

The Brumadinho dam rupture disaster in Minas Gerais (Brazil) and the productivity: regional economic impacts using a computable general equilibrium approach

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Content

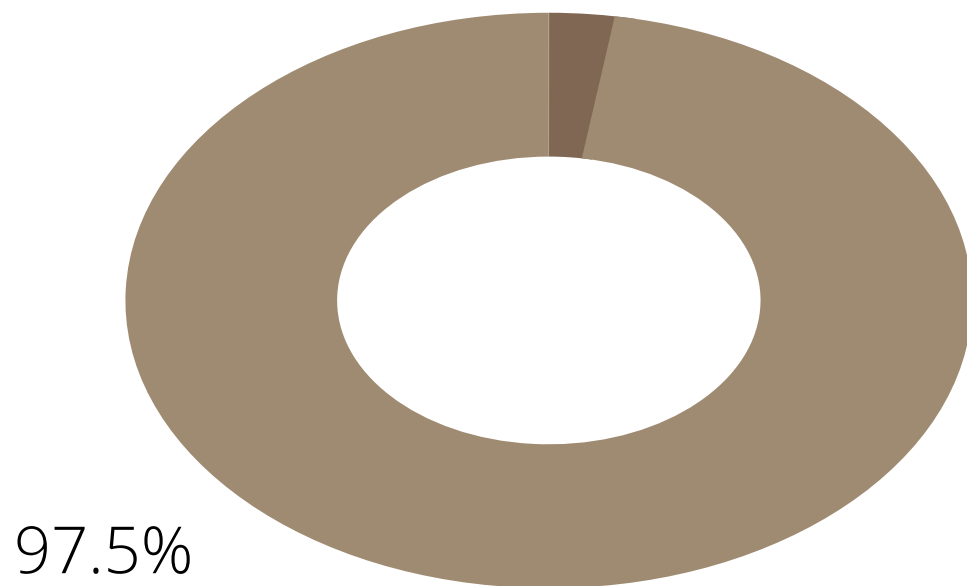
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Introduction

