

MINING ROYALTIES AND SOCIOECONOMIC DEVELOPMENT IN PARÁ

METHODOLOGY



CLIMATE
POLICY
INITIATIVE



METHODOLOGY
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ECONOMIC MODEL

To formally estimate the statistical significance of the correlations presented in the text, a Fixed Effect design is employed, where it is possible to systematically exclude the effect of fixed factors across time and municipalities, by estimating the following expression:

$$y_{it} = \alpha + \beta CFEM_{it} + \gamma_i + \gamma_t + \tilde{u}_{it} \quad (1),$$

which y_{it} denotes the outcome variable in municipality i year t , $CFEM_{it}$ denotes mining royalties per capita, γ_i is a fixed effect for municipality i , γ_t is a fixed effect for year t , \tilde{u}_{it} is a residual term. To facilitate exposition, when the outcome variable is one of the IFDM indexes, $CFEM_{it}$ is measured in R\$ 100. When the outcome variable is the homicide rate, $CFEM_{it}$ is measured in R\$ 1. The parameter β recovers the correlation between $CFEM_{it}$ and the outcome variable net of fixed effects; that is, net of all possible variables that can also correlate with $CFEM_{it}$ and y_{it} but are either fixed across time (γ_t) or fixed across municipalities (γ_i). The researchers do not claim that the estimates of β recover a causal relation between mining royalties and the outcome, since it cannot be argued that the residual term is not correlated with $CFEM_{it}$. This restriction arises from the fact that the municipalities that benefit the most from the mining royalties are in fact very different from the other municipalities in the State of Pará. Therefore, it is likely that there are other variables correlated with $CFEM_{it}$ that vary with time and affect the outcomes of interest.

Table 1 shows the correlations between mining royalties and socioeconomic outcomes. Column (0) shows the estimate expression (1) without any fixed effect; in column (1) only the year fixed effect is included; finally, column (2) features the municipality and year fixed effect. The table shows that without both fixed effects, the correlations among mining royalties and the outcomes of health, education, employment, income, and violence are all positive and statistically significant. That is, a methodology that does not consider fixed characteristics of the municipalities would suggest that mining royalties increase a range of outcomes of economic interest as well as increase the presence of violence. Nonetheless, when netting out the fixed effects in column (2) no statistical significance of estimated correlations for the economic outcomes is found. Furthermore, the sign of the presence of violence flips and shows a negative correlation between royalties and the homicide rate.

Table 1. Correlation Results Between Mining Royalties and Socioeconomical Outcomes

Outcome	(0)	(1)	(2)
Health	0.0507*** (0.011)	0.0144*** (0.001)	0.0036 (0.003)
Education	0.0481*** (0.013)	0.0082*** (0.001)	0.0001 (0.001)
Employment and Income	0.0524*** (0.011)	0.0169*** (0.001)	- 0.0022 (0.002)
General	0.0502*** (0.012)	0.0131*** (0.001)	0.0003 (0.001)
Homicide Rate	0.016412*** (0.00563)	0.005802** (0.0023)	0.001367*** (0.00045)
Year FE	No	Yes	Yes
Municipality FE	No	No	Yes
R2	0.02	0.05	0.62

Source: CPI/PUC-Rio with data from National Mining Agency, *Federação das Indústrias do Estado do Rio de Janeiro (FIRJAN)*, and *Atlas da Violência*, 2022

To investigate the effect of mining royalties on fiscal expenditures and revenue a Fixed Effect estimator is employed, as described in expression (1), but now y_{it} denotes the outcome fiscal variable in municipality i year t and $CFEM_{it}$ denotes mining royalties in municipality i year t . Focusing on column (2) to Table 4, the increase of R\$ 1 from mining royalties is associated with the increase of an equal amount of total expenditures. This amount is equally divided between current expenses and capital expenses. Discerning some of the possible classifications of fiscal expenses, wages and pensions from the public sector is the area that is most affected by mining royalties increases, followed by health and education expenses.

