Income inequality and Economic Development: evidences from Brazilian Municipalities

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by

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1 Introduction

The relationship between economic development and income inequality has been widely discussed in literature. Kuznets (1955) initially argued that income inequality increases at an early stage of economic development while a country is developing and reaches a peak at a certain point. After this turning point, income inequality declines at advanced stages of economic development. There is a set of empirical research on the Kuznet curve, for instance, Dollar and Aart (2000), Thorton (2001), List Gallet (1999), and finally Mendes Adesida (2013).

Currently, Brazil, which is headed by the President Michel Temer, is facing a huge economic and political crisis. According with updated projections, the real GDP decreased 3.77% in 2015 and 3.5% in 2016. The economy is trying to recover from the two years of recessions, with a growth of 0.98% in 2017 and projected growth of 2.5% for 2018. During the last years a set of corruption cases have been reported in the media, which promoted a set of public manifestation across the country. In this scenario, a lot of political individuals have been prosecuted and convicted for corruption, including the former president Luiz Inácio Lula da Silva who was convicted for corruption and money laundering. During the last decade, a set of social policies have been implemented in order mitigate the problem of poverty across Brazil, for instance, the Program Bolsa Escola, the Program Bolsa Familia, among others. There are several criticisms related with the social programs implemented by the former President Lula da Silva. Data shows that these social projects have been lifting millions of peoples out of the poverty, however income inequality remains a huge social problem in Brazil. Hence, in this context, is important to investigate, with statistical data, the income inequality at the municipalities.Regarding Brazil, just a few empirical work have been developed in this subject, for instance, Jacinto et al. (2009) developed this research, at municipal level, by using panel data methodology. Additionally, some others papers have looked for national empirical evidences, for instance, Barros Gomes (2008), Taques Piza (2010), and Figueiredo et al. (2011).

The present note aims to improve the empirical debate on the Kuznets curve for Brazil. Regarding Brazilian literature, our paper depart from the earlier works in two major ways: most of the cited papers used parametric models, and as we know parametric models may produce biased and inconsistent estimates if the model is wrong specified. We used a non-parametric method, namely the Generalized Additive Model (GAM), which allows a more flexible approach to the specification of the model. Moreover, parametric models were also used for benchmarking- we used nonparametric specification test to verify the accuracy of such models. The best parametric model suggest an inverted N-shaped relationship between inequality and development, and the non-parametric model suggest a U-shape relationship between both.Our results confirms the supremacy of the non-parametric method over the parametric one.

Our second contribution is related with the data. In order to perform the empirical research, we used the new data available on municipal inequality released by the *Altas do Desenvolvimento Humano no Brasil* 2013(PNUD).

Beyond the introduction, this paper is organized as follows: In the second section, the data set used is presented. The econometric methodology is briefly outlined in section three, and empirical results are presented in the section four. Concluding remarks are presented in fifth section.

2 The Data

We used the most recent data available on municipal inequality in Brazil. The data used in this study were obtained from the platform *Altas de Desenvolvimento Humano dos Municipios*, which was published by the PNUD-Brazil (2013). We used cross-section data from 5,566 Brazilian municipalities. Following others paper in the literature, the municipal nominal GDP *per capita* was used as a proxy for economic development. We used the Gini index as a proxy for income inequality.

3 The Econometric Methodology

Several empirical papers have used parametric methods to test the Kuznets curve. As we know these procedures may provide biased and inconsistent estimates if the model is wrongly specified. Hence, we decided to use a more flexible econometric models, namely the Generalized Additive Model (GAM). Moreover, in order to verify the performance of the two methodologies, we used non-parametric specification test.

We used pooled-OLS estimator in the following parametric models:

$$gini = \beta_1 + \beta_2 gdp + \epsilon_i \tag{1}$$

$$gini = \beta_1 + \beta_2 gdp + \beta_3 gdp^2 + \epsilon_i \tag{2}$$

$$gini = \beta_1 + \beta_2 gdp + \beta_3 gdp^2 + \beta_4 gdp^3 + \epsilon_i \tag{3}$$

Where Gini represents the Gini index and gdp represents the GDP *per capita*. To ensure robust estimates, we used robust-White standard errors. Moreover, in order to verify the robustness of the parametric estimates, we used a nonparametric test, which was developed by Hsiao, Li and Racine (2007).

As aforementioned, in our empirical research we also used a nonparametric regression to obtain the relationship between income inequality and economic development. Suppose the following equation:

$$y_i = f(x_{i1}) + f(x_{i2}) + f(x_{i3}) + ...f(x_{in}) + \epsilon_i \tag{4}$$

Where y is the dependent variable, x_i are the n covariates in the model, and $\epsilon_i \sim \mathcal{N}(0, \sigma^2)$. The function f(.) shows the partial effects of that a specific covariate in the dependent variable. In many empirical studies on Kuznets curve, authors use many types of controls, namely, education, mortality index, country openness, etc. We did not include these controls in our estimations. However, it is known, in the literature, that these variables have a direct impact on GDP *per capita*. Hence, in practical sense, the loss, for not including these covariates in our model, is minimum, i.e., we opted for a more parsimonious model.

In our model there is just one explanatory variable, hence the relationship can be written as:

$$gini_i = f(gdp_i) + \epsilon_i \tag{5}$$

In the nonparametric model there is no parameter to be estimated. Instead of parameters, the full function f(.) is obtained. Hence, the nonparametric approach imposes less restriction on the shape of the relationship between the dependent variable and the covariate.To perform the nonparametric estimation, we used the MGCV package (version 1.8-0, developed by Simons Wood, University of Bath) in the R software.