THE EXTRACTIVE INDUSTRY IN BRAZIL

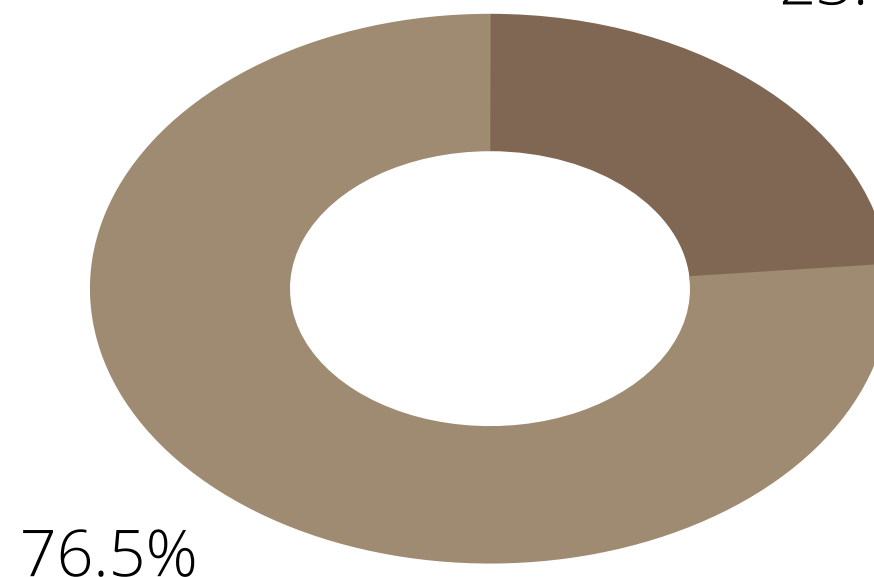
RELATIVE SHARE OF THE
EXTRACTIVIST SECTOR IN
NATIONAL GDP

2.5%

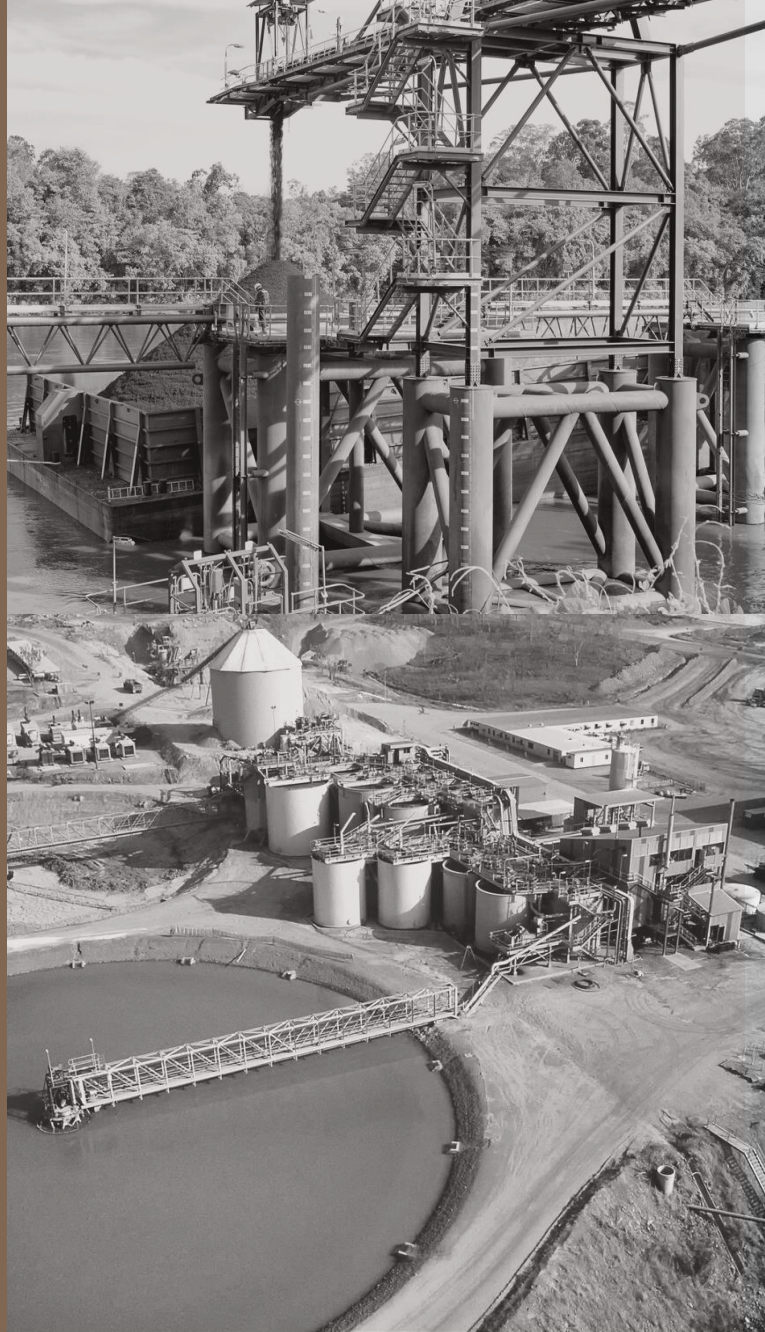


RELATIVE PARTICIPATION OF MINAS
GERAIS IN BRAZILIAN EXTRACTIVE
PRODUCTION

23.6%



Source: IBGE (2021)



PRODUCTION FEATURES

- It is Capital-Intensive and depends on Natural Resources;
- Primary Product Aimed at Exportation;

NEGATIVE EXTERNALITIES

- Contamination of Water Resources;
- Geological Impacts (Erosive Processes);
- Landscape Degradation;
- Air pollution

Disaster

JANUARY 25TH, 2019

Disruption of the tailings dam at the Córrego do Feijão mine, under the responsibility of Vale S.A. mining company.

