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Key-words: flow of funds, asset liability matrix, financial imbalance, system of national account, financial instruments

JEL Code: C67, D53, G20, N26, O16

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1. Introduction

The subprime mortgage crisis highlighted a clear gap regarding the lack of useful and timely information on where the risks were, their scale, and how they flowed through an economy. In addition, the lack of transparency and limited coverage of statistical information on markets and the financial system, as well as the lack of theoretical concepts, made it difficult for policy makers and market participants to understand the transmission and develop effective surveillance and timely responses to the financial streams.

In response, the Financial Stability Board (FSB) and International Monetary Fund (IMF), in close cooperation with national central banks and statistical institutes, began collecting and structuring information on both the macro- and micro-structures of markets. Additionally, they began developing and disseminating methods to measure and monitor economic imbalances.

The financial crisis has provided new context for gaining insights on how to measure vulnerabilities in the non-financial sectors that can feedback into the financial system and vice versa. Empirical analyses are crucial to address how the financial positions of households and non-financial firms affect borrowers' defaults, and therefore ultimately, the position of financial institutions' balance sheets. In that regard, having better data on income and savings as well as on the household debt sector are also required.

The greater availability of sector accounts and financial statements allows for greater advanced knowledge on systemic risks and vulnerabilities as well as on the relationship between real sector accounts and the analysis of financial accounts. As highlighted by the FSB (2009), the flow of funds (FOF) provides an additional focus on vulnerabilities

arising from the maturity (liquidity), monetary (internal/external), and capital (leverage) structures of the major financial sectors.

In this context, the FOF method was "revived"[3] and complementary approaches were developed to explain the theoretical foundations. FOF can be used alongside the national account since it includes financial transactions in its regional analysis, pointing to its role as supporting real transactions and allowing observation of the changes between real and financial linkages. As such, it aids in understanding the formation and collapse of financial bubbles, and its application should be encouraged.

National Financial Balances (NFBs) are a key input in the FOF method. These accounts consist of a set of articulated balance sheets held by institutional sectors in the economy. If updated NFBs are accessible, policy makers should monitor funds to preview imbalances in order to give them time to adjust the provision or absorption of funds accordingly to control and prevent an undesired situation.

The Organization for Economic Cooperation and Development (OECD) discloses NFBs and financial accounts to a group of countries, including Brazil, but its lag time is about 3 years.

Since 1999, monetary policy in Brazil, as established by the Monetary Policy Committee (COPOM), has been following an inflation target regime with the main instrument being the short-term interest rate in the overnight interbank reserve market (SELIC). The Central Bank of Brazil (BCB) seeks to ensure the inflation target through open market operations coupled with rediscounts and a requirement of compulsory deposits.

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[3] Tsujimura and Mizoshita (2003) present the compilation procedure of the Asset-Liability-Matrix from the FOF accounts in the balance sheet format and its input–output analysis application. Leung and Secrieru (2012), Burkowski, et al (2016) and Aray, et al (2017) present the Financial and Social Accounting Matrix, the latter also presented the corresponding Asset-Liability-Matrix as a satellite account. Tsujimura and Tsujimura (2018) present a complete system of national accounts from the FOF method using flow data of current, capital, and financial accounts.

Through the maintenance of the macroeconomic tripod (free floating exchange rate, inflation target regime, and fiscal target) together with developmental economic policies and the liquidity of the international market, growth acceleration has been achieved by controlling inflation and lowering the real interest rate of the economy. However, recent years have shown some decreases in the growth's trajectory.

Table 1 shows the evolution of Brazil's gross domestic product (GDP) in current values and in exchange amounts, exchange rates, interest rates (SELIC), and the inflation target, as measured by the general price index (IPCA).

As can be seen in Table 1, the amount of GDP (volume) decreased in 2009, and in recent years (2015 and 2016) decreased again. Are real economy transactions or financial transactions the cause of these observed economic defaults?

In line with the worldwide trend of applying the FOF method to access relevant information about the structure and evolution of economic transactions, and on the basis that better information could be used to develop the most appropriate economic policies, this paper aims to better understand the origins of financial crisis from an FOF perspective.

