 2005 to 2013 and considers that the housing deficit better reflects inequality in the Brazilian economy, a highly unequal country. We estimate a growth regression where the housing deficit is the main explanatory variable taken alongside other control variables. The findings point to the existence of a negative linear association between the housing deficit and the growth rate of real GPD per capita across the 27 Brazilian states, with a higher explanatory power relative to the regressions that use the Gini index. The association is also stronger for the sample of richer states. Other statistically significant regressors include initial income and human capital/education. Our findings endorse investing in housing as a potential important means for fighting inequality and promoting faster economic growth in Brazil. Attention should also be given to broadening access to higher quality utilities such as electricity and sanitation. The promotion of universal access to education as a means to increase the human capital stock is also a path to achieve faster growth in Brazil.

Key words: *housing inequality, economic growth, Brazilian states, panel data*

JEL Classification: C23, O18, O40

INTRODUCTION

Brazil is a country with high contrasts in terms of income distribution, as evidenced in the United Nations Human Development Report (HDR), which identified the country as the ninth most unequal country in the world in 2017, a position based on the Gini Index that recorded a value of 0.549 in 2017. On the other hand, over the period 2000-2015, Brazil's real GDP per capita recorded an average annual growth rate of 1.7%, according to OECD Statistics. In this study we investigate whether Brazil could have grown faster if not for the high level of inequality.

According to the literature, the relationship between inequality and economic growth can be either negative or positive. Neves and Silva (2014) argue that there is no universal sign that applies to all countries at all times for the relationship between inequality and economic growth and so researchers and policymakers must take into account the specificities of each country or region. In any case, the sign of the effect of inequality on growth in less developed countries is in general negative and more intense and so policies aimed at reducing inequality in developing countries such as Brazil will likely have a positive impact on economic growth.

[*] Corresponding author, e-mail: mcsimoes@fe.uc.pt

One of the clearest expressions of inequality in the Brazilian case is access to housing, and so this study will focus on the relationship between the housing deficit and economic growth to gain a better understanding of the role of inequality on economic growth in this particular situation. Access to housing of adequate quality is essential to guaranteee the well-being of inidividuals. Lack of or inadequate housing can thus have repercussions in terms of labour force reproduction or the supply of goods and services, mainly because housing represents shelter, protection, and security. The debate on housing access in Brazil is necessary to understand and deal with inequalities that affect a large proportion of the population. A significant proportion of the Brazilian population sets as a main goal to own a house, because housing is seen as performing a social function, as a means to provide shelter for the family and assist in its development, besides being associated with success and social position.

This paper investigates the inequality-growth nexus using state-level data for Brazil from 2005 to 2013, retrieved from different sources, such as the Institute for Applied Economic Research (IPEA) and the Brazilian Institute of Geography and Statistics (IBGE) that make available census and national accounts data for the different states. We consider that the housing deficit, computed by Fundação João Pinheiro (FPJ), better reflects inequality in the Brazilian economy, a highly unequal country. Albeit over the past decade targeted income and social inclusion policies managed to achieve a reduction in inequality, it remains high and so it is important to assess the potential growth benefits from inequality reduction using indicators that enable the design of more precise and effective policies. The empirical formulation adopted corresponds to a growth regression where the housing deficit is the main explanatory variable taken alongside other control variables. This indicator measures housing shortages at the state level relative to the total population of a state. In its calculation, the housing deficit considers any housing in which one of the following occurs: precarious housing; different families' cohabitation; excessive rent burden; or excessive number of dwellers in rented housing.

The remainder of the paper is organized as follows. In the next section we carry out a brief review of the literature on the relationship between income inequality and economic growth. Section 3 presents the empirical model and the estimation methodology. The variables selected and a brief descriptive analysis of the data are presented in section 4. Section 5 presents and discusses the results and policy implications. Section 6 concludes.

LITERATURE OVERVIEW

How does inequality affect a country's economic growth performance? The relationship between inequality and economic growth can be either positive or negative and the results from the vast empirical literature on the subject to date, such as Barro (2000), also show considerable ambiguity.

Several researchers have analysed the relationship between inequality and economic growth taking into account different transmission channels in order to gain a better understanding on the sign, as reviewed by Neves and Silva (2014) and Neves, Afonso and Silva (2016). While the aggregate savings and the R&D channels predict a positive impact of inequality on growth, other transmission channels point to a negative relationship, including: (i) credit constraints and associated barriers to the accumulation of human and physical capital; (ii) socio-political instability; (iii) redistribution and associated high tax burdens; and (iv) joint education and fertility decisions. Some of the possible explanations for the negative effects are: (a) in the presence of strong credit constraints, the poorest population will not be able to invest in physical and human capital, mainly because they have few (if any) guarantees to give as collateral for obtaining credit (Barro, 2000); (b) inequality may increase the risk of political instability, with negative investment outcomes. For instance, when inequality is accompanied by low rates of social mobility, people may be attracted to criminal practices rather than formal work or education, and high crime rates may lead to lower investment as the enforcement of