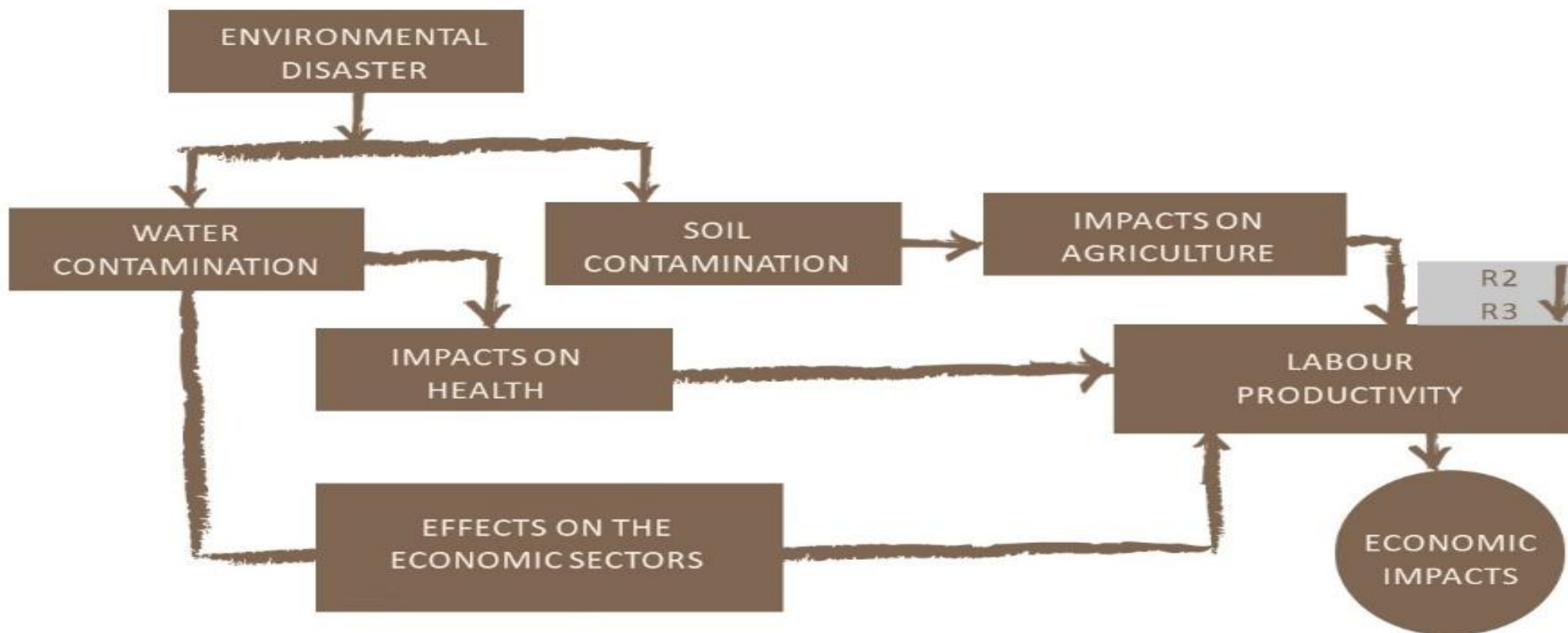
Things hit by the leaking mud: plant facilities, loading terminal, maintenance workshops and administrative buildings, as well as the road access were blocked.

It is estimated that at least 18 municipalities have been affected along the Paraopeba River basin, resulting in 1.165.667 people exposed directly and indirectly.

The Halt of activities reduced its extractive production around 8.5 million tons.

270 people have died and another eleven are still missing. In addition to local and regional losses and damage (material and cultural, economic, environmental and health).

The relationship between the Brumadinho disaster, labor productivity, and economic impacts



Goals

The main objective of this study is to estimate the interregional economic impact of a reduction in labor productivity in municipalities affected by the Brumadinho disaster.

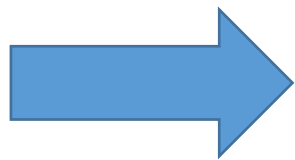
The hypothesis is that the pollution of this natural disaster negatively affects the economy through negative externalities, whether driven by soil or water contamination, as it increases health problems and reduces the quality of inputs for several economic sectors. Consequently, there are changes in labor productivity, which results in economic impacts.

Goals (cont.)

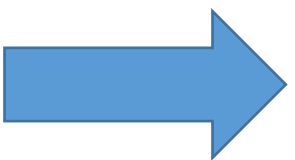
Specifically, we aim at:



Estimating the input-output tables by disaggregating the affected regions in Minas Gerais.



Analyzing the economic structure of the affected regions and the importance of the extractive sector.



Calculating the regional impacts as a function of sectoral changes in labor productivity.