Therefore, the FOF method is applied to discover any imbalances in the Brazilian economy and to determine whether the origins of financial crisis were related to the real economy or to pure financial transactions.

FOF imbalances can be observed using the difference in economic transactions between financial and non-financial firms over time, which means that funds are not flowing ordinarily to enterprises in order to finance their excess investments. Another kind of imbalance can be observed with growth in discrepancy of dispersion, which reflects the difference between assets' and liabilities' power of dispersion. The structural path

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decomposition (SPD) of change in the discrepancy of dispersion shows whether the origins of a crisis were due to real or financial transactions.

Although limited by the available data, FOF matrices were developed for the Brazilian economy from 2004 to 2015. From these, power of dispersion indices (PDIs) were developed to show the relative position of institutional sectors in the financial market. In order to observe the evolution of FOF and access imbalances, the total value of financial transactions (TVFT) both in the total economy and in each institutional sector were calculated and analyzed. To show when the economy was in financial crisis and to determine whether its origins were from the real economy or financial transactions, the discrepancy of dispersion was calculated and SPD was applied.

In the analysis, we used NFBs from the Brazilian Institute of Geography and Statistics (IBGE, 2011) and from the OECD (OECD, 2018). We also used the balance sheet of the BCB (BCB 2004 to 2015) to develop the FOF method's application.

Even with using lagged data on the state of the Brazilian economy, the FOF method was accurate in illustrating the moment when financial crisis reached the Brazilian economy. The diagnostic analysis provided by the FOF indices highlight how a financial crisis spreads through an economy, and allows for a number of recommendations, including the need for the monitoring of timely data. It also highlights the contributions of this paper.

The structure of the paper is as follows. Following this introduction, section 2 presents the main concepts of the FOF method of national accounts. Section 3 describes the application to the Brazilian economy as well as the methodology, data, and results. Section 4 gives some concluding remarks and highlights the main results.

2. From system of national accounts to FOF: main concepts

Keynes (1935) defined the fundamental concept of national accounts as well as its basic identities. Since the 1940s, economists developed measures to further build upon Keynesian Theory, with most countries eventually adopting some kind of system to account for national accounts.

The system of national accounts was later proposed by Simon Kuznetz in 1937 and improved on by Richard Stone, both of which popularized and disseminated the concept of the system of national accounts (SNA). In addition, the input-output system as proposed by Wassily Leontief (1936, 1943), the national wealth system as proposed by Raymond Goldschmidt (1933), and the system of FOF as proposed by Copeland (1949, 1952) are all alternative ways of calculating the national account. Table 2 presents the main account, resulting balance, and economic aggregates of the widely used SNA.

In current accounts, the gross value added by production accounts adjusted for the distribution of income results in gross disposable income (Income).

Gross disposable income (Income) minus all used income (Consumption) equals gross savings (Savings), which leads to the first macroeconomic identity:

I.   Income − Consumption = Savings

In the accumulation account, gross savings (Savings) minus gross fixed capital formation (Investments) equals net capacity or borrowing requirement, which leads to the second macroeconomic identity:

II.   Savings − Investments = Net capacity or borrowing requirement

The financial balance sheet account (FBSA) compiles the stock of financial assets and liabilities held by economic agents on an initial date, all changes to those assets and liabilities that occur during the period, and the financial assets and liabilities held on the final date.

From the perspective of the SNA, the main result of the FBSA is net worth. Changes in net worth come from changes in net capacity or the borrowing requirement. Net capacity increases net worth, and may be countered by an increase in financial assets or by a larger decrease in liabilities. On the other hand, the net borrowing requirement decreases net worth, and may be countered by an increase in liabilities or by a larger decrease in financial assets.

The result of current and accumulation accounts is that they generate a flow (increases and decreases) of financial assets and liabilities, which leads to changes in the overall stock of financial assets and liabilities.

Therefore, net capacity or borrowing requirement equals the change in the stock of financial assets and liabilities, which leads to the third macroeconomic identity:

III.   Financial assets − Liabilities = Net capacity or borrowing requirement

If II and III are both true, it follows that the fourth macroeconomic identity is the fundamental concept of the FOF method:

IV.   Savings − Investments = Financial assets − Liabilities

Table 3 presents the uses and resources of current, capital, and financial balance sheet accounts in an accounting scheme (T-account).

