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Mining Contribution to Municipalities Development

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Abstract: Mining activity in Brazil has significantly contributed to the country development. However, this contribution is not always fully noticed by society. This study aims to bring more evidence to this mining activity contribution, based on highly regarded development indicators, such as the HDI (Human Development Index), created by the UNDP (United Nations Development Programme). The HDI was traditionally designed as an instrument to evaluate the degree of countries development and was subsequently deployed to states and municipalities (IDHM (Municipal Human Development Index) for Brazilian municipalities). In addition to IDHM released by the UNDP, FIRJAN (Federation of the Industries of the State of Rio de Janeiro) developed its own IFDM (FIRJAN Municipal Development Index). The statistical analysis shows that the average of the municipalities with mining activities has superior development indices than those with non-mining activities, especially in the two major mining states: Minas Gerais and Pará.

Key words: Mineral activity, human development, IDHM (Municipal Human Development Index), IFDM (FIRJAN Municipal Development Index).

1. Introduction

Brazil has one of the world's largest reserves of metallic and non-metallic minerals [1]. Brazil's largest mining companies are also among the world's largest mining companies, with the major part of their production destined for export. Mining industry has significantly contributed, directly and indirectly, to Brazil's economy. According to the IBRAM (Brazilian Mining Association), the whole extractives sector (including oil and gas) accounted for 3% of the GDP (Gross Domestic Product) of the country [2]. In foreign trade, mining industry contributed more than US$ 34 billion in mineral exports in 2014 and had also provided a multiplier effect of up to 13 indirect or induced jobs; that is, almost 2.7 million workers involved in some way with the mining activity [1]. Mineral extraction accounts for US$ 727 million in Brazilian tax collection royalties in the year 2014 [3].

This research aims to quantify the contribution of the mining activity in the development of the municipalities that have this type of activity in its territory, using the HDI (Human Development Index) as a measure. Created for the UNDP (United Nations Development Programme), the HDI was traditionally designed to evaluate the degree of countries development, consolidating since the 1990s as the best-known indicator for such purposes [4, 5].

Subsequently, the HDI has been adapted to states and municipalities, giving rise to the IDHM (Municipal Human Development Index), published by the UNDP [5, 6], FIRJAN (Federation of the Industries of the State of Rio de Janeiro) [7] and IFDM (FIRJAN Municipal Development Index). IDHM is calculated from data on income, longevity and education census conducted every ten years by the Brazilian Institute of Geography and Statistics [6]. On the other hand, IFDM is updated through government official employment, income, health and education data, which provides an annual disclosure of this indicator [7]. The two indices range from 0 to 1. The closer to 1, the higher human development is.

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The HDI metric indicates that Norway and Australia are two of the most developed countries of the world and both have a significant share of the mining activity in GDP. Thus, authors use the IFDM and IDHM to verify through statistical evidence if the municipalities that have mining activity have a development index superior to the others. Here, it is considered that the mining municipalities are those which have collected the CFEM (Financial Compensation for Exploration of Mineral Resources) in the last 6 years (2010-2015) [3].

The paper is organized in two parts. The first used hypothesis test with a 5% significance level to verify if the municipalities with mining activity (in this paper referred to as "mining cities") have development indices superior to non-mining municipalities. In the second part, it was demonstrated through histograms, the percentiles where are located the main mining cities of the two major Brazilian mining states (Pará and Minas Gerais), accounting for 80% of CFEM collected over the past 6 years (2010-2015).

1.1 Theoretical Framework

One of the major concerns of the international organizations is the progress of the human being in terms of development. This trajectory has been monitored and evaluated by several government institutions, social scientists and academics, with the objective to subsidize the decision and orientation of the development of corporate actions and public projects. Several indicators can be used to evaluate these trends, but some indicators have become frequent in the evaluation of these interventions [8-11]. In this regard, the recommendations of the United Nations Commission on Sustainable Development have become popularly known among policymakers, who have strongly argued that indicators are needed to monitor progress towards sustainable development in order to assist decision-makers at all levels. In addition, the commonly used economic welfare indicators should also be considered as social, environmental and institutional indicators to achieve a broader and more complete picture of the social development. From this wide approach, social scientists have used HDI as a standard measure to analyze the progress of human development at the municipal level and also to run comparative analysis [8, 9]. In parallel, alternative indicators have also emerged to evaluate the human progress variables in a temporal scale. For example, FIRJAN is one example of the human progress indicator [11].