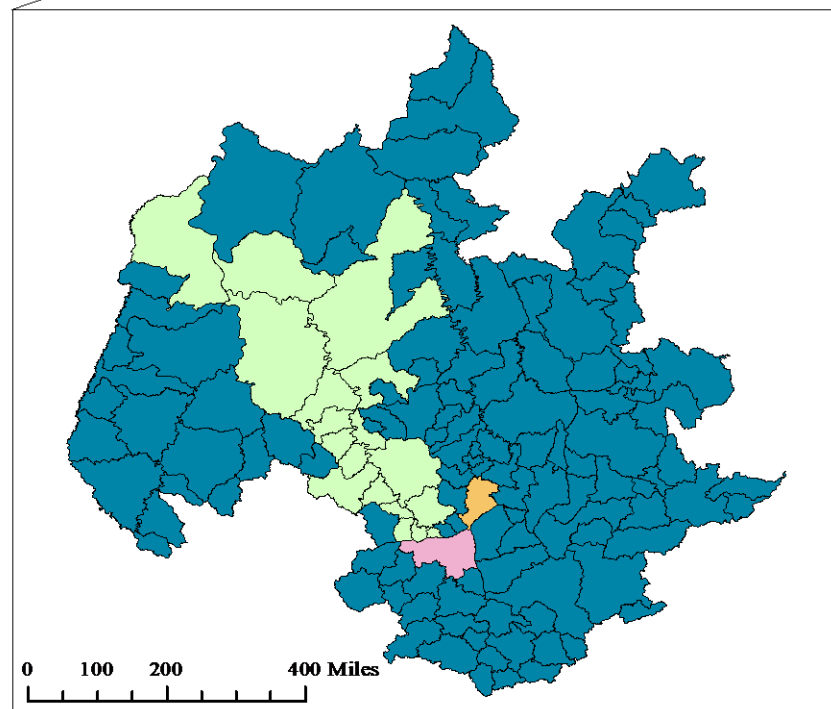
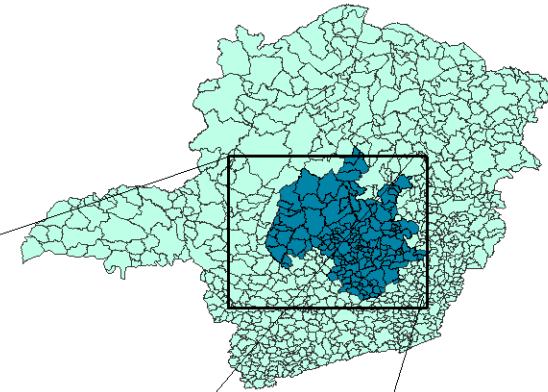
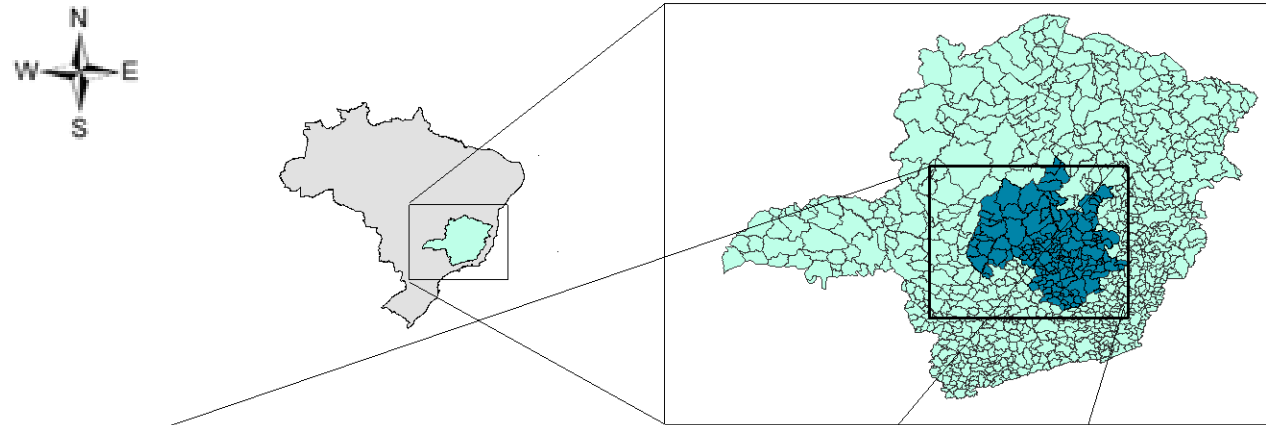
Modelling framework

B-Maria (Brumadinho) CGE Model

- For modelling the short-run regional economic impacts of the Brumadinho dam rupture, we employ the B-Maria model developed by Haddad (1999) adapted for the case of Minas Gerais.
- B-Maria is a Brazilian Multisectoral Regional and Interregional Analyze model.
- It is based on ORANI structure.
- We use the static version.

Database

- The model is calibrated with data of 2015, which is provided by the estimated Interregional Input-Output matrix based on the Interregional Input-Output Adjustment System (IIOAS) method, as detailed in Haddad et al (2017).
 - RAIS – Annual Social Information Report – Brazil Ministry of Economy.
 - POF – Household Budget Survey – Brazilian Institute of Geography and Statistics.
 - Municipal GDP – National Accounts - Brazilian Institute of Geography and Statistics.
 - Comex Stat – Brazil Ministry of Economy.
 - Distance Matrix – Google Maps.
- Input-Output tables were desagregated into 22 sectors and 5 regions.
 - R1 - Belo Horizonte
 - R2 - Brumadinho
 - R3 - Other's cities affected by disruption of the tailings dam.
 - R4 - Rest of Minas Gerais State
 - R5 - Rest of Brazil

**Municipalities**

- Other municipalities in region
- Other affected municipalities
- Belo Horizonte
- Brumadinho

Map of municipalities affected by the rupture of the dam in Brumadinho-MG.