These results do not support the hypothesis that mining royalties are directly spent in those areas but that the increase in mining royalties may generate budget adjustments such that the budget in those areas are affected. These affected areas are depicted in Table 2. Finally, an increase in mining royalties is not associated with an increase in fiscal revenue from urban property tax (*Imposto Predial e Territorial Urbano - IPTU*).¹ This might indicate that mining royalties reduce the fiscal effort of benefited municipalities.

¹ Brasil, Eric Universo Rodrigues. "O novo código de mineração no Brasil: uma análise econômica da compensação financeira sobre a exploração dos recursos". PhD dissertation, Universidade de São Paulo, 2016.

Table 2. Correlation Results Between Mining Royalties and Fiscal Variables

	(0)	(1)	(2)
Expenditure	2.220*** (0.15)	1.981*** (0.146)	0.997*** (0.129)
▪ Current	1.417*** (0.125)	1.209*** (0.108)	0.515*** (0.086)
▪ Capital	0.803*** (0.049)	0.772*** (0.053)	0.482*** (0.065)
Public Sector Wages and Pension	1.181*** (0.108)	1.008*** (0.1)	0.390*** (0.082)
Education	0.796*** (0.074)	0.674*** (0.064)	0.316*** (0.072)
Health	0.725*** (0.048)	0.643*** (0.052)	0.374*** (0.078)
Transportation	0.253*** (0.037)	0.248*** (0.038)	0.097*** (0.046)
Housing	0.380*** (0.032)	0.351*** (0.027)	0.105** (0.048)
IPTU	0.009*** (0.003)	0.002 (0.005)	0.001 (0.002)
Year FE	No	Yes	Yes
Municipality FE	No	No	Yes
R ²	0.08	0.08	0.78

Source: CPI/PUC-Rio with data from National Mining Agency and Tesouro Nacional, 2022

DATA

IFDM

The Firjan Index of Municipal Development (*Índice Firjan de Desenvolvimento Municipal* - IFDM)² is built by the Industry Federation of the State of Rio de Janeiro (*Federação das Indústrias do Estado do Rio de Janeiro* - FIRJAN). This index measures, at the municipality level, socioeconomic development through a methodology that aggregates indicators of education, health, employment, and income for the years 2005 to 2016. The composition of each index is given in Appendix A, Table 2. The General Index is a simple average of the three specific area indexes. Table 3 shows the components and sources of the IFDM built by FIRJAN.

2 FIRJAN. *Índice Firjan de Desenvolvimento Municipal*. May 5, 2022. bit.ly/3wdyrlG.

Table 3. Description of Data Sources for Calculating Socioeconomical Outcomes

Index	Composition	Source
Employment and Income	<ul style="list-style-type: none"> Formal job post and creation Income Formal wages Gini index for formal workers 	Ministry of Labor and Social Security
Education	<ul style="list-style-type: none"> Primary school enrollment rate Dropout rate Age-Grade distortion rate Percentage of teachers with higher Education at elementary schools Average daily class hours IDEB results 	Ministry of Education
Health	<ul style="list-style-type: none"> Rate of prenatal appointments Infant mortality rate from avoidable causes Infat mortality rato from I11 - defined causes Hospitalization sensitive to primary care 	Ministry of Health

Source: CPI/PUC-Rio with data from FIRJAN, 2022

Figure 1 shows the geographical distribution of each individual index for the years 2007 and 2016. The cluster composed by the municipalities of Canaã dos Carajás, Parauapebas, Curionópolis and Marabá generally performs well in the indicators. Those are some of the municipalities with high mining royalties, both in absolute and per capita terms. On the other hand, the highlighted municipalities of Itaituba, Novo Progresso, Oriximiná and Terra Santa, which also receive a considerable amount of mining royalties, do not show strong indicator performance, particularly in health and employment and income.

EXPENDITURE DATA

Expenditure data at the municipality level is from the National Treasury of Brazil via FINBRA (Municipal Finances).³ The data was collapsed to the categories depicted in Table 2.