The accumulation account is a continuation of the current account, as both are flows, and together they represent the result of the real economy. In table 3, income is the resource, consumption is current account usage, and savings are the balance. This result is then

transferred to the capital account where savings are resources and investments are uses of capital, with the balance being net capacity or borrowing requirement.

The FBSA is a stock account, with liabilities as resources and financial assets as uses of funds, that measures the economy's financial health. The linkage is that the change observed in the stock of financial assets and liabilities represents the net capacity or borrowing requirement of capital.

The FOF method explores the concept that the real economy is affected by changes in the stock of financial assets and liabilities. Therefore, from analyzing the internal changes of elements in the FBSA, it is possible to estimate the impact of these change on the real economy. This is the linkage explored by FOF.

There are two possible economic results coming from current and capital accounts (hereinafter real economy): (1) net capacity requirement, and (2) net borrowing requirement.

Economic result (1) occurs when savings are larger than investments; the result is a positive net capacity/borrowing requirement, and there is more savings than investments. The difference between the changes in the stock of financial assets and liabilities is positive. The identity that holds true in the financial account is given by V:

V.   Financial assets + Net capacity = Liabilities

Economic result (2) occurs when investments are larger than savings. If the result of the current account is a net borrowing requirement, it happens because there are more investments than savings and, necessarily, changes in the stock of liabilities will be bigger than changes in the stock of financial assets. The identity which holds true in the financial account is given by VI:

VI.   Financial assets = Liabilities + Net borrowing requirement

Table 4 and 5 present two possible economic scenarios in the accounting scheme.

FOF Method

The FOF analysis was developed by Copeland (1949, 1952), with the "system of money flow" being presented as a set of interrelated T-shaped accounts in a single table that records financial assets and liabilities held economy-wide and by each institutional sector. It is a T-shaped account wherein each use has a corresponding resource with the same amount.

Each institutional sector is located in a column, and corresponding financial assets and liabilities, detailed by financial instruments, are located in rows. For each institutional sector, there are two columns (uses and resources): one for assets and the other for liabilities. Since each payment must have a corresponding receiver of funds, the row sums of the assets are equivalent to the row sums of the total economy's liability. However, the total asset of a sector does not necessarily match its own total liability, and if the difference is posted as a surplus of funds, it means there are excess savings in the real economy. If there is a deficiency of funds, however, it means that there is excess investment in the real economy.

With this system, it is possible to visualize the whole economy and aggregate institutional sectors, the total stock of assets, the total stock of liabilities, and any excess assets or liabilities, which together shows the excess savings or investments in the real economy.

The methods of converting T-shaped accounts into a matrix format were proposed independently by Stone (1966) and Klein (1983). The Stone and Klein formulas can be used as a pair because the two methods are symmetrical in their mathematical operations. The first step in using them together is to extract the asset and liability tables from the FBSA.

The asset table (P-Table) is composed of all financial assets held by institutional sectors (p_{ki}), excess liabilities in relation to assets (ρ_i), the totals by instrument (t_k^P), and the total by sector (t_i). The semantic structure of the asset table (P-Table) is presented in Table 6.

Similarly, the liability table (R-Table) consists of all the resources of funds obtained from liabilities by the institutional sectors (r_{ki}), excess assets in relation to liabilities (ψ_i), the totals by instrument (t_k^R), and by sector (t_i). The semantic structure of the liability table (R-Table) is presented in Table 7.

Tsujimura and Mizoshita (2003) and Tsujimura and Tsujimura (2010) demonstrated that the Stone and Klein methods are identical in the sense that they convert two transaction × sector matrices into a sector × sector matrix. However, while the Stone formula uses the right-hand side (receipts or liabilities) of the T-account as its base, the Klein formula uses the left-hand side (payment or assets) of the T-account as its base.

P is defined in the asset table and R in the liability table, while p_{ki} and r_{ki} denote those elements, in the format of Tables 6 and 7. While k indicates transaction instruments, i denotes the institutional sector; n and m are the number of transaction instruments and institutional sectors so that P and R are both in n x m matrices.