Regional Statistics

| ID | Region Name | Number of Municipalities | GDP R\$ (2015) | GDP (%) | Population (2015) | Population (%) |
|----|---|--------------------------|----------------|---------|-------------------|----------------|
| R1 | Belo Horizonte | 1 | 87.309.968 | 1,46% | 2.502.557 | 1,22% |
| R2 | Brumadinho | 1 | 1.601.341 | 0,03% | 37.857 | 0,02% |
| R3 | Rest of municipalities affected by the rupture of the dam in Brumadinho | 17 | 32.554.114 | 0,54% | 875.750 | 0,43% |
| R4 | Rest of Minas Gerais State | 834 | 397.865.790 | 6,64% | 17.452.937 | 8,54% |
| R5 | Rest of Brazil | 4.717 | 5.476.455.785 | 91,34% | 183.580.948 | 89,79% |
| | BRAZIL | 5.570 | 5.995.786.998 | 100,00% | 204.450.049 | 100,00% |

Source: IBGE (2021)

Scenario

- The scenario consists of evaluating the inter-regional impact of the labor productivity reduction in the affected regions.
- For this, the estimates of the average annual growth of labor productivity for the Brazilian economy sectors in the period of 2002-2013 made by Veloso et al (2015) were used as a reduction parameter.

Equation of Labor Technical change by Occupation:

$$LABOR_{j,q} * a1lab_{j,q} = \sum_o [LAB_OCC_IND_{o,j,q} * a1labo_{o,j,q}]$$

- We use the standard short run closure.

Shock Values

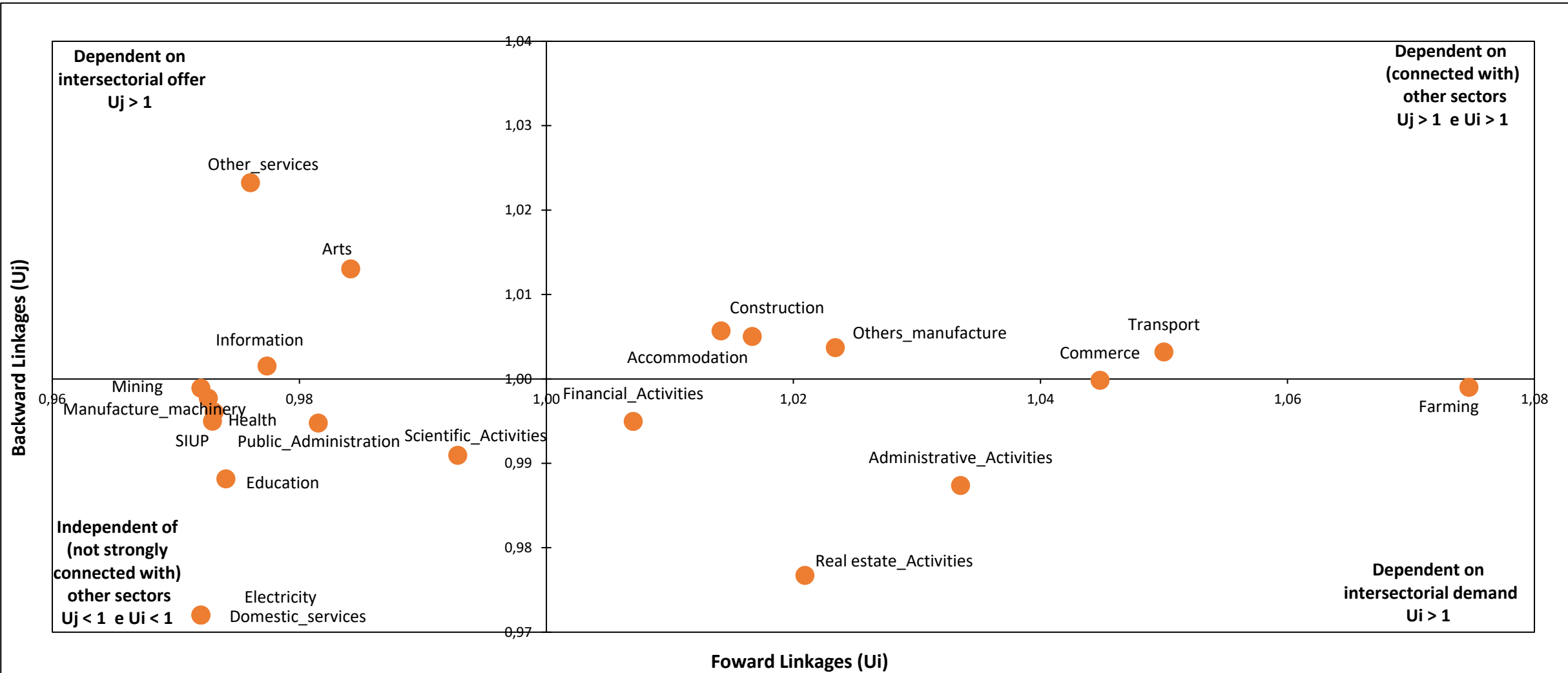
The shock has been implemented in R2 and R3 regions of the model