VIOLENCE

To the extent that a portion of mining activities is illegal,⁴ the presence of illegal markets may affect the presence of violence.⁵ To measure violence, municipality data on homicide rates from 2007 to 2019 was gathered from Atlas da Violência.⁶ Figure 2 shows the distribution of homicide rates in the state of Pará.

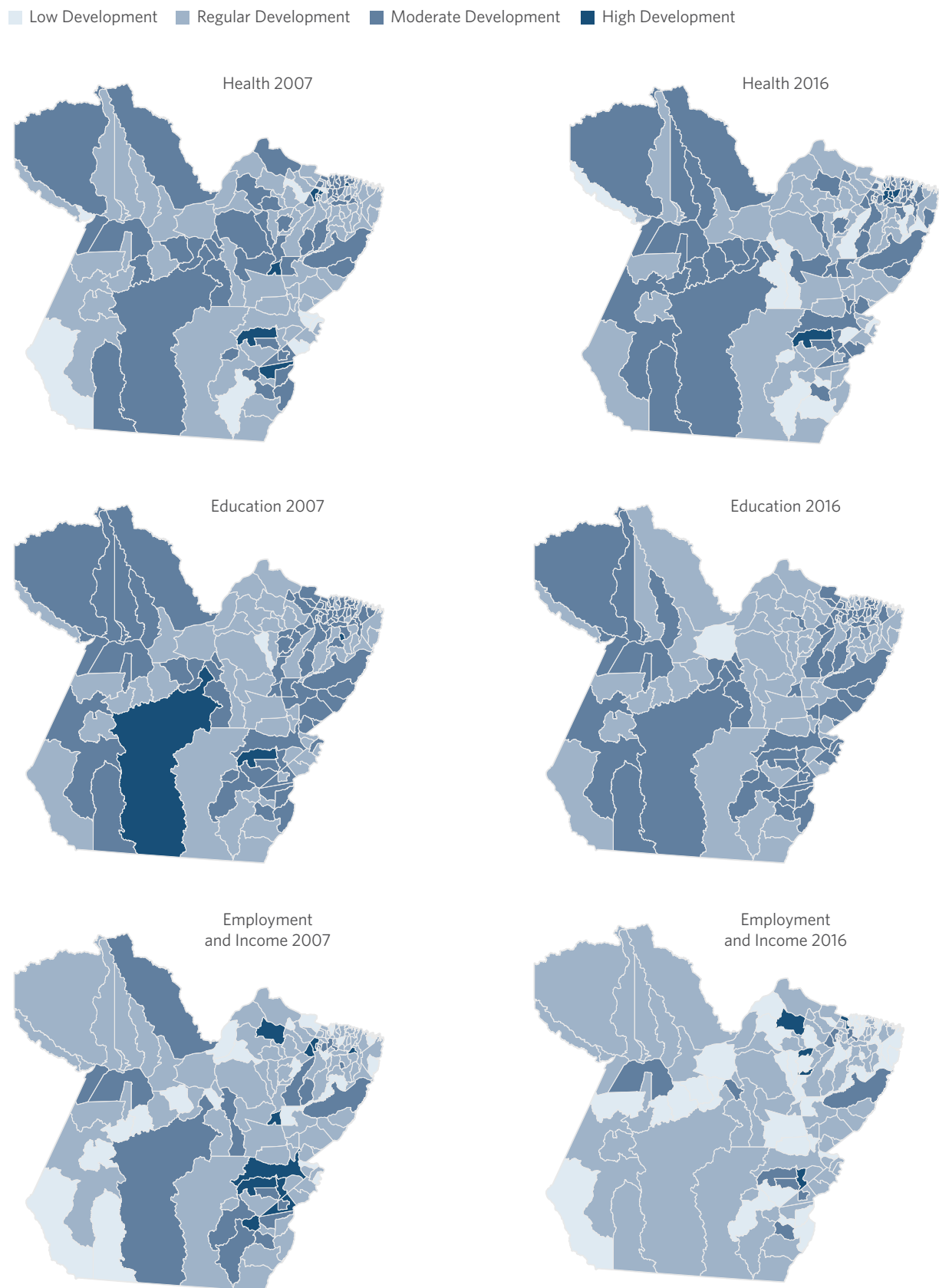
³ Municipal Finance National Treasury of Brazil. *FINBRA (Finanças Municipais)*. May 5, 2022. bit.ly/3kZg312.