The diagonal matrices included are $\hat{T}$, $\hat{T}^P$, and $\hat{T}^R$. $\hat{T}$ is defined in the m × m matrix, with t_i as its diagonal elements and zeros elsewhere. Likewise, $\hat{T}^P$ and $\hat{T}^R$ are n × n diagonal with t_{pk} and t_{rk} as elements, respectively. Ψ and P are vertical vectors of dimension m whose elements are ψ_i and p_i, where, p_i is excess savings and ψ_i is deficiency of funds, according to identities V and VI. Equations 1 to 3 present this relationship:

$$t_i = max(\textstyle\sum_{k=1}^{n} p_{ki}, \sum_{k=1}^{n} r_{ki})$$
Eq. 1

$$t_k^P = \textstyle\sum_{i=1}^{m} p_{ki} \; ; \; t_k^R = \sum_{i=1}^{m} r_{ki}$$
Eq. 2

$$\psi_i = t_i - \textstyle\sum_{k=1}^{n} p_{ki} \geq 0; \; \rho_i = t_i - \sum_{k=1}^{n} r_{ki} \geq 0$$
Eq. 3

Where ψ_i and ρ_i are surplus and deficiency of funds, respectively, according to macroeconomic identities V and VI.

The Stone and Klein formulas are denoted by the superscripts S and K, respectively, and the apostrophe denotes a transposed matrix. Equations 4 and 5 present this relationship:

$$U^S \equiv R; V^S \equiv P'$$
Eq. 4

$$U^K \equiv P; V^K \equiv R'$$
Eq. 5

Next, in order to define matrices $B^S, D^S, B^K,$ and D^K, the coefficients of the matrices in Equations 4 and 5 are divided by the column sum in each cell, and are expressed by Equations 6 and 7:

$$B^S = U^S \hat{T}^{-1}; D^S = V^S (\hat{T}^P)^{-1}$$
Eq. 6

$$B^K = U^K \hat{T}^{-1}; D^K = V^K (\hat{T}^R)^{-1}$$
Eq. 7

The FOF matrices Y^S and Y^K, and the corresponding coefficient matrices C^S and C^K, are defined according to Equation 8 with sector-by-sector FOF matrices being represented by Equation 9:

$$C^S = D^S B^S; \; C^K = D^K B^K \qquad\qquad \text{Eq. 8}$$

$$Y^S = C^S \hat{T}; \; Y^K = C^K \hat{T} \qquad\qquad \text{Eq. 9}$$

Y^S and Y^K are sector-by-sector FOF accounts; therefore, y_{ij}^S indicates how many funds sector i obtains from sector j (in monetary value) and y_{ij}^K indicates how many funds sector j employs in sector i (in monetary value).

TVFT

Each column of Y^S and Y^K shows the TVFT of each sector; that is, the sum of the enterprises column in Y^S shows the total value of financial transactions made by enterprises. The sum of each column represents the TVFT of the whole economy.

The TVFT of each institution can be expressed by Equation 10, and the TVFT of the entire economy, Z_{ij}, is expressed by Equation 11:

$$Z_j^S = \sum_{i=1}^{m} y_{ij}^S; \; Z_j^K = \sum_{i=1}^{m} y_{ij}^K \qquad\qquad \text{Eq. 10}$$

$$Z^S = \sum_{j=1}^{m} \sum_{i=1}^{m} y_{ij}^S; \; Z^K = \sum_{j=1}^{m} \sum_{i=1}^{m} y_{ij}^K \qquad\qquad \text{Eq. 11}$$

Tsujimura and Tsujimura (2018) proposed equation 10 and 11 applying them to a matrix with flow of production, income and financial transactions, that is, total economic transaction. In that context they named the metric TVET. In the actual approach equation 10 and 11 are applied to an exclusively financial matrix, in this context, it will be named TVFT (total value of financial transactions).

As highlighted in Tsujimura and Tsujimura (2018), observing changes in the TVET of non-financial firms and the TVET of the whole economy matters because when the TVET of the entire economy grows more than the TVET of production sectors, it is evidence of vulnerability and economic imbalance. In the U.S. case, it was a sign of financial bubble formation.