| Sector | Variation (%) of labor productivity | Sector | Variation (%) of labor productivity |
|-----------------------|-------------------------------------|---------------------------|-------------------------------------|
| Farming | 6,40 | Information | 1,00 |
| Extractive_industries | 0,80 | Financial_Activities | 4,90 |
| Manufacture_food | 0,80 | Real estate_Activities | 0,70 |
| Manufacture_machinery | 0,80 | Scientific_Activities | 1,40 |
| Others_manufacture | 0,80 | Administrative_Activities | 1,40 |
| Electricity | 0,80 | Public_Administration | 0,90 |
| SIUP | 2,10 | Education | 1,40 |
| Construction | 1,10 | Health | 1,40 |
| Commerce | 3,00 | Arts | 1,40 |
| Transport | 1,10 | Other_services | 1,40 |
| Accommodation | 1,40 | Domestic services | 0,00 |

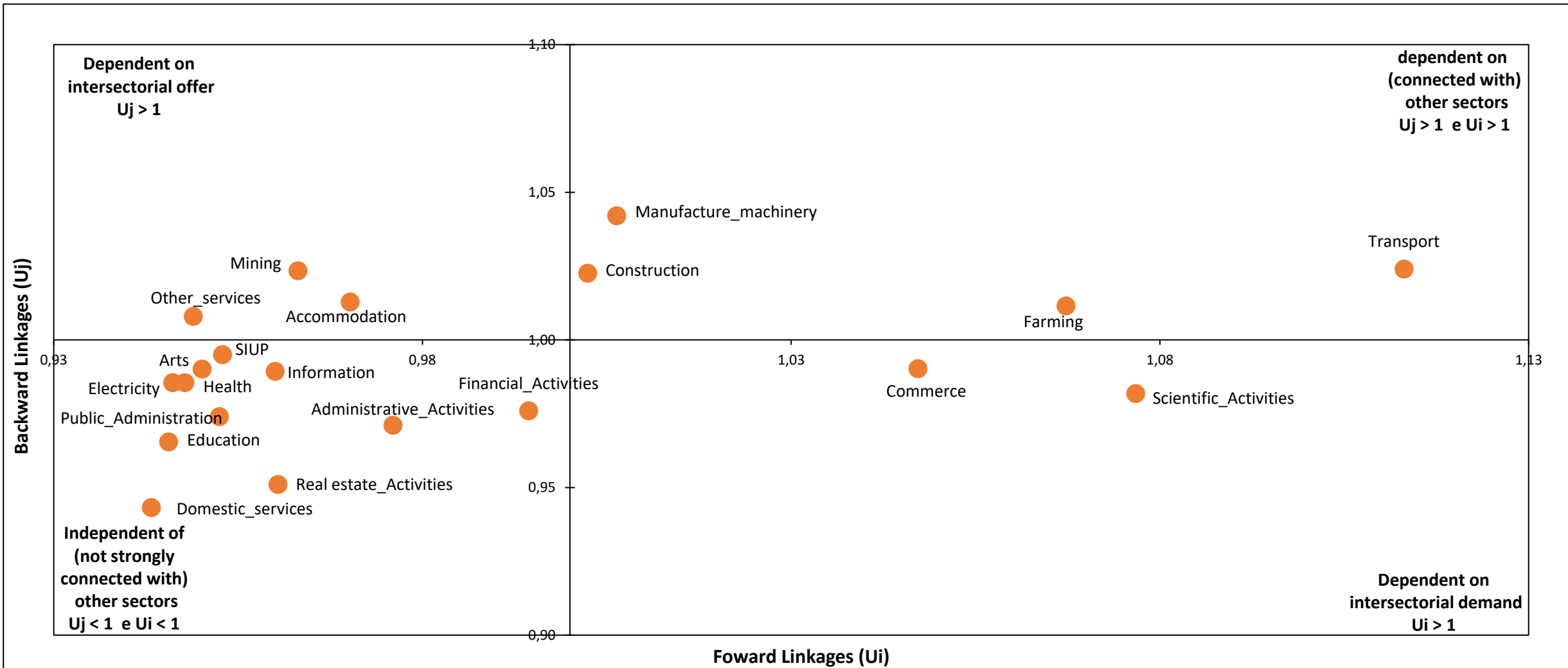
Source: Veloso et al (2015)

