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Industry and Competitiveness Research Group (GIC)

# Disaggregated Gross Fixed Capital Formation in the Brazilian Economy 2000- 2013

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## Introduction

The Methodology for the Estimation of the CFMs

Some Results from Estimated CFMs

Next Steps

- Investment in fixed capital is an important element in the process of structural transformation of an economic system:
  - Embodied technical change;
  - It may lead to changes in the organization of production activities.
- Discovering which industries are leading the investment process in fixed capital is an important tool for the study structural change in the economy.
- Obstacle: the limited availability of disaggregated GFCF data in Brazilian official statistics.
  - There is no data for GFCF by industry in the Brazilian System of National Accounts (SNA).
- The Industry and Competitiveness research group of the Federal University of Rio de Janeiro (GIC-UFRJ) developed a methodology to disaggregate GFCF Brazilian data by means of the estimation of Capital Flow Matrices (CFMs).

- The first CFM for the Brazilian economy was estimated for 2005 by the GIC-UFRJ in the context of the project “Investment Perspectives in Brazil” (UFRJ/UNICAMP) financed by the Brazilian Development Bank (BNDES);
- A second version was developed as a part of the Project LA-KLEMS by the GIC-UFRJ. It extended and adapted the first proposal for the 2000-2007 period ;
- A third version was developed as a part of the Project LA-KLEMS by the GIC-UFRJ in association with IPEA and Petrobras. It used new data which made it possible the estimation of CFMs for the 2000-2009 period;
- The present version estimates the CFMs for 2000-2013 with reworked database (FINAME/BNDES and Non-residential construction) and correspondence tables. This version is fully compatible with the last methodology mark for the Brazilian SNA (Ref. 2010).

The Brazilian SNA Ref. 2010 follows the UN’s SNA 2008 Standards

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- The CFM can be considered as an “addendum” to the Input-Output Matrix database.
- It disaggregates the vector of total GFCF present in the SUTs of the Brazilian System of National Accounts (SNA) to obtain the GFCF by industry.
- We estimate four CFMs: a Total CFM at consumers price; a Total CFM at basic prices; a National Supply CFM at basic prices; and a Imported Supply CFM at basic (CIF) prices.
- CFMs valuated at basic prices are related as follows:

$$\text{Total CFM} = \text{National Supply CFM} + \text{Imported Supply CFM}$$

## Simplified example of a CFM

| Product      | Industry 1 | Industry 2 | Industry 3 | Total       |
|--------------|------------|------------|------------|-------------|
| Product 1    | 100        | 150        | 50         | 300         |
| Product 2    | 50         | 80         | 120        | 250         |
| Product 3    | 20         | 200        | 140        | 360         |
| Product 4    | 160        | 140        | 150        | 450         |
| <b>Total</b> | <b>330</b> | <b>570</b> | <b>460</b> | <b>1360</b> |

  

Total GFCF by Industry

Total GFCF by product

Total GFCF

Source: MIGUEZ (2016)

- The methodology involves the estimation of an “Allocation Matrix” and a “Weighting Matrix” that allow us to distribute total GFCF products by each industry;
- Three steps are necessary:
  - Calculate total GFCF evaluated at basic;
  - Identify for each GFCF product user and non-user industries;
  - Define the information used to calculate the weights of GFCF demand of user industries in total GFCF demand for each product;
- The data for the estimation of these two matrices comes from different sources which are heterogeneous in terms of:
  - Availability;
  - Quality
  - Type of valuation;
  - Classifications.



- The estimation of the CFMs is very demanding. It requires the combination of two major groups of data:
- Data related to GFCF:
  - Total GFCF by products are available in the SUTs (valuated at current and last year consumers prices);
  - Imported GFCF products which are available in the Brazilian international trade database system (AliceWeb).
- Data used in the compilation of the allocation and weighting matrices:
  - Total Output by Industry (SNA);
  - Annual Extractive and Manufacturing Industry Survey (PIA) - Product view;
  - Annual Extractive and Manufacturing Industry Survey (PIA) - Enterprise view;
  - Annual Construction Industry Survey (PAIC);
  - Annual Wholesale and Retail Trade Survey (PAC);
  - Annual Survey of Services (PAS);
  - FINAME/BNDES (credit line for the acquisition of machinery and equipment).