property rights is weakened and since they create uncertainty (Gründler and Scheuermeyer, 2018); (c) income redistribution policies, if common in more unequal countries, may lead to the need to increase the tax burden and the transfer of resources from the richest to the poorest, possibly discouraging labour supply and effort and investment by firms; and (d) finally, Gründler and Scheuermeyer (2018) suggest that the most unequal societies tend to have high fertility rates and low levels of education because the poorest cannot afford to invest in their children's education and they regard children as a chance to increase family income. By contrast, richer families are willing to have fewer children and invest more in their education. As for the possible positive effect of inequality on economic growth through aggregate savings, according to Gründler and Scheuermeyer (2018), Kaldor (1955) argued that inequality stimulates growth as the marginal propensity to save increases with the income level and so the richest save a higher fraction of their income, increasing investment and in this way growth. The positive effect of inequality on economic growth is also revealed through the demand side. More unequal income distributions increase the demand for high quality products such as luxury goods and high-tech products, and not just for basic needs, for a given price increase. When the price effects outweigh market size effects, innovative companies are favoured by the presence of those that are willing to pay higher prices for new products, and thus inequality can stimulate R&D, a main driver of economic growth (Halter et al., 2014). Identifying the impact of inequality on economic growth is thus an empirical issue, which has been the subject of extensive research.

At the empirical level it is possible to find studies that obtain a negative effect of inequality on growth, results that are in turn contradicted by a significant number of other studies that arrive at a positive effect. Neves and Silva (2014) suggested, based on a comprehensive survey of this literature, that differences in estimation methods, the quality of the data collected and sample coverage may influence the relationship between inequality and growth obtained by different empirical studies. Neves, Afonso and Silva (2016) conducted a meta-analysis of the empirical literature that estimates the relationship between inequality and growth based on a reduced form regression, i.e. studies that seek to identify the direct impact of inequality on growth. The main results and conclusions drawn support different impacts of inequality on growth, highlighting that: (i) the impact is negative and stronger in developing countries relative to richer countries; (ii) inequality in wealth distribution has a stronger negative impact on growth than inequality in income distribution, possibly due to the fact that the relevant transmission channels in action in the two types of distribution are not the same, and therefore policies focusing on reducing inequality in developing countries will be more likely to have a positive impact on growth. Income inequality refers to the discrepancy in income distribution among holders of productive factors or between individuals and is mainly due to unemployment, low paid jobs or a high wage pay gap, common in developing countries. Inequality in the distribution of wealth is measured based on the distribution of productive factors, human capital, physical capital, or on the distribution of real and financial assets (Castelló and Doménech, 2008). In the presence of wealth inequality, the less favoured will be less likely to make investments in productive factors, such as human and physical capital, and will prefer direct income transfers over investment. This scenario possibly leads the government to increase taxation so that infrastructure and other productive public investments can be carried out, for example.

For the Brazilian case, two recent empirical studies on the relationship between inequality and growth are Cruz et al. (2015) and Bessaria et al. (2018). Cruz et al. (2015) investigate the link based on data for the 27 Brazilian states over the period 1995-2009. By focusing on Brazil at the state level it is possible to overcome some of the data comparability issues involved in cross-country studies, especially as far as inequality is concerned. The growth regression estimated by the authors considers a non-linear relationship between inequality and growth by including both a linear and a quadratic term of the Gini index of income distribution, alongside other control variables such as initial income per capita, the crime rate, schooling, fertility, life expectancy, openness and state intervention. The results using the System-GMM estimator point to a positive relationship between inequality and growth in the richer states and the opposite

applies in the poorer states. Another important growth determinant in the case of the Brazilian States according to the authors is educational attainment. In Bessaria et al. (2018) the main explanatory factors of output growth rate differences across Brazilian states are income inequality and education. Using state level data for the period 1990-2014 to estimate a growth regression, the authors conclude that additional years of education positively affect economic growth and, by contrast, income inequality, measured by the Gini index, has a negative growth impact. The data used, besides real GDP per capita and the Gini index, included investment (capital expenditure), political instability (homicides rate), openness and regional dummies. Bessaria et al. (2018) also show that, during this period, there was a reduction in income inequality at the national level and, following the trend of the Brazilian economy, all of its macro-regions (recorded a reduction in income inequality, higher in the Southern regions. The authors additionally carried out cointegration tests in a panel data context and concluded that there is a long run relationship between real GDP per capita growth, the Gini index and educational attainment at the state level.

For the specific case of Brazil, what the study by Bessaria et al. (2018) suggests is that inequality is likely to have a negative impact on economic growth, even though the empirical literature has not reached a consensus on this issue. Brazil is characterized by strong social contrasts, high income inequality and a poorly educated population. Their paper investigates the inequality-growth nexus at the state level for Brazil considering as a proxy for inequality the housing deficit. Brazil is frequently in the spotlight for the lack of domestic security and the large number of "favelas" where violent episodes frequently occur. The choice of the housing deficit as a proxy for inequality in Brazil is due to the importance of housing in terms of providing individuals with better living conditions, thus improving other important factors for the well-being of people, such as health and educational outcomes. The big inequality levels in the country resulted in the exclusion of the poor, who are deprived of some basic rights, such as access to decent quality housing and consequently greater security. Access to decent housing is a right of every citizen inscribed in the Brazilian Constitution and, in addition, housing investment is able to deliver benefits not only to the low-income population but also to the country as a whole, if it is able to promote economic growth.

EMPIRICAL STRATEGY AND DATA

To investigate the link between inequality and economic growth in Brazil we use data for the 27 states that compose this country. Limited time coverage for our explanatory variable of interest, the housing deficit, for some states implied that the analysis concentrates on the period 2005-2013. In this way we have data for the 27 states observed over two 4-years sub-periods (2005-2009 and 2009-2013) in order to overcome to some extent business cycle effects, as is usual in empirical studies of economic growth. The panel is balanced with 2 observations for each of the 27 states, which gives a total of 54 observations.