⁴ Siqueira-Gay, Juliana, and Luis E. Sánchez. "The outbreak of illegal gold mining in the Brazilian Amazon boosts deforestation". *Regional Environmental Change* 21, no. 2 (2021): 1-5.

⁵ Chimeli, Ariaster B., and Rodrigo R. Soares. "The use of violence in illegal markets: Evidence from mahogany trade in the Brazilian Amazon". *American Economic Journal: Applied Economics* 9, no. 4 (2017): 30-57.

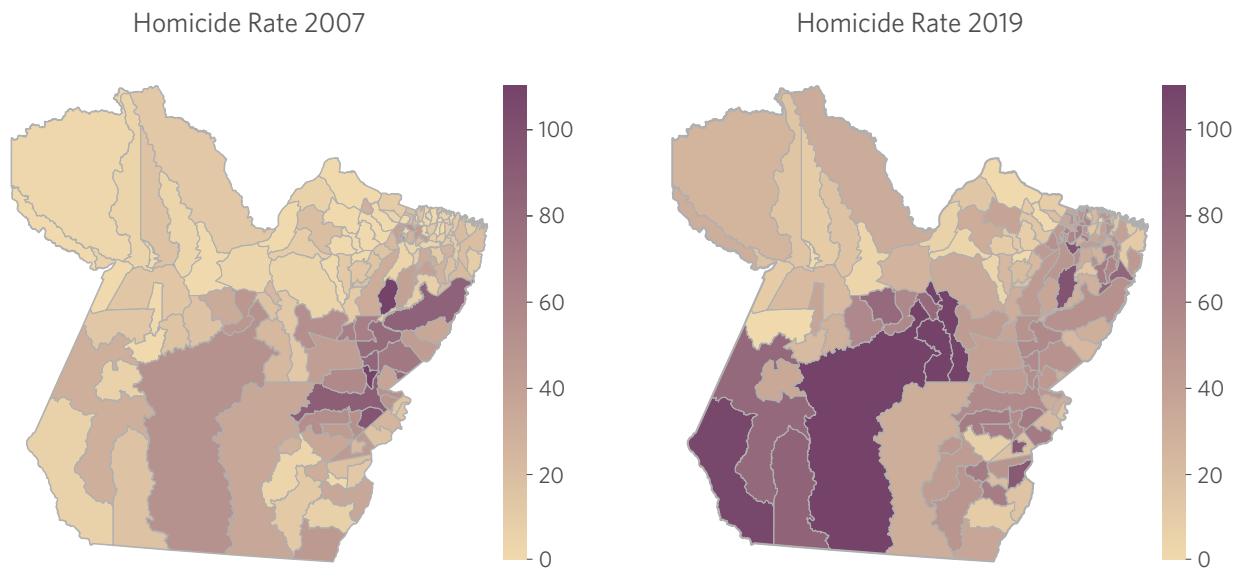
⁶ IPEA. *Atlas da Violência*. May 5, 2022. bit.ly/39So9pWV.

Figure 1. Geographical Distribution of Socioeconomical Outcomes for Health, Education, and Employment and Income in Pará in 2007 and 2016



Source: CPI/PUC-Rio with data from FIRJAN, 2022

Figure 2. Distribution of Homicide Rates in Pará in 2007 and 2019



Note: Homicide rates are measured per 100,000 people.

Source: CPI/PUC-Rio with data from *Atlas da Violência*, 2022