The most widely used indicator for assessing a country's performance is the HDI. According to The Economic Times [12], "HDI is a statistical tool used to assess a country's overall achievement in its social and economic dimensions. The social and economic dimensions of a country are based on people's health, their level of education and their standard of living." According to UNDP [13], "the goal of creating the HDI was to offer a counterpoint to another widely used indicator, the GDP per capita, which considers only the economic dimension of the development." Created by Mahbub ul Haq with the collaboration of the Indian economist Sen, A. [4], winner of the 1998 Nobel Prize in economics, "the HDI is intended as a general and synthetic measure that, although broadening the perspective on human development does not cover nor exhaust all aspects of development."

To measure the development of municipalities, UNDP proposed an adaptation of HDI to generate the IDHM. This organization defines it as "a measure made up of indicators of three dimensions of human development: longevity, education and income" [6]. The index ranges from 0 to 1, like the original HDI. The Brazilian IDHM follows the same three dimensions of the global HDI—longevity, education and income, but it goes farther and adapts the global methodology to the Brazilian context and the availability of national indicators. Although they measure the same phenomena, the indicators taken into account in IDHM are more adequate to evaluate the development of Brazilian municipalities [6].

The IDHM update is based in the Brazilian Institute of Geography and Statistics census data, thus, its last update was in 2010. Considering this, FIRJAN developed the IFDM, an indicator with a similar method of HDI, but which allows an annual update according to this federation. IFDM is a study from the FIRJAN system that annually accompanies the socioeconomic development of more than 5 thousand Brazilian municipalities in three basic criteria: employment & income, education and health. Created in 2008, it is exclusively based on official public statistics made available by the Ministries of Labor, Education and Health [7].

2. Material

This research aims to test whether there are significant differences in the mean IDHM and IFDM indicators for mining cities comparatively to non-mining ones in Brazil with a 5% level of significance, that is, if the mining cities have better performance in these indicators in average when compared with other municipalities.

The material used in this research refers to the registration of IDHM (2010) and IFDM (2013) of municipalities with mineral activity *versus* municipalities that do not have mining activity. The importance of the participation of the mining activity in municipal revenues is an indicative of the mining participation degree in that municipality. The groups were divided into centiles (10th centile, 5th centile, 1st centile and all municipalities that have collected CFEM for the last six years) gathered by revenues of CFEM in relation to the total revenue collected by the municipality, on average, in the period from 2010 to 2015. Thus, the groups consider all mining municipalities, which have relevance above 1%, 5% and 10% of CFEM compared to the total revenue of these mining cities, as informed on the balance sheets disclosed in the STN (National Treasury Secretariat) website [14].

In order to test whether the means of these indicators are different or not, the t-test was developed for independent samples, which requires the normality of the data distribution and homogeneity of variances. Thus, data were submitted to normality test using Kolmogorov-Smirnov and Levene tests to assess whether the variances are homogeneous. In the case of evidence to reject the null hypothesis, it is concluded that the indicators fit the non-parametric Mann-Whitey statistic, which is used to test the equality of means when the assumptions of normality are violated.

3. Results and Discussion

3.1 Results and Statistical Tests

To test the hypothesis that municipalities with mineral activity have development indices superior to other municipalities, the averages of the two development indices covered in this research (IFDM and IDHM) were compared in four mining presence levels according to the collection of CFEM of last six years by revenue. In all comparisons, for IFDM and IDHM, the mining cities averages were higher than non-mining. Moreover, there was an increase in development rates in both indicators, as it increases the participation of CFEM in municipalities' revenue, as shown in Tables 1 and 2.

To confirm the statistical significance of the superiority of human development average of mining municipalities, the normality of the data were tested to see which statistical test is more appropriate for this data profile through its probability value (p-value). Tables 3 and 4 confirm that data are not normal and Tables 5 and 6 show that the averages are not homogeneous.