The baseline empirical model is given by equation (1):

$$GrGDP\ pc_{it} = \alpha \quad + \beta_1 lnGDPpc_{i;init} + \beta_2 \frac{Hous\_Def_{i;init}}{Pop_{i;init}} + \beta_3 School_{i;init} + \beta_4 Inv_{it} + \beta_5 GrPop_{it} + \varepsilon_{it} \qquad (1)$$

According to equation (1), economic growth depends on initial output, the accumulation of factors of production, physical and human capital, the population growth rate and inequality. The control variables included in the empirical model were selected taking into account the predictions of the augmented Solow model (Mankiw, Romer and Weil, 1992) and previous empirical studies on the relationship between inequality and growth (Forbes, 2000). The dependent variable, *GrGDPpc*, is the annual average growth rate of real GDP per capita, our measure of economic growth. Initial income, *lnGDPpc* measured at the beginning of each sub-period, intends to capture the possibility of convergence among the Brazilian states due to the

diminishing marginal returns assumption of exogenous growth models, according to which initially poorer states will grow faster and converge to the income levels of the richer states. The estimated coefficient on initial income per capita is thus expected to be negative. Also according the augmented Solow model, higher rates of accumulation of physical and human capital, measured respectively as the investment rate (*Inv*) and as the average years of schooling of the population aged 25 and above (*School*) are expected to lead to faster growth and so the respective estimated coefficients are expected to be positive. Finally, as far as control variables are concerned, faster population growth (*GrPop*) saps growth since the same amount of inputs has to be distributed across a higher number of workers and so the respective estimated coefficient is expected to be negative. Our explanatory variable of interest is inequality, proxied by the initial housing deficit per capita, $\frac{Hous\_Def}{Pop}$. Although the literature has not reached a consensus on the sign of the link between inequality and growth, the prevailing evidence for developing countries is that the relationship is negative and so we expect that the respective estimated coefficient is negative for Brazil, classified by the World Bank as an upper middle income country. α is the constant terms and ε_{it} the error term. Table 1 contains a description of the variables used and respective sources.

Table 1. Variables and sources

Notation	Description	Source
GrGDPpc	Annual average growth rate of real GDP per capita for each 4-years sub-period	IPEA
lnGDPpc	Log of real GDP per capita at the beginning of each 4-years sub-period.	IPEA
$\frac{\text{Hous\_Def}}{\text{Pop}}$	Shortage or inadequate housing per capita at the beginning of each 4-years sub-period.	Fundação João Pinheiro and IBGE
School	Average years of schooling of the population aged 25 and above at the beginning of each 4-years sub-period	IPEA
Inv	Annual average investment rate for each 4-years sub-period. Due to limited data availability at the state level the proxy used corresponds to public capital expenditure as a percentage of GDP.	Brazilian Ministry of Finance (Ministério da Fazenda)
GrPop	Annual average growth rate of the population for each 4-years sub-period.	IBGE
GINI	Gini index of the distribution of personal income at the beginning of each 4-years sub-period.	IPEA

Concerning the data used, it is important to look in some detail at the indicator chosen to measure inequality in Brazil, the housing deficit, calculated annually by Foundation João Pinheiro (FJP), in a partnership with the Ministry of Cities, the Inter-American Bank for Development Bank (IDB) and the United Nations Development Program (UNDP). The protocol signed between the FJP and the federal government is relatively recent, 1995, and the main objective is to calculate the Brazilian housing deficit and improving its calculation methodology. But it was from 2003 onwards, with the creation of the Ministry of Cities, that the computation and analysis of such indicator gained more importance. Based on the calculations of the housing deficit, the central government makes decisions on housing policies, housing subsidies, sanitation and urban transport (FJP, 2014). Indeed, the main objective of the housing deficit indicator is to guide those responsible for the implementation of public policies and programs reduce this deficit. This indicator can measure and track the development and progress of

housing policies adopted by the government, and inform policy makers on the need for government action.

The indicator of the housing deficit that will be used in this work is directly related to housing shortages. The housing deficit can be understood in two ways: the deficit due to the need for an increase in the stock of housing and the deficit due to the need to replace the depreciation of the existing stock. The first component is due to lack of housing and the second component is due to the need to replace existing decaying housing. The calculation of the housing deficit is the result of the sum of four elements: precarious housing, family cohabitation, excessive rent burden and excessive density. These elements are presented in Table 2 below. The calculation methodology used by the FJP ensures that double counting does not occur.

Table 2. Components of the housing deficit

1. Precarious Housing
1.1. Improvised housing
Usually located in a building that was not built exclusively for housing, as well as places considered unsuitable for housing which are occupied for this purpose.
1.2. Rustic housing
Housing not made of masonry or paired wood. The dominant material is usually uncoated mud, reused wood, etc.
2. Family Cohabitation
2.1. Rooms
According to the IBGE "rooms are private housing consisting of one or more rooms located in a casa de cômodo, cortiço, cabeça-de-porco, etc."
2.2. Cohabiting Families
Families living in the same house, with the intention of constituting their own / separate home.
3. Excessive Rental Burden
Rent is considered excessive when the household spends 30% or more of its income to pay for the rental of housing. (Households with incomes above three minimum wages are not included in this indicator).
4. Excessive Density in Rented Households
Excessive density occurs when permanent private rented housing has more than three inhabitants per room.