- The “Allocation Matrix” define the user and non-user industries for each GFCF product.
- The elements of these matrices are ones and zeros that, for each GFCF product, identify user and non-user industries respectively.
- We used the following criteria in its construction:
  - Product description at a very disaggregated level;
  - Analysis by expert engineers (field research\*);
  - Technical information;
  - Similarity with products already classified.

\*Field research: Expert Engineers filled a form where they reviewed and refined the elements of the allocation matrix :

## An extract of the Allocation Matrix

| Products                     | Industries                 |                   |                       |
|------------------------------|----------------------------|-------------------|-----------------------|
|                              | Animal raising and fishing | Business services | Public administration |
| Purebred horses for breeding | 1                          | 0                 | 0                     |
| Revolvers and pistols        | 0                          | 1                 | 1                     |
| Wood office furniture        | 1                          | 1                 | 1                     |

Source: MIGUEZ (2016)

- The product “Purebred horses for breeding” is required only by the “Animal raising and fishing” industry;
- The product “Revolvers and pistols” is required only by “Business services” (where private security is in) and “Public Administration” (to equip the police and the army);
- The product “Wood office furniture” is for general use (i.e., all industries demand some furniture);

## Imported Supply CFM ( $CFM_{IS}$ )

- Basic information used:
  - Import values by product (listed by NCM/HS) in US\$ CIF units from the Brazilian international trade database system (AliceWeb ), which were then converted into Real CIF units (R\$ CIF); the result is aggregated to obtain a vector of total imported GFCF products compatible with the SNA product classification.
  - The estimated “Allocation Matrix”;
  - Total Output from the SUTs of the SNA;
- Estimation of the Weighting Matrix:
  - Multiplication of each column of the “Allocation Matrix” by the total Output of the corresponding industry;
  - Division of each line of the matrix obtained in the last step by the sum of its own respective line, so that each line sums up 100%
- Estimation of the Imported Supply CFM:
  - Multiplication of each line of the “Weighting Matrix” by the corresponding value of total imported GFCF product.

## Total CFM at basic prices ( $CFM_{Tpb}$ )

- Basic information used:
  - Total GFCF by product (from the SUTs of the SNA);
  - The estimated “Allocation Matrix”;
  - To calculate the “Weighting Matrix”: Total Output by Industry, Annual Survey of Extractive and Manufacturing Industry, Annual Survey of Extractive and Manufacturing Industry (PIA), Annual Survey of Construction (PAIC), Annual Survey of Wholesale and Retail Trade (PAC), Annual Survey of Services (PAS), FINAME/BNDES;
- Estimation of the “Weighting Matrix”:
  - Multiplication of each line of the “Allocation Matrix” by the values by industry of the chosen source for the weights;
  - Division of each line of the matrix obtained in the last step by the sum of its own respective line, so that each line sums up 100%.
- Estimation of the Total CFM ( $CFM_{TS}$ ):
  - Multiplication of each line of the “Weighting Matrix” obtained in the last step by the corresponding value of total GFCF product at basic prices.

## National Supply CFM ( $CFM_{NS}$ )

- The  $CFM_{NS}$  is calculated by the difference between the  $CFM_{TS}$  and the  $CFM_{IS}$ ;
- However, because the data used in the last two matrices come from different sources, and were also subjected to some manipulation, they are not fully compatible with each other;
- As a consequence, some  $CFM_{NS}$  elements end up assuming negative values;
- To correct these values the hypothesis we supposed that the imported values from the estimated  $CFM_{IS}$  were more “accurate”. Thus we used the following criteria :
  - If a  $CFM_{NS}$  element is positive, we maintained the value estimated;
  - If a  $CFM_{NS}$  element is negative, we assumed that the corresponding element in the  $CFM_{TS}$  is equal to the value of the corresponding element in the  $CFM_{IS}$ ;

$$CFM_{TS} - CFM_{IS} < 0 \Rightarrow CFM_{NS} < 0 \longrightarrow CFM_{IS} = CFM_{TS} \Rightarrow CFM_{NS} = 0$$

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- We will briefly present here the following indicators calculated from the estimated CFMs at constant basic prices:
  - i. GFCF Average growth rates by industry;
  - ii. Average GFCF share of each industry in total GFCF;
  - iii. The contribution of each industry to total GFCF growth;
  - iv. Average imported GFCF share of each industry in total imported GFCF.