As the normality of the data was not confirmed, the nonparametric Mann-Whitey was used, which confirmed that indeed the mining cities have higher development indices, measured by IDHM and IFDM at a 5% significance level, in the four levels of mining influence, as shown in Table 7 through the p-value.

Table 1 Municipality IDHM average.

Centile-levels of influence of collected CFEM	Non-mining	Mining
All	0.6443	0.6772
1st centil	0.6584	0.6803
5th centil	0.6590	0.6824
10th centil	0.6590	0.7156

Table 2 Municipality IFDM average.

Centile-levels of influence of collected CFEM	Non-mining	Mining
All	0.6319	0.6744
1st centil	0.6502	0.6863
5th centil	0.6508	0.6878
10th centil	0.6508	0.7281

Table 3 Kolmogorov-Smirnov test (p-value) applied to IDHM.

Centile-levels of influence of collected CFEM	Non-mining	Mining
All	0.0000	0.0000
1st centil	0.0000	0.0180
5th centil	0.0000	0.1660
10th centil	0.0000	0.2000

Table 4 Kolmogorov-Smirnov test (p-value) applied to IFDM.

Centile-levels of influence of collected CFEM	Non-mining	Mining
All	0.0000	0.0000
1st centil	0.0000	0.0130
5th centil	0.0000	0.0300
10th centil	0.0000	0.0690

Table 5 Variance test (p-value) applied to IDHM.

Centile-levels of influence of collected CFEM	Brazilian municipalities
All	0.0000
1st centil	0.0000
5th centil	0.0810
10th centil	0.0010

Table 6 Variance test (p-value) applied to IFDM.

Centile-levels of influence of collected CFEM	Brazilian municipalities
All	0.2300
1st centil	0.0000
5th centil	0.5370
10th centil	0.1650

Table 7 Mann-Whitey test (p-value).

Centile-levels of influence of collected CFEM	Brazilian municipalities
All	0.0000
1st centil	0.0000
5th centil	0.0270
10th centil	0.0000

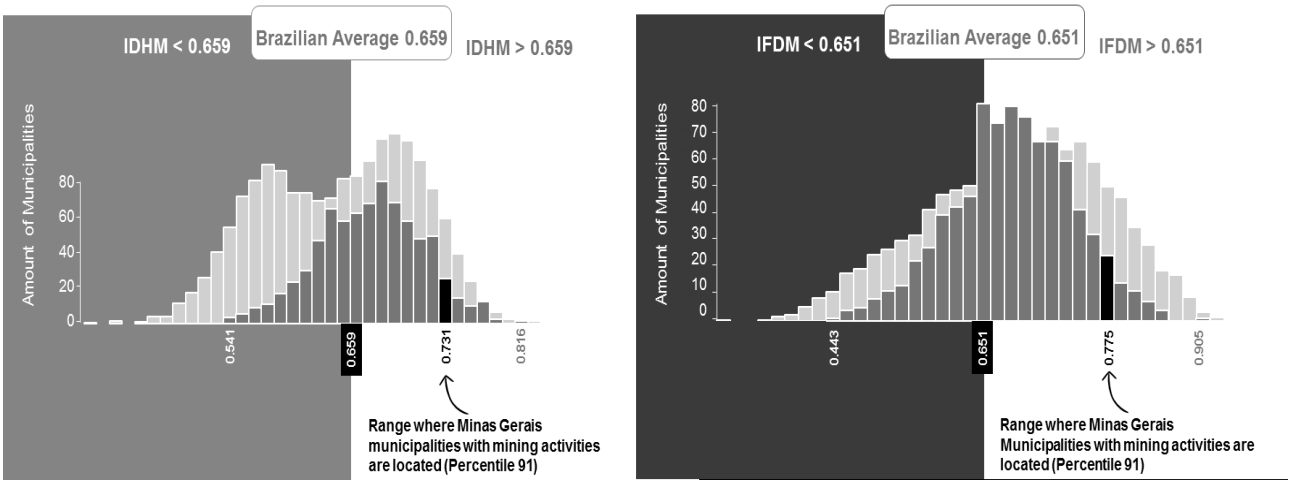

Fig. 1 Distribution of Minas Gerais municipalities by IDHM and IFDM (mining municipalities are represented by dark gray bars) [3, 6, 7, 14].