Source: based on information from IBGE and Fundação João Pinheiro.

Table A.1 in the appendix contains descriptive statistics for real GDP per capita for the 27 Brazilian states between 2005 and 2013. The highest real per capita GDP recorded was that of the Federal District in 2013, corresponding to a value of 63.05 thousand reais (the Brazilian currency). In contrast, the lowest real GDP per capita recorded during this period was in the state of Piauí in 2005 (5.63 thousand reais), located in the Northeast region of Brazil. For the total sample (27 states) the average real GDP per capita was 17 thousand reais. Table A.2 in the appendix contains descriptive statistics for the annual average growth rate of real GDP per capita for the two sub-periods under analysis, 2005-2009 and 2009-2013. The state of Pará, located in the North part of Brazil, recorded the lowest growth rate, 0.86% in 2005- 2009. The state of Paraná, located in the South part of Brazil, recorded the highest growth rate, 12.81%, 2009-2013.

As far as the explanatory variable of interest is concerned, Figures 1 and 2 in the appendix show that over the period 2000-2015, for five Brazilian regions and for Brazil as a whole, respectively, although the housing deficit is still considerable it recorded a slight improvement

during this period. The total Brazilian housing deficit went from 7,222,644 in 2000 to 6,355,743 in 2015, a reduction of about 12%. As shown in table A.3 in the appendix, the state with the largest housing deficit in this period was São Paulo (1510463 units in 2005). The fact that this number is so high for São Paulo is associated with the fact that São Paulo is the most populous state over the period. São Paulo was the only state that in 2015 recorded a housing deficit that exceeds one million houses (1.337 million), and of the total housing deficit for this specific year, 48% (639 thousand houses) is located in the metropolitan region of São Paulo. Also for the year 2015, Minas Gerais recorded the second largest housing deficit, 575 thousand units, followed by Bahia, with a deficit of 461 thousand units. Throughout the sample period, the state with the lowest total housing deficit was Roraima, with 13799 units in 2008.

RESULTS

We first applied three diagnostics tests, the F-test, the Breusch-Pagan test and the Hausman test, to choose between pooled OLS, fixed effects or random effects estimation methodologies. Pooled OLS assumes that the units under analysis behave in exactly the same way and so the constant term and the estimated coefficients in equation (1) are common to all the 27 states over the 2 sub-periods for which they are observed. If this assumption is not correct and the model suffers from ommitted variable bias then the results are not robust. Fixed effects considers that the behaviour of real GDP per capita can differ across the 27 states due to specific features that remain constant over time, which is translated in a different intercept for each cross section unit. With random effects these specific characteristics of each cross-section unit are also taken into account, but are not considered constant over time (they are random), so heterogeneity is included in the error term. Table 3 presents the results of the three diagnostic tests based on the estimation of equation (1). The F-test considers as the null hypothesis that pooled OLS is the adequate estimation procedure against fixed effects. The Breusch-Pagan test considers as the null hypothesis that pooled OLS is the adequate estimation procedure against random effects. Finally, the Hausman test considers as the null hypothesis that fixed effects is the adequate estimation procedure against random effects. According to the results presented in Table 3, the p-value for the F-test does not allow us to reject pooled OLS as the adequate estimation procedure at the usual significance levels since it is higher than 10%. On the other hand, the Hausman test tell us that we cannot reject fixed effects as the most adequate estimation procedure relative to random effects. In this case, it is thus not necessary to perform the Breusch-Pagan test since transitivity of results from the former two tests implies that pooled OLS is the most adequate estimation procedure relative to fixed effects and random effects. We thus proceeded with the estimation of our empirical model using pooled OLS.

Table 3. Results of the diagnostics tests to select the appropriate panel estimation procedure

Test	Statistic	p-value
F	F(26, 22) = 1.5925	0.1355
Breusch-Pagan	---	---
Hausman	H = 73.4513	1.95744e-014

Source: authors' computations using the econometric package Gretl.

Table 4 contains the results of the estimation of the baseline regression given by equation (1) using pooled OLS. As can be seen in column (1), the housing deficit adjusted for population size presents a negative and statistically significant coefficient at the 1% significance level. This result confirms, at least in qualitative terms, the results observed in Neves, Afonso and Silva (2016), which concluded that the effect of inequality on output growth is negative in developing countries. The signs of the estimated coefficients for most of the control variables also confirm the theoretical predictions. Initial real per capita GDP presents a negative contribution to real

per capita GDP growth, which suggests conditional convergence between the Brazilian states. The estimated coefficient for the level of education is positive and statistically significant as expected. In the case of the population growth rate, the estimated coefficient is negative as expected, but not statistically significant. In the case of the investment rate, the estimated coefficient is negative, contrary to theoretical predictions, but it is not statistically significant, suggesting that the accumulation of physical capital is not a relevant source of growth for the Brazilian states, contrary to what happens with the accumulation of human capital.