- High performance industries in terms of GFCF along the period:
  - “Agriculture, forestry and fishing”;
  - “Mining and quarrying”;
  - “Electricity and public utilities”;
  - “Transportation and Storage”;
  - “Public administration”.

- Service industries:
  - Above average performance in terms of average growth rates;
  - Low contribution to total GFCF growth rate, as result of their relatively low GFCF share in total GFCF;
  - Above average imported GFCF share in total imported GFCF, albeit with a downward trend along the period.

- “Manufacturing” industries :
  - Below average GFCF rate of growth (except during 2010-2013);
  - Largest GFCF share => Despite the low growth rates, it presented a large contribution to total GFCF growth;
  - High imported GFCF shares in total GFCF;
  - Heterogonous performance in terms of its sub-sectors:
    - › Good performances: “Food and beverages”, “Paper and paper products”, “Coke and refined petroleum”, “Machine e equipment” and “Motor vehicles”;
    - › Bad performances: “Textile”, “Clothing articles and accessories”, “Leather and related products” and “Chemicals and chemic products”.

## Average Annual Growth (2000-2013) - SNA 12

| SNA 12   | 2000-2003    | 2003-2010   | 2010-2013   | 2000-2013   |
|--|--------------|-------------|-------------|-------------|
| Agriculture, forestry and fishing                | 6,4%         | 6,6%        | 7,1%        | 6,7%        |
| Mining and quarrying                             | 16,3%        | 10,3%       | 9,3%        | 11,5%       |
| Manufacturing                                    | -7,7%        | 4,3%        | 10,2%       | 2,7%        |
| Electricity and public utilities                 | 14,9%        | 10,9%       | -4,1%       | 8,1%        |
| Construction                                     | -4,8%        | 12,8%       | 7,5%        | 7,3%        |
| Domestic trade                                   | -11,9%       | 4,8%        | 21,6%       | 4,2%        |
| Transportation and storage                       | -3,8%        | 17,8%       | -13,9%      | 4,6%        |
| Information and communication services           | -0,7%        | 10,4%       | 0,8%        | 5,5%        |
| Real estate                                      | -4,1%        | 8,3%        | 14,6%       | 6,7%        |
| Other services                                   | -6,8%        | 13,0%       | 15,3%       | 8,6%        |
| Financial services                               | -51,7%       | 54,8%       | 1,7%        | 7,4%        |
| Public administration + Residential construction | -4,7%        | 13,8%       | -2,5%       | 5,4%        |
| <b>Total</b>                                     | <b>-3,0%</b> | <b>9,8%</b> | <b>3,5%</b> | <b>5,3%</b> |

Source: MIGUEZ (2016)

## Average Annual Share on Total GFCF (2000-2013) - SNA 12

| SNA 12   | 2000-2003     | 2003-2010     | 2010-2013     | 2000-2013     |
|--|---------------|---------------|---------------|---------------|
| Agriculture, forestry and fishing                | 9,5%          | 9,6%          | 9,4%          | 9,4%          |
| Mining and quarrying                             | 3,6%          | 3,7%          | 4,9%          | 4,0%          |
| Manufacturing                                    | 34,0%         | 27,7%         | 24,2%         | 28,1%         |
| Electricity and public utilities                 | 7,4%          | 9,3%          | 11,0%         | 9,2%          |
| Construction                                     | 4,5%          | 4,2%          | 5,2%          | 4,6%          |
| Domestic trade                                   | 6,9%          | 4,4%          | 5,8%          | 5,4%          |
| Transportation and storage                       | 7,7%          | 12,0%         | 10,0%         | 10,4%         |
| Information and communication services           | 3,5%          | 4,1%          | 3,9%          | 3,9%          |
| Real estate                                      | 0,8%          | 0,8%          | 0,9%          | 0,8%          |
| Other services                                   | 4,1%          | 4,3%          | 5,6%          | 4,8%          |
| Financial services                               | 0,4%          | 0,7%          | 1,2%          | 0,8%          |
| Public administration + Residential construction | 17,5%         | 19,3%         | 17,8%         | 18,5%         |
| <b>Total</b>                                     | <b>100,0%</b> | <b>100,0%</b> | <b>100,0%</b> | <b>100,0%</b> |