Results

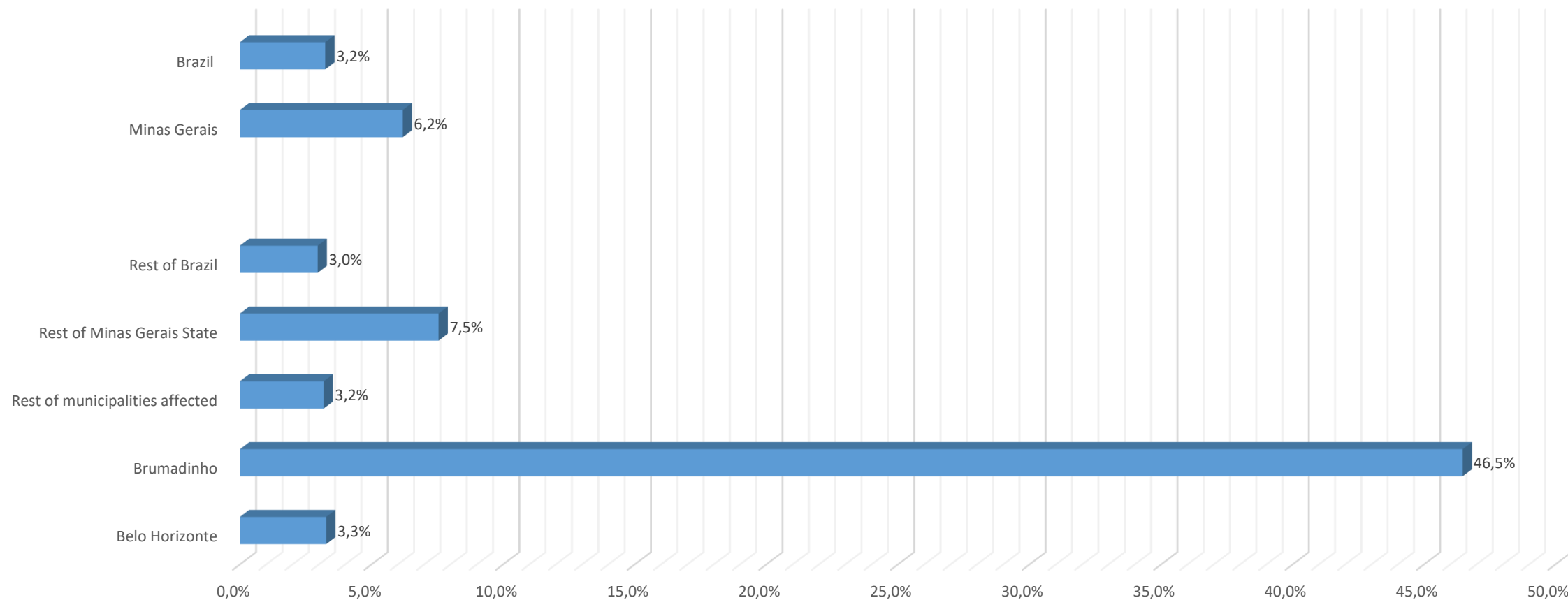
Brumadinho Linkages



Rest of Municipalities Affected Linkages



THE IMPORTANCE OF EXTRACTIVE INDUSTRY IN MINAS GERAIS AND BRAZIL



Results

| | GDP | HOUSEHOLD CONSUMPTION | EMPLOYMENT | EXPORT | IMPORT |
|---------------------------------|--------|-----------------------|------------|--------|--------|
| Belo Horizonte | -0,016 | -0,035 | -0,025 | -0,003 | 0,018 |
| Brumadinho | -0,246 | -0,563 | 0,289 | -0,125 | -0,168 |
| Rest of municipalities affected | -0,444 | -0,858 | 0,501 | -0,326 | -0,336 |
| Rest of Minas Gerais | -0,003 | -0,004 | -0,004 | -0,007 | 0,007 |
| Rest of Brazil | -0,002 | -0,003 | -0,003 | -0,002 | -0,021 |