Next we carried out a sensitivity analysis of the results to the consideration of the standard measure of inequality, the Gini index of income distribution. Again the diagnostic tests results point to pooled OLS as the most adequate estimation procedure (results available from the authors). Table (4), column (2), contains the results using the Gini index. As can be seen, the estimated coefficient for the Gini index is also negative, although not statistically significant. It is also important to note that the explanatory power of the model is now smaller: the adjusted R^2 decrease to around 22% and the value of the Akaike information criterion is higher, when the best model is the one that minimizes this value. In summary, the results using the housing deficit are more robust than the results using the Gini index. These results are in accordance with those reported in Neves, Afonso and Silva (2016), according to which the negative growth impact of an unequal distribution of wealth is stronger than the negative growth impact of an unequal income distribution. We can think of the housing deficit as closer to a measure of inequality in the distribution of wealth, while the Gini index used is a measure of inequality in the distribution of income.

Table 4, columns (3) and (4), presents the results of accommodating the possibility of a nonlinear relationship between inequality and economic growth in the form of an inverted U so that an increase in inequality may increase the pace of economic growth up to a certain level beyond which additional increases in inequality become detrimental to growth. To capture this effect, a quadratic term of the inequality measure was introduced, in addition to the linear term. Table 4, columns (3) and (4), contain the estimation results by alternatively considering the housing deficit or the GINI index as measures of inequality and again using the pooled OLS method. As can be seen, the estimated coefficients of both linear and quadratic inequality terms are not statistically significant, regardless of the inequality measure considered, thus not confirming the existence of a nonlinear relationship. Note that the explanatory power of the models also seems to decrease based on the lower adjusted R^2 value, while the information criteria values are higher than for the linear models.

To overcome, to some extent, the possibility of omitted variable bias we further estimated our empirical model with the inclusion of regional dummies. The dummies correspond to the five Brazilian macro-regions: North, Northeast, Midwest, Southeast and South. The dummies allow us to capture specific regional effects, which may have been ignored before, such as effects of differences in violence, culture, regional institutions, among others. The regression includes only four of the dummies (regions), North, Northeast, Southeast, and Midwest, due to the obvious linear dependency problems that the inclusion of a fifth dummy would cause. The results show that only the dummy for the North region presents a negative estimated coefficient, as can be seen in Table 4, columns (5) and (6). Moreover, none of the dummies revealed a statistically significant coefficient.

Table 4. Results for the whole sample (Pooled OLS)

	(1)	(2)	(3)	(4)	(5)	(6)
Const	0.0987*** (0.0306)	0.1205 (0.0798)	0.0983*** (0.0334)	−0.2852 (0.8873)	0.1018 (0.0477)	0.1655 (0.0813)
LnGDPpc	-0.095*** (0.0223)	-0.093*** (0.0244)	−0.0951*** (0.0225)	−0.0912*** (0.0251)	-0.1149*** (0.0275)	-0.1063*** (0.0313)
School	0.0379*** (0.0102)	0.0408*** (0.0112)	0.0379*** (0.0104)	0.0407*** (0.0113)	0.0449 (0.0105)***	0.0472 (0.0115)***
Inv	-0.0283 (0.0364)	-0.0442 (0.0395)	−0.0284 (0.0372)	−0.0470 (0.0403)	-0.0152 (0.0363)	-0.0320 (0.0396)
GrPop	0.1449 (0.4966)	-0.1109 (0.5382)	0.1442 (0.5023)	−0.071 (0.5497)	0.3262 (0.5319)	0.0412 (0.5926)
Def_House	-0.993*** (0.2959)		−0.9643 (0.9375)		-1.0389 (0.2974)	
Def_House^2			−0.3407 (10.394)			
GINI		-0.1476 (0.1271)		1.325 (3.209)		-0.2626 (0.1600)
GINI^2				−1.3463 (2.9322)		
Dum_North					-0.0169 (0.0185)	-0.0116 (0.0228)
Dum_Northeast					0.0059 (0.0204)	0.0178 (0.0276)
Dum_Southeast					0.0075 (0.0153)	0.0111 (0.0176)
Dum_Centre-West					0.0149 (0.0163)	0.0178 (0.0196)
R^2	0.4092	0.2905	0.4093	0.2937	0.4879	0.3835
Adjusted R^2	0.3477	0.2166	0.3339	0.2036	0.3830	0.2574
F- stats (p-value)	0.000089	0.0045	0.00025	0.0092	0.000233	0.0065
Akaike	-223.6166	-213.729	−221.618	−211.971	-223.3215	-213.3138
BIC	-211.6827	-201.796	−207.7	−198.05	-203.432	-193.424
Hannan-Quinn	-219.0142	-209.127	−216.248	−206.602	-215.6508	-205.6430

*Notes: standard errors in parenthesis. ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.*

Source: authors' computations using the econometric package Gretl.

We also analysed the sensitivity of the results obtained to the division of the sample according to the value of real GDP per capita in the year 2005, in accordance with the study by Brueckner and Lederman (2018), who concluded that the relationship between inequality and growth depends on initial income. The results of Brueckner and Lederman (2018) provide support for the assumption that income inequality is conducive to faster growth in poor countries, but is detrimental to growth in high to middle income economies. Regression with panel data was thus performed for two distinct samples: high and low income states. The sample was split based on the average real GDP per capita in 2005, equivalent to 12037 reais. The first sub-sample, which comprises the high income states, those with values of income per capita in 2005 above the average, contains 13 states (Amazonas, Federal District, Espírito Santo, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Rio de Janeiro , Rio Grande do Sul, Roraima, Sao Paulo, Santa Catarina); the second sub-sample comprises the low-income states, those with below

average intial income per capita, and contains 14 states (Acre, Alagoas, Amapá, Bahia, Ceara, Maranhão, Para, Paraiba, Pernambuco, Piaui, Rio Grande do Norte, Rondonia, Sergipe, Tocantins). The results obtained with the splitting of the sample are shown in Table 5. The three diagnostics tests were also applied and pointed to pooled OLS as the most adequate estimation procedure when using the housing deficit, columns (1) and (2), also for the high-income states of column (4) when using the GINI index, while for the low-income states when using the GINI index, column (3), the adequate estimation procedure is fixed effects. These results are available from the authors. The main take away from these results is that the housing deficit has a stronger negative association with growth in the initially richer states. Of course this result could be the consequence of reverse causality since richer states attract more people, which in turn results probably in a higher housing deficit. The other results remain basically unchanged.