4 Results

The results from the parametric models are presented in following table:

Table 1: **Results from the Parametric Model**

Models[1]	Model 1	Model 2	Model 3
gdp	-7.4*10-5**	-03.4*10-4**	-6.1*10-4**
gdp^2		2.2*10-7**	6.2*10-7**
gdp^3			-1.6*10-10**
Inverted-U		No	
N-Shaped			No
Inverted N-Shaped			Yes
Adjusted R^2	0.07	0.18	0.19
N	5,566	5,566	5,566

[1] In order to control for heteroskedasticity, the White-corrected standard errors was used. ** significant at 5%.

According to the parametric model 2 there is no inverted U-shape relationship between inequality and economic development. In fact the model suggests just a U-shape function, namely the income inequality decreases at an early stage of economic development while a country is developing and reaches a minimum at a certain point. After this turning point, income inequality rises at advanced stage of economic development.

When we verify the results of the third model (the best model (R^2=0.19)), the parametric model illustrates an inverted N-shape relationship between these two variables. This is different from the result found in a recent study on the Sub-Saharan African countries (Mendes and Adesida, 2013).

Notwithstanding the parametric results, in order to verify the robustness of these results, we performed nonparametric specification test.

Let us assume that we want to test whether the parametric model is correctly specified or not. A traditional way to proceed is to form a hypothesis analysis. In such a case, the null and the alternative hypotheses can be written as:

$$H_0 : E[y|x] = m(x, \beta) \tag{6}$$

$$H_1 : E[y|x] \neq m(x, \beta) \tag{7}$$

Where m(x,β) is a known function, in which β represents a p x 1 vector of unknown parameters to be estimated.

By applying nonparametric estimation on the null, and using the method of iterated expectations, we obtain the statistic- test proposed by Li and Racine (2008). Under the null hypothesis, bootstrap methods can be used to obtain the distribution of the statistic.

The results of the test are presented in the following table (only the results for the two best parametric models is presented here).

Table 2: **Nonparametric Specification Test**

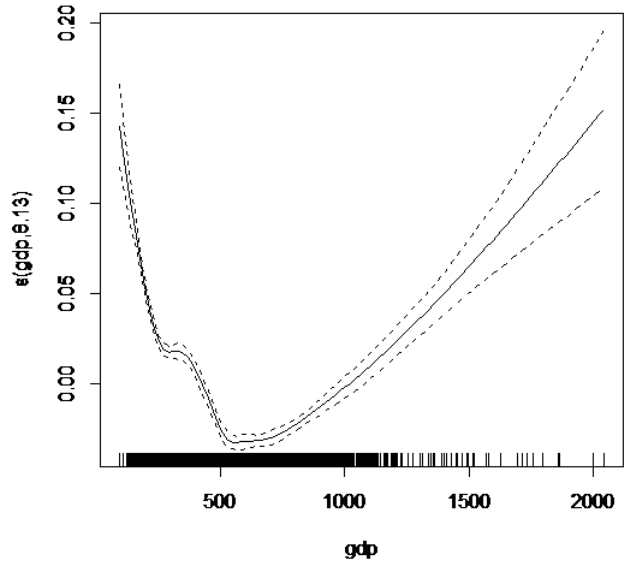
Models[1]	Jn-Statistic	Wild Bootstrap p-value	Decision
Model 2	20.2	0.000	Rejects the null at 0.1%
Model 3	17.2	0.000	Rejects the null at 0.1%

[1] Null hypothesis=the parametric model is correctly specified.

The results from the nonparametric specification test show that the parametric model is not well specified -therefore, the parameters may be biased. Hence, we decided to use another approach, namely we applied nonparametric regression.

The nonparametric approach gives the general function for the relationship between the dependent variable and the covariates. For the present study, the nonparametric result is presented in the following figure.

Figure 1: **Gini and GDP per capita**[1]



[1] The solid curves and the dashed curves represent the estimated nonparametric functions and 95% pointwise confidence intervals, respectively. Thin plate regression spline was used as the basis for the smooth terms..

Results from the nonparametric regression suggest the existence of an U-shape relationship between income inequality and economic development: at an early stage of

economic development, there is a decrease in the income inequality and reaches a minimum at certain point. After this turning point, income inequality rises at advanced stages of economic development. Therefore, according with our results for Brazilian municipalities there is no empirical evidence for the Kuznets curve. The results shows that an increasing income inequality can be observed in more developed municipalities.

The significance test for the nonparametric regression is presented in the following table.

Table 3: Nonparametric Statistical Significance

Models	F-Statistic	P-value	R-square
gini=f(gdp per capita)	168.5	0.000	0.21

The result obtained in this study rejects the existence of the Kuznets curve for the Brazilian municipalities. Moreover, the results show that the nonparametric model (R^2=0.21) is superior to parametric one (R^2=0.19).

5 Final Remarks

This note aimed to investigate, within Brazilian municipalities, the relationship between income inequality and economic development. We used data from 5,566 Brazilian municipalities, and applied parametric and nonparametric tools were used. The results obtained show that there is no inverted-U relationship between these two variables. Our best model (the nonparametric model) suggest an U-shape relationship between income inequality and economic development. This finding differs from previous studies presented in the literature. This results indicates that even in the more developed municipalities, the gap between rich and poor is increasing.

6 References

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