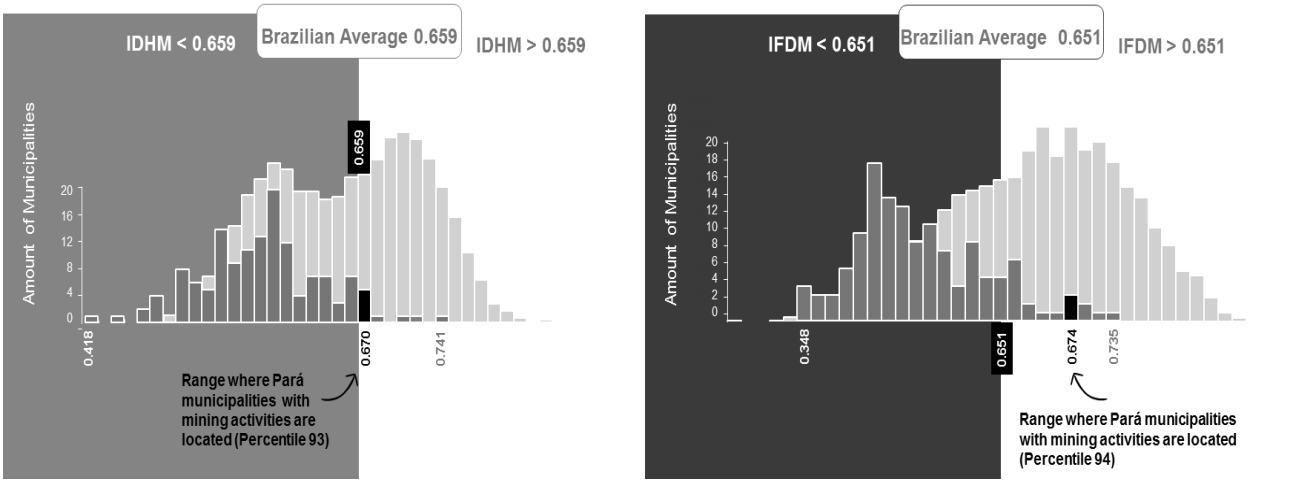

Fig. 2 Distribution of Pará municipalities by IDHM and IFDM (mining municipalities are represented by dark gray bars) [3, 6, 7, 14].

3.2 Positioning of the Main Mining Cities in Minas Gerais and Pará

Both states of Minas Gerais and Pará together account for 80% of the Brazilian CFEM collected in the past six years (2010-2015). It can be seen that the mining municipalities occupy a prominent position in tax collection in these states. The most important mining municipalities (91% of revenues) in Minas Gerais are positioned in the percentile 91 in IDHM and 91 in IFDM distribution of mining municipalities. In Pará, the most important mining cities (90% of revenues) are positioned in the percentiles 93 in IDHM and 94 in IFDM distribution of Pará municipalities (in both cases represented by few municipalities above Brazilian average). These results are shown in the histograms of Figs. 1 and 2.

4. Conclusions

This study analyzed the contribution of mining activities to the development of Brazilian municipalities where it is present. It were used 2010 IDHM and 2013 IFDM development indicators, applied in municipalities with mining activity identified by the collection of CFEM as published at DNPM (National Department of Mining Production) site [3].

The hypothesis that mining municipalities have higher rates of development than the non-mining ones was tested in four levels of mining influence, as measured by the volume of CEFEM collection, represented in relation to their total revenue. The result of the study showed that mining cities are more developed than non-mining ones in all four levels of influence, considering IDHM and IFDM, to a statistical level of significance of 5%. It was also found that the averages on both indicators increase as the level of mining influence increases.

The increase in human development indicators for mining cities is more evident in the states of Minas Gerais and Pará. These two states are responsible for 80% of Brazilian CFEM collected over the last six years (2010-2015), where the main mining cities in both states are responsible for 90% of the tax collection over those years. In addition to that, they are located above the 90th percentile of the distribution of the cities from these two states.