Table 5. Results with the two sub-samples, 14 richest states and 13 poorest states (Pooled OLS/Fixed effects)

	(1) **14 richest states**	**(2)** **13 poorest states**	**(3)** **14 richest states**	**(4)** **13 poorest states**
Const	0.1266 (0.0501)	0.1534 (0.0898)	-0.3607 (0.7096)	-0.0157 (0.1605)
LnGDPpc	-0.1086*** (0.0346)	-0.1210** (0.0501)	0.0142 (0.2552)	-0.0741 (0.0742)
School	0.0433*** (0.0146)	0.0370** (0.0141)	0.0846* (0.0369)	0.0372** (0.0155)
Inv	-0.0313 (0.0595)	-0.0110 (0.0519)	0.7487* (0.3254)	-0.0383 (0.0543)
GrPop	1.4364 (0.7185)	-0.0051 (0.7469)	1.0334 1.0869	-0.3079 (0.7885)
Def_House	-2.1733*** (0.5218)	-0.8629* (0.4475)		
GINI			-0.5439 (0.5125)	0.0637 (0.2363)
R^2	0.6519	0.3593	0.4256	0.2535
Adjusted R^2	0.5649	0.2137	0.2820	0.0838
F-stat. (p-value)	0.00042	0.0641	0.0367	0.2321
Akaike	-112.7503	-110.8854	-99.7273	-106.6045
BIC	-105.2017	-102.8921	-92.1787	-98.6112
Hannan-Quinn	-110.5765	-108.4417	-97.5536	-104.1608

*Notes: standard errors in parenthesis. ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.*

Source: authors' computations using the econometric package Gretl.

Overall our results point to the housing deficit as an important policy instrument for public decision makers. Since public resources are scarce, it is very important to define priorities and accurate indicators are of paramount importance in order to avoid waisting scarce resources. In such an unequal context as is the case of Brazil, it is probably not efficient nor effective to

implement the same public housing policies across the states, with different income levels, as shown by the results presented in Table 5. The construction of new residential units seems of utmost importance to foster growth. A possible measure in this regard would be the financing of housing investments in a longer time horizon, thereby promoting access by low income households. Financing is essential for building new houses and also for maintaining the existing ones, as highlighted by Maricato (2017), p. 57, "Production because it is the immobilization of significant capital over a long period of time, and consumption because housing is a special, high-priced commodity that requires credit for its purchase." Improving Brazil's housing situation should not only be concerned with building new housing units, but also with helping the poorest people maintaining the existing ones. Stimulus packages for taking advantage of empty houses could also be used by the government, given the large number of empty houses because owners cannot find people who can pay the rent demanded or simply do not want to rent their houses. Policies that facilitate and encourage the renting market may also help to reduce Brazil's housing deficit and in this way promote growth.

CONCLUSION

In this paper we investigated the relationship between inequality and economic growth for Brazil using state-level data for the period 2005-2013 and focusing on the housing deficit as an indicator of inequality of opportunities, instead of the most often used Gini index of income distribution. According to the literature, inequality can have a negative growth effect through three main channles: it generates socio-political instability that reduces investment, increases the demand for redistribution which hurts incentives and in a context of credit market imperfections prevents the poor from investing. But a positive impact can also emerge if higher inequality creates incentives to work harder and with higher effort, innovate and if the rich have a higher propensity to save and there are investment indivisilities. For developing countries such as Brazil previous evidence points predominantly to a negative impact. The housing deficit can be seen as an indicator of wealth inequality, which previous literature as argued can be more important for the explanation of economic growth than income inequality since, quoting Islam & McGillivray (2019), pp.1-2 "(…) a negative growth effect of wealth inequality may be more noticeable than that of income inequality as wealth accumulates over time by generating its own income in terms of interests, dividends, rents, and capital gain and passing on between generations." It could also be the case that when national wealth is highly concentrated in a few elites there will be an increase in political rent-seeking, resulting in less productive investment decisions and barriers to the entry of new investors which will also slow down growth (Morck et al. (2000)). For instance, Deininger & Olinto (2000) find evidence that land inequality, a proxy for wealth inequality, has a relatively large significant negative effect on growth in a sample of 60 countries over the period 1960-1990, while income inequality reveals to have only a tenuous growth effect and in some cases with a positive sign. Also, the authors findings indicate that a highly unequal distribution of assets reduces the effectiveness of educational interventions. Our findings also revealed that the housing deficit is more strongly associated with the dynamics of real GDP per capita for the sample of Brazilian states over the period under analysis than the Gini index.