PDI

PDI is a measure of the direct and indirect effects of a payment or receipt of funds from the Stone and Klein formulas. From the FOF coefficient matrices (C^S, C^K) as expressed in Equation 9, the FOF Leontief Inverse is defined according to Equations 12 and 13:

$$A^S = (I - C^S)^{-1}$$ Eq. 12

$$A^K = (I - C^K)^{-1}$$ Eq. 13

From the FOF Leontief inverse, the PDI from the Stone and Klein formulas are derived and expressed in Equations 14 and 15:

$$\omega_j^K = \frac{\sum_{i=1}^m a^S{}_{ij}}{\frac{1}{m}\sum_{j=1}^m \sum_{i=1}^m a^S{}_{ij}}$$ Eq. 14

$$\omega_j^S = \frac{\sum_{i=1}^m a^K_{ij}}{\frac{1}{m}\sum_{j=1}^m \sum_{i=1}^m a^K_{ij}} \qquad\qquad \text{Eq. 15}$$

where:

a^S_{ij} are the elements of the FOF Leontief Inverse from the Stone formula (A^S), and

a^K_{ij} are the elements of the FOF Leontief inverse from the Klein formula (A^K).

According to Mizoshita and Tsujimura (2003), the PDI from the Stone formula, hereinafter PDI-FR (Fund Raising) indicates the total demand for funds, both direct and indirect, as induced by an increase in demand for funds in a given sector j (as pointed out in the macroeconomic identity, when a sector has excess investment in the real economy).

PDI-FR shows the spreading effects of funds when there are variations in the demand for funds. On the other hand, the PDI from the Klein formula, hereinafter PDI-FE (fund employment) shows the spreading effects of funds when there are variations in the supply of funds. The supply of funds in the total economy, both direct and indirect, are induced by increases in the funds supply of a given sector j (excess savings in the real economy).

In the Stone formula, the indices represent the reaction caused by a demand for funds (excess investments) while in the Klein formula, the indices represent the reaction created by the supply of funds (excess savings).

Discrepancy of dispersion index and SPD

The PDIs previously presented is obtained by normalizing either column of the FOF Leontief inverse matrix. The dispersion of assets is obtained by adding the elements of the FOF Leontief inverse from the Stone formula and the dispersion of liabilities is

obtained by adding the elements of the FOF Leontief inverse from the Klein formula. The discrepancy of dispersion is the difference between asset dispersion and liability dispersion.

From the elements of the FOF Leontief inverse, as defined in Equations 12 and 13, liability dispersion is expressed in Equation 16 and asset dispersion in Equation 17.

$$w^S = \sum_{i=1}^{m} \sum_{j=1}^{m} a^S ij \qquad\qquad \text{Eq. 16}$$

$$w^K = \sum_{i=1}^{m} \sum_{j=1}^{m} a^K ij \qquad\qquad \text{Eq. 17}$$

Where:

w^S is the liability dispersion index,

w^K is the asset dispersion index,

$a^S ij$ are the elements of the FOF Leontief Inverse from the Stone formula (A^S), and

$a^K ij$ are the elements of the FOF Leontief inverse from the Klein formula (A^K).

Subtracting the liability dispersion index from the asset dispersion index gives the discrepancy of dispersion index (DDI), as shown in Equation 18.

$$w^{S-K} = w^S - w^K \qquad\qquad \text{Eq. 18}$$

DDI shows the difference between the sum of elements of the Leontief inverse matrices from Klein and Stone formulas.

That is, it shows the difference between the total power of dispersion of asset and liability, by demonstrating that systemic risks and vulnerabilities are related to both the real economy and financial accounts. This is the imbalance that can be observed using the FOF method.

SPD

The causes of Leontief inverse changes can be broken down into two categories: i) the sum of each element of the coefficient matrix, and ii) the distribution of coefficients among them. While the latter is a purely monetary phenomenon (i.e., the decision of the financial portfolio), the former is the reflection of the objective economy (the real economy), because excess assets and liabilities correspond to excess savings (supply of funds) or excess investments (demand of funds), respectively.