It is noteworthy that the factors analyzed in this study only explain the part related to the influence of mining activity. There are other variables, such as public policies and administration, culture and history of the city, among other factors, which may also influence human development index.

Finally, it is important to pay attention to the recommendations of expansion of the wealth concept proposed by Stiglitz, J. E., et al. [15], whose consequences change the concept of human development indicators.

References

[1] IBRAM (Brazilian Mining Association). 2012. "The Strength of Brazilian Mining." Brasília: IBRAM. Accessed July 26, 2017. http://www.ibram.org.br/sites/1400/1457/00000294.pdf.

[2] IBRAM and ICMM (Internacional Council of Mining & Minerals). 2013. "The Mining Sector in Brazil: Building Institutions for Sustainable Development." Accessed July 26, 2017. http://www.icmm.com/website/publications/pdfs/mining-parterships-for-development/5423.pdf.

[3] DNPM (National Department of Mineral Production). *CFEM Collection*. Accessed September 13, 2016. https://sistemas.dnpm.gov.br/arrecadacao/extra/Relatorios/arrecadacao_cfem.aspx.

[4] Sen, A. 1994. "Human Development Index: Methodology and Measurement." Accessed September 13, 2016. https://ora.ox.ac.uk/objects/uuid:98d15918-dca9-4df1-8653-60df6d0289dd/datastreams/ATTACHMENT01.

[5] IPEA (Institute of Applied Economic Research), Brazilian Institute of Geography and Statistics, João Pinheiro Fundation, United Nations Development Programme. 1998. "Human Development Index (IDH) and Quality of Life Index." Brasília: IPEA.

[6] UNDP (United Nations Development Programme). 2013. "Brazilian Municipal Human Development Index." Brasília: UNPD, IPEA, FJP. Accessed September 13, 2016. http://www.atlasbrasil.org.br/2013/en/o_atlas/idhm/.

[7] FIRJAN (Federation of Industries of Rio de Janeiro State). 2014. "FIRJAN Municipal Development Index (IFDM)." Rio de Janeiro: FIRJAN. Accessed September 13, 2016. http://www.firjan.com.br/ifdm/.

[8] Candia, R. C., Galery, R., and Iramina, W. S. 2014. "Financial Compensation for the Use of Mineral Resources at the Minas Gerais State—Brazil." *Mine Planning and Equipment Selection*. Cham: Springer, 1325-34.

[9] Parandekar, S. 2006. "Efficiency of Brazilian Municipalities." *Inputs for a Strategy for Cities*: 105-36. World Bank. Accessed July 26, 2017. http://documents.worldbank.org/curated/en/810791468005449718/pdf/357490BR.pdf#page=115.

[10] Desai, M. 1991. "Human Development: Concepts and Measurement." *European Economic Review* 35 (2-3): 350-7.

[11] Avelino, B. C., Bressan, V. G. F., and da Cunha, J. V. A. 2013. "A Study on the Accounting Factors Influencing the FIRJAN Municipal Development Index (IFDM) in Brazilian Capitals." *Journal of Education and Research in Accounting* 7 (3): 263-78. Accessed September 13, 2016. http://www.repec.org.br/index.php/repec/article/viewFile/993/772.

[12] The Economic Times. 2016. "Definition of 'Human Development Index'." Accessed September 13, 2016. http://economictimes.indiatimes.com/definition/human-development-index.

[13] UNDP (United Nations Development Programme). 2016. "What is the HDI?" Accessed September 13, 2016. http://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idh.html.

[14] STN (National Treasury Secretariat). 2016. "Accounting

and Fiscal Information System of the Brazilian Public Sector." Accessed September 13, 2016. https://siconfi.tesouro.gov.br/siconfi/pages/public/consulta_finbra/finbra_list.jsf;jsessionid=HuZTnYtlKPFdSIx9JLdgXMA7.node2.

[15] Stiglitz, J. E., Sen, A., and Fitoussi, J. P. 2010. "Report by the Commission on the Measurement of Economic Performance and Social Progress." *Paris: Commission on the Measurement of Economic Performance and Social Progress*.