The evidence found of a growth-reducing impact of the housing deficit is of policy relevance in a number of aspects, supporting housing policy as a means to promote social inclusion, provide more equal chances to every citizen and stimulate economic growth. Housing policies should be designed to ensure adequate housing for all citizens and promote growth so that improving people's access to quality housing should become a priority. In Brazil, recent efforts in this direction have been made, for instance with the *Minha Casa Minha Vida* (My House My Life) program, which introduced financial subsidies through public banks for the purchase of the first house. However, little has been done by the government to subsidize the maintenance and depreciation of housing, which directly impacts the quality of the flow of services derived from

existing housing. In addition to facilitating people's access to funds to maintain their capital stock (housing), the government could set as a priority, whithin an economic growth agenda, the extension to the whole country of basic services, such as sanitation and electricity. Additionally, these policies can have spillover effects on human capital, another important determinant of the growth of real GDP per capita in our sample of Brazilian states according to our findings. Access to housing and of better quality can be an important determinant of the quality of the education received (learning outcomes) and the health status of the population. Especially at early stages of economic development, quality housing is highly correlated with the population's health conditions and even the quality of education. Therefore, policies aimed at expanding access to and the quality of housing should be a priority, not withstanding the need for other more direct measures aimed at reducing inequality in the wealth and income distributions, such as increasing the minimum wage, encourage higher savings rates among the poorer (e.g. through compulsory retirement plans), provide access to low-cost financial services (that can also facilitate home ownership) or investments in education.

The evidence presented in this paper should in any case be interpreted with some caution since it is based on a rather short period of time, which additionally did not allow us to control in a more precise way for the possibility of reverse causality. As more data on the housing deficit becomes available, in particular covering a longer time period, it will be possible to deal with these limitations.

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APPENDIX

Table A.1. Summary statistics for real GDP per capita, thousands of reais, 27 states, 2005-2013, constant 2002 prices

States	Average	Std. Dev.	Min.	Max.
Acre	11,41	1,70	9,40	14,78
Alagoas	8,18	1,76	6,61	11,29
Amapá	12,91	2,22	10,82	17,37
Amazonas	17,33	2,20	15,33	21,81
Bahia	10,73	1,54	9,27	13,62
Ceará	9,20	1,67	7,35	12,42
Distrito Federal	56,64	4,16	51,12	63,05
Espírito Santo	23,80	4,98	18,13	32,66
Goiás	16,83	3,71	13,47	23,52
Maranhão	7,21	1,39	5,81	9,96
Mato Grosso	20,54	3,91	16,26	28,04
Mato Grosso do Sul	18,52	4,32	14,41	26,75
Minas Gerais	18,05	3,00	15,13	23,70
Pará	10,98	2,03	9,30	15,15
Paraíba	8,57	1,76	6,89	11,85
Paraná	21,11	4,57	17,18	30,32
Pernambuco	10,98	2,31	8,76	15,33
Piauí	7,11	1,44	5,63	9,82
Rio de Janeiro	27,02	5,81	22,15	38,38
Rio Grande do Norte	10,87	2,30	8,98	15,27
Rio Grande do Sul	23,04	3,34	19,12	29,76
Rondônia	14,59	2,74	11,31	18,94
Roraima	14,18	2,04	12,04	18,46
Santa Catarina	25,29	3,52	22,04	32,33
São Paulo	30,04	5,10	24,36	39,28
Sergipe	11,97	2,29	9,75	16,09
Tocantins	12,09	2,09	9,73	16,10
Total	17,01	10,43	5,63	63,05

Source: authors based on data from IPEA.

Table A.2. Annual average growth rate of real GDP per capita, 2005-09 and 2009-13

States	Period	Annual average growth rate
Rondônia	2005-2009	4,60%
	2009-2013	5,88%
Acre	2005-2009	3,54%
	2009-2013	6,72%
Amazonas	2005-2009	0,90%
	2009-2013	7,23%
Roraima	2005-2009	2,80%
	2009-2013	6,91%
Pará	2005-2009	0,86%
	2009-2013	11,25%
Amapá	2005-2009	2,59%
	2009-2013	8,43%
Tocantins	2005-2009	4,03%
	2009-2013	7,56%
Maranhão	2005-2009	2,52%
	2009-2013	10,48%
Piauí	2005-2009	3,90%
	2009-2013	9,19%
Ceará	2005-2009	2,95%
	2009-2013	9,44%
Rio Grande do Norte	2005-2009	1,85%
	2009-2013	11,13%
Paraíba	2005-2009	2,31%
	2009-2013	10,83%
Pernambuco	2005-2009	2,90%
	2009-2013	10,56%
Alagoas	2005-2009	2,07%
	2009-2013	10,97%
Sergipe	2005-2009	3,09%
	2009-2013	8,61%
Bahia	2005-2009	1,33%
	2009-2013	7,54%
Minas Gerais	2005-2009	1,28%
	2009-2013	9,43%
Espírito Santo	2005-2009	2,82%
	2009-2013	9,53%
Rio de Janeiro	2005-2009	1,98%
	2009-2013	11,53%
São Paulo	2005-2009	2,93%
	2009-2013	8,13%
Paraná	2005-2009	1,52%
	2009-2013	12,81%
Santa Catarina	2005-2009	1,45%
	2009-2013	7,35%
Rio Grande do Sul	2005-2009	2,69%
	2009-2013	7,45%
Mato Grosso do Sul	2005-2009	3,05%
	2009-2013	12,21%
Goiás	2005-2009	2,48%
	2009-2013	11,07%
Mato Grosso	2005-2009	2,07%
	2009-2013	9,26%
Distrito Federal	2005-2009	1,57%
	2009-2013	2,87%

Source: authors based on data from IPEA.

Table A.3: Summary statistics for the Housing Deficit, units, 2005-2013

States	Average	Std. Dev.	Min.	Max.
Acre	25641.78	5011.24	18804.00	34054.00
Alagoas	104768.67	17064.99	84377.00	131963.00
Amapá	23451.78	6625.82	15546.00	35419.00
Amazonas	166549.89	26223.29	131574.00	212487.00
Bahia	477590.67	78827.16	379160.00	657555.00
Ceará	292796.33	55367.58	245951.00	424321.00
Distrito Federal	114963.33	10039.00	98269.00	126169.00
Espírito Santo	99232.89	15100.09	77033.00	125412.00
Goiás	184292.11	27276.73	145678.00	229488.00
Maranhão	430812.78	70407.48	274930.00	539571.00
Mato Grosso	90276.89	19653.12	66866.00	118889.00
Mato Grosso do Sul	78738.67	6855.49	65024.00	87182.00
Minas Gerais	528256.00	85922.57	431049.00	682432.00
Pará	316086.56	60371.95	256212.00	427327.00
Paraíba	121643.00	15083.21	101315.00	153320.00
Paraná	253781.67	43691.66	199633.00	325681.00
Pernambuco	286144.89	60138.47	236658.00	427923.00
Piauí	120979.78	21460.24	93316.00	165177.00
Rio de Janeiro	454335.89	87469.45	368098.00	596207.00
Rio Grande do Norte	116039.33	13126.68	97647.00	143319.00
Rio Grande do Sul	257215.11	57141.10	191189.00	368233.00
Rondônia	49683.22	12380.29	30579.00	71281.00
Roraima	19504.44	4309.01	13799.00	25237.00
Santa Catarina	156419.78	24458.30	128464.00	195947.00
São Paulo	1254420.11	181327.02	1032999.00	1510463.00
Sergipe	76520.33	10209.60	66445.00	99998.00
Tocantins	59464.00	11305.17	42706.00	82111.00
Total	**228133.70**	**253411.64**	**13799.00**	**1510463.00**

Source: authors based on data from Foudation João Pinheiro.

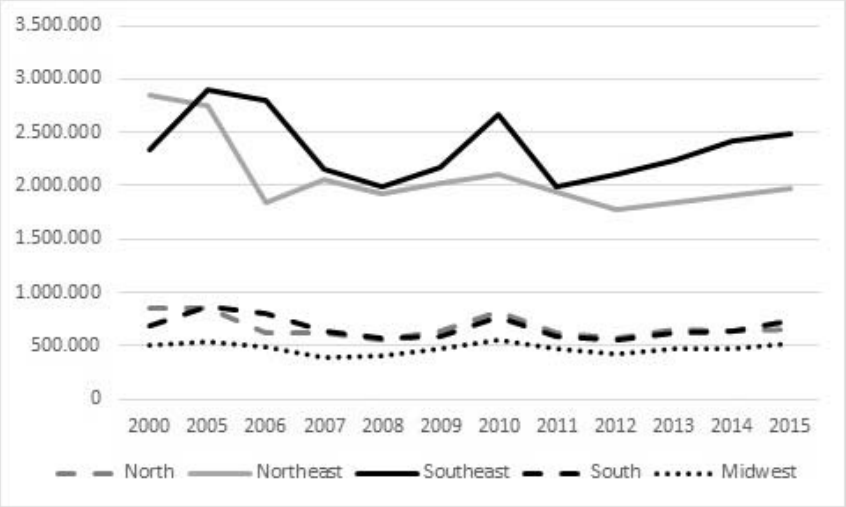

Figure 1. Housing deficit in 5 Brazilian regions, units, 2000-2015
Source: authors based on data from Foundation João Pinheiro

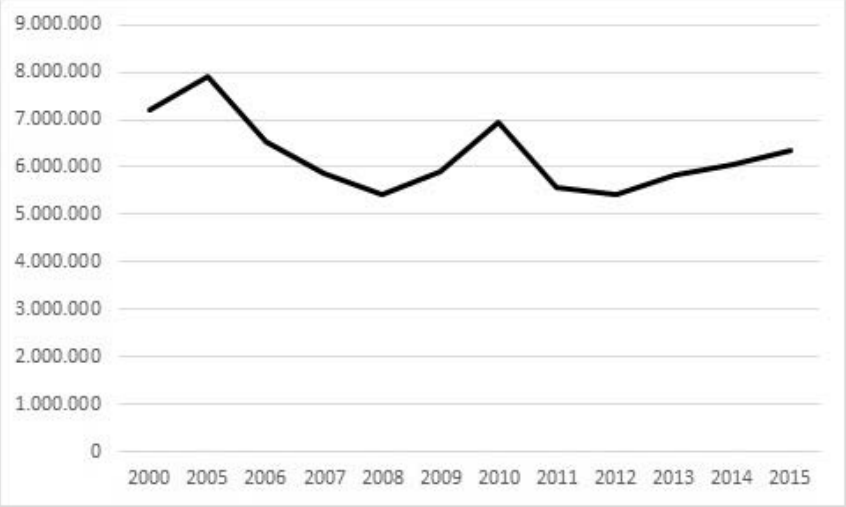

Figure 2. Housing deficit in Brazil, units, 2000-2015
Source: authors based on data from Foundation João Pinheiro

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