Source: MIGUEZ (2016)

## Contribution to Average Annual Growth (2000-2013) - SNA 12

| SNA 12   | 2000-2003    | 2003-2010   | 2010-2013   | 2000-2013   |
|--|--------------|-------------|-------------|-------------|
| Agriculture, forestry and fishing                | 0,6          | 0,7         | 0,7         | 0,6         |
| Mining and quarrying                             | 0,5          | 0,5         | 0,4         | 0,4         |
| Manufacturing                                    | -2,6         | 1,1         | 2,3         | 0,8         |
| Electricity and public utilities                 | 1,2          | 1,3         | -0,5        | 0,7         |
| Construction                                     | -0,2         | 0,5         | 0,4         | 0,3         |
| Domestic trade                                   | -0,9         | 0,2         | 1,1         | 0,3         |
| Transportation and storage                       | -0,3         | 1,8         | -1,5        | 0,4         |
| Information and communication services           | 0,0          | 0,4         | 0,0         | 0,2         |
| Real estate                                      | 0,0          | 0,1         | 0,1         | 0,1         |
| Other services                                   | -0,3         | 0,5         | 0,8         | 0,5         |
| Financial services                               | -0,3         | 0,2         | 0,0         | 0,1         |
| Public administration + Residential construction | -0,8         | 2,4         | -0,5        | 0,9         |
| <b>Total</b>                                     | <b>-3,0%</b> | <b>9,8%</b> | <b>3,5%</b> | <b>5,3%</b> |

Source: MIGUEZ (2016)

## Average Imported Share on Industry GFCF (2000-2013) - SNA 12

| SNA 12   | 2000-2003    | 2003-2010    | 2010-2013    | 2000-2013    |
|--|--------------|--------------|--------------|--------------|
| Agriculture, forestry and fishing                | 6,1%         | 4,3%         | 4,7%         | 4,9%         |
| Mining and quarrying                             | 30,6%        | 23,8%        | 16,8%        | 24,3%        |
| Manufacturing                                    | 50,4%        | 40,4%        | 41,6%        | 43,5%        |
| Electricity and public utilities                 | 50,5%        | 46,0%        | 41,7%        | 46,4%        |
| Construction                                     | 16,5%        | 14,8%        | 15,8%        | 15,5%        |
| Domestic trade                                   | 21,9%        | 20,6%        | 16,4%        | 20,1%        |
| Transportation and storage                       | 21,6%        | 10,1%        | 23,4%        | 16,2%        |
| Information and communication services           | 58,6%        | 41,2%        | 33,0%        | 44,4%        |
| Real estate                                      | 34,6%        | 19,3%        | 18,4%        | 23,5%        |
| Other services                                   | 37,0%        | 29,5%        | 17,1%        | 29,0%        |
| Financial services                               | 66,7%        | 28,3%        | 19,6%        | 37,4%        |
| Public administration + Residential construction | 45,7%        | 35,1%        | 66,8%        | 45,0%        |
| <b>Total</b>                                     | <b>32,5%</b> | <b>30,0%</b> | <b>26,1%</b> | <b>25,3%</b> |

Source: MIGUEZ (2016)

Introduction

CFM's Estimation Methodology

Results from CFM's Estimations

**Next steps**



- Resumption of the technical cooperation agreement between the GIC-UFRJ and the IBGE (Brazilian official statistical office);
- Transference of the experience in the compilation of disaggregated GFCF data to IBGE;
- In the future, we hope that IBGE will assume the compilation of CFMs or a similar database with information on the GFCF by industry.

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