Activity Level

| | Belo Horizonte | Brumadinho | Rest of municipalities affected | Rest of Minas Gerais | Rest of Brazil |
|---------------------------|----------------|------------|---------------------------------|----------------------|----------------|
| Farming | 0,025 | -0,668 | -0,698 | 0,001 | -0,001 |
| Extractive_ind | -0,014 | -0,125 | -0,145 | -0,001 | 0,001 |
| Manufacture_food | -0,052 | -0,297 | -0,283 | -0,009 | -0,004 |
| Manufacture_machinery | -0,084 | -0,475 | -0,328 | -0,076 | -0,069 |
| Others_manufacture | -0,015 | -0,225 | -0,219 | 0 | 0,002 |
| Electricity | -0,006 | 0 | -0,104 | 0 | 0 |
| SIUP | -0,271 | -1,788 | -1,993 | -0,128 | 0,019 |
| Construction | -0,007 | -0,261 | -0,293 | 0 | 0 |
| Commerce | -0,002 | -0,999 | -1,007 | -0,001 | -0,001 |
| Transport | -0,013 | -0,42 | -0,427 | -0,002 | -0,002 |
| Accommodation | -0,014 | -0,442 | -0,463 | -0,001 | 0 |
| Information | -0,013 | -0,346 | -0,362 | 0 | 0 |
| Financial_Activities | -0,004 | -1,231 | -1,234 | 0 | 0 |
| Real estate_Activities | 0 | -0,006 | -0,006 | 0 | 0 |
| Scientific_Activities | -0,01 | -0,395 | -0,422 | 0 | 0,001 |
| Administrative_Activities | -0,022 | -0,781 | -0,712 | 0 | 0 |
| Public_Administration | -0,011 | -0,069 | -0,101 | 0 | 0,002 |
| Education | -0,016 | -0,633 | -0,62 | -0,008 | -0,009 |
| Health | -0,011 | -0,458 | -0,51 | -0,001 | -0,002 |
| Arts | -0,001 | -0,213 | -0,94 | 0,037 | -0,003 |
| Other_services | -0,027 | -0,373 | -0,409 | -0,001 | 0 |
| Domestic services | -0,031 | -0,155 | -0,429 | 0,045 | 0,053 |

Sectoral Exports

| | Belo Horizonte | Brumadinho | Rest of municipalities affected | Rest of Minas Gerais | Rest of Brazil |
|---------------------------|----------------|------------|---------------------------------|----------------------|----------------|
| Farming | -0,227 | 0 | -1,08 | -0,012 | 0,005 |
| Extractive_ind | 0,049 | -0,125 | -0,038 | -0,002 | -0,008 |
| Manufacture_food | -0,044 | 0 | -0,312 | -0,009 | -0,003 |
| Manufacture_machinery | -0,009 | 0 | -0,338 | 0,011 | 0,011 |
| Others_manufacture | -0,009 | -0,245 | -0,256 | -0,007 | -0,008 |
| Electricity | 0,026 | 0 | 0 | -0,002 | -0,008 |
| SIUP | 0,994 | 0 | 0 | 0,467 | -0,077 |
| Construction | 0,002 | 0 | 0 | -0,005 | -0,005 |
| Commerce | -0,008 | 0 | 0 | -0,004 | -0,002 |
| Transport | -0,001 | 0 | 0 | -0,004 | -0,004 |
| Accommodation | 0,011 | 0 | 0 | -0,005 | -0,005 |
| Information | 0,018 | 0 | 0 | -0,005 | -0,006 |
| Financial_Activities | 0,005 | 0 | 0 | -0,004 | -0,004 |
| Real estate_Activities | 0 | 0 | 0 | 0 | -0,006 |
| Scientific_Activities | 0,023 | 0 | 0 | -0,005 | -0,008 |
| Administrative_Activities | 0,018 | 0 | 0 | -0,004 | -0,006 |
| Public_Administration | -0,001 | 0 | 0 | -0,004 | -0,007 |
| Education | -0,004 | 0 | 0 | -0,004 | -0,004 |
| Health | 0 | 0 | 0 | -0,004 | -0,004 |
| Arts | -0,009 | 0 | -0,081 | -0,063 | -0,001 |
| Other_services | 0,029 | 0 | 0 | -0,003 | -0,005 |
| Domestic services | 0 | 0 | 0 | 0 | 0 |

Conclusions

- The dam rupture of Brumadinho in Minas Gerais affected directly 18 municipalities in Minas Gerais state.
- It generated severe socioeconomic and environmental effects.
- Simulations using B-Maria (Brumadinho) show that the aggregated results are small. However, the sectoral analysis demonstrates that differences in the output of the sector are more significant, as well as the impacts on exports from the extractive sector, which is an important component of the Brazilian trade balance.
- The estimation and calibration of this model are useful for future studies investigating the impacts of this disaster on the region. In addition to assisting in the planning of public policies to minimize the negative results of this tragedy.
- It is relevant for the analysis to incorporate capital productivity in the next simulations, considering that sectors most affected by the disruption are capital-intensive.

Thank You!

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