As such, structural path decomposition (SPD) is useful to determine whether the cause of financial bubbles lies in the structure of the financial market itself or is merely a mirror image of the objective economy, a lack of investment in plants and equipment, or similar.

DDI was defined previously in Equation 18. Equation 19 defines the decomposition of DDI as:

$$\Delta w^{S-K}{}_{t,t} = \left\{ \frac{(w^K{}_{t,t} - w^K{}_{t,t-1}) + (w^K{}_{t-1,t} - w^K{}_{t-1,t-1})}{2} - \right.$$

$$\left. \frac{(w^S{}_{t,t} - w^S{}_{t,t-1}) + (w^Y{}_{t-1,t} - w^Y{}_{t-1,t-1})}{2} \right\} + \left\{ \frac{(w^K{}_{t,t} - w^K{}_{t-1,t}) - (w^K{}_{t,t-1} - w^K{}_{t-1,t-1})}{2} - \right.$$

$$\left. \frac{(w^S{}_{t,t} - w^S{}_{t-1,t}) - (w^S{}_{t,t-1} - w^S{}_{t-1,t-1})}{2} \right\} \text{ Eq.19}$$

where subscript t,t defines the first and second period of the FOF Leontief inverse.

According to Mizoshita and Tsujimura (2004), the first term of the expanded right side of Equation 19 is the portion attributed to changes in the real economy (a decline or increase in savings and in investments) while the second term is the segment referring to changes in the structure of the financial market (alterations in asset–liability portfolio allocation).

3. Brazilian FOF Analysis

3.1 Methodology and Data

The P- and R-Tables were extracted from the NFB and the balance sheets of the BCB. From these, FOF matrices for the Brazilian economy were developed utilizing Equations 1 to 9 as previously described.

The NFB (IBGE, 2011 and OECD 2018) and balance sheets of the BCB (BCB 2004 the 2015) were the sources of data used in the development of Brazilian FOF analysis.

For the period of 2004 to 2009, the NFB was published as part of the Integrated Economic Accounts by the BCB together with Brazilian Institute of Geography and Statistics (IBGE, 2011). However, the publication was discontinued after 2009.

For the period of 2009 to 2015, the data were available only from OECD. Data from 2015 were the latest used before the preparation of this paper. In the future, we expect to include periodic updates. Non-consolidated SNA 2008 was also used (OECD, 2018).

Financial assets and liabilities are described using seven main financial instruments held by five institutional sectors. The main financial instruments of the NFB are listed below:

F0 Gold and DES[4]

F1 Cash and Deposits

F2 Titles

F3 Loans

F4 Shares

F5 Technical Insurance

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[4] F0 Gold and DES are not included in the FOF BR analysis because they refer to monetary funds.

F6 Derivatives

F7 Other

The five institutional sectors included in the NFB are non-financial firms, financial firms, households, the government, and the rest of the world.

The sector "financial firms" was separated into two groups: the BCB and "financial firms." This was done by subtracting the stock of assets and liabilities from the BCB's balance sheets and financial firms' stock of assets and liabilities presented in the NFB.

The BCB's balance sheet is released monthly together with other financial statements and explanatory notes. Annual data (i.e., data ending on December 31 of each year) from 2004 to 2015 were used in the analysis. The balance sheet is an accounting statement that represents stock accounts, indicating the inventory of assets (physical and financial assets), and liabilities (liabilities and shareholders' equity), which are held by an entity on a certain date. The preparation of the BCB's balance sheet follows the General Accounting Plan of the Central Bank. The BCB's balance sheet is available monthly since 1965. Table 8 presents the codification plan between the national balance accounts and the accounts the BCB's balance sheets.

In order to present an overview of the FOF, the relative position of the Brazilian economy's institutional sectors were determined by PDIs using Equations 14 and 15 as previously described. The results are combined in a graph where the PDI-FR is plotted on the horizontal axis and the PDI-FE on the vertical axis. With this combination, four graph positions are possible, and Table 9 presents these possibilities along with designations based on the economic position of institutional sectors according to their graph position.

In order to determine whether the origins of financial crisis are related to the real economy or to pure financial transactions and whether a changing difference between the transactions of financial and non-financial firms is in some way related to financial crisis, two measures are used:

i) DDI was calculated and decomposed, according to Equations 16 to 19 as previously described; and

ii) the difference between the TVFT of financial firms and the TVFT of the non-financial firms (hereinafter enterprises) is calculated, according to Equations 10 and 11 as previously described.

3.2 Results

The Brazilian 2015 FOF matrices from Stone and Klein results are shown in Tables 10 and 11, respectively.

Figure 1 presents the relative positions of institutional sectors in the economy from the FOF perspective, as determined by the scattering of PDI.

From the results, the BCB is shown to be in a structural position as a financial intermediary but with a reduction in the ability to disperse funds. The BCB graph position shows a trend towards the center of the chart. The PDI-FR decreases throughout the period, while there is an increase in the PDI-FE in 2009, after which it decreases.

As well as the BCB, financial firms also show a reduction in their ability to spread funds when raising them. However, different from the BCB, financial firms moved from the fourth to first quadrant by consolidating their position as a financial intermediary. Even with a reduction in PDI-FR, there was a high increase in PDI-FE. This indicates an improvement in the dispersion ability when employing funds.

Government presents a relevant change from the first quadrant to the fourth. The movement was much closer to yet moving away from the horizontal axis. From 2004 to 2015, the government has reduced its role as a financial intermediary and has increased its role in the investment sector.

Enterprises increased the PDI-FE until 2009, but after that began showing a reduction in their ability to employ funds. As the main investment sector of the economy, the concern is that a decrease in PDI-FR shows that enterprises' finances are being restricted.

Households maintained their structural position in the savings sector, as being the bigger provider of funds, showing growth in the PDI-FE and a decrease in the PDI-FR.

While all of domestic sectors reduced their PDI-FR, non-Brazilian economies, that is the rest of the world, increased their PDI-FR. This result illustrates that the Brazilian economy's saving surplus is being heavily allocated abroad.

The DDI of the Brazilian economy, asset dispersion, liability dispersion, and annual change in DDI from 2004 to 2015 is presented in Table 12.

From the table, there is a significant increase in the discrepancy in 2008, followed by a sharp decline in 2009. From 2010 to 2013, the discrepancy continually decreases. In 2014, there is an increase followed by another decline in 2015.

The high DDI in 2008 highlights the intensity of the financial crisis occurring at that time and its effects in Brazilian economy. In the following year (2009), Brazil experienced a shrinking economy, especially in its GDP growth rate.

The increase observed in 2014 also precedes a decline in economic growth. In fact, the total GDP amount (volume) of the Brazilian economy decreased in the following year

(2015). There is, however, a difference in magnitudes of the DDIs between 2008 and 2014.

It is interesting to note that variations in the supply and demand for funds, that is, the variations derived from the need for capital or having excess savings, seem to influence the DDI more than purely financial actions.

The SPD of DDI is shown in Table 13. In addition, Figure 2 shows the changing contribution of the objective economy as derived from changes in the supply and demand for funds, as well as the contribution of the financial market as derived from changes in financial assets and liability portfolios.

The change in DDI in the beginning of the period is mainly caused by changes in the objective economy. Financial portfolios adjust based on the results of current and capital accounts only. Economic growth requires greater efforts to raise funds in order to finance investments and also to provide options for allocating funds to the surplus savings of the saving sectors.

 DDI decomposition shows that changes in the supply and demand of funds change in the same direction as the DDI in all years. For changing the DDI, the contribution of changes coming from the supply and demand of funds is proportionally greater than the contribution of the change coming from the portfolios of financial assets and liabilities, except in 2008.

In fact, changes in the financial market occur in the opposite direction of the change in DDI in most years except for 2008 and 2009. There is a significant increase in

2008, which was influenced by the objective economy (40%) but was mainly caused by changes in the financial portfolio (60%).

The sharp fall in 2009 was mainly caused by changes in the real economy (88%), and changes in financial portfolios contributed to a decrease in the imbalance (12%).

The increase in DDI occurred in 2014 was mainly caused by the objective economy (52%), but different from the 2008 increase, the financial market contribution (47%) was in the opposite direction.

The TVFT, which includes liabilities transactions of the total Brazilian economy and of each institutional sectors, from 2004 to 2015 are presented in Figure 3 and Table 14.

Overall, the TVFT grew more than 300% between 2004 and 2015, but with decreasing growth rates. The highest growth rate is observed in 2007 and lower growth rates are observed in the years from 2008 to 2013.

The change in the total TVFT is not symmetrical across institutional sectors. Each sector presents differentiated changes corresponding to its level of participation in the financial transactions. It can be observed that the TVFT of the government and enterprise showed lower growth than the total economy, while the other sectors increased more than proportionally to the increase of the total. In particular, TVFT growth in the rest of the world is around 700% over this period. As this result is obtained by the Klein formula's FOF matrix, it corresponds to an increase in the rest of the world's PDI-FR.

Differences between the TVFT of financial firms and the TVFT of enterprises are presented in Figure 4.

From Figure 4, there is a growing increase in the difference between the TVFTs of financial firms and enterprises over time, with a peak being reached in 2008, which occurs simultaneously with the spread of the international financial crisis to peripheral countries. The difference between TVFTs decreased in 2009, at the same time that counter-cyclical credit and economic policies were facilitating the flow to corporate finance. From 2010 to 2013, the difference between TVFTs has been increasing, with a slight decrease occurring in 2014. Figure 5 shows the changes in the TVFT rate between financial firms and enterprises over time.

From 2005 to 2008, the growth rate of financial firms and the total economy was above the growth rate of enterprises.

Tsujimura and Tsujimura (2018) observed that between 2005 and 2007, the growth rate of the TVET of total economy was above the growth rate of the TVET of enterprises[5]. This period corresponds to the formation of the subprime mortgage bubble.

The Brazilian TVFT behavior is similar to US TVET behavior. However, in Brazil, the events leading up to the crisis extends to 2008. The crisis begins affecting real aspects of the Brazilian economy (reducing the GDP growth rate, decreasing investment, increasing unemployment, among others) only in 2009.

In 2009, enterprises' TVFT growth rate is higher than both that of financial firms and the total economy.

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[5] TVET refers to entire economic transactions, includes production, income and financial transactions (TSUJIMURA & TSUJIMURA, 2018), while TVFT includes exclusively financial transaction. Although conceptual difference, both of metrics allow the observation of the relative involvement of the sectors in the transactions occurred in the economy during a determinate period.

Between 2010 and 2012, the growth rate of financial firms' transactions was above the growth rate of enterprises' transactions, indicating imbalances.

In 2013 and 2014, the situation reverts back, and the TVFT growth rate of enterprises is greater than financial firms, but in 2015, it again returns to a state of imbalance.

According to internal reports (IBGE, 2018), the Brazilian GDP showed a declining growth rate beginning in 2010, with a small recovery in 2013, followed by a drastic fall in 2014 (growth of just 0.5%).

In this sense, it is necessary to be concerned that the most recent period shows an increase in the difference between financial and non-financial firms' TVFTs. It is not yet possible to know if this difference has peaked since there are no updated data for Brazil's NFB. Despite this lack of knowledge, however, we do know that the GDP has dropped in 2015 and again in 2016.

The growing difference between total transactions and transactions of enterprises indicates a greater concentration of transactions exclusively in the financial sector.

Together, these results point to an overall increase in total financial transactions. On the one hand, this indicates the growing participation of various agents in the financial market, but on the other hand, the observation that the growth of enterprises' transactions does not match the growth of the total TVFT is an indicator of the emergence of economic imbalances.

Changes in DDI combined with financial and non-financial firms' TVFT difference highlight that in level (financial and non-financial firms TVFT gap), the difference in 2015 is close to that observed in 2008.

4. Concluding Remarks

From the wider perspective of FOF, the power of dispersion showed that institutional sectors occupied an economic structural position. Financial firms improved their roles as financial intermediaries and the BCB facilitated that development, while households improved their roles as saving sectors, and the government more closely considered enterprises as investment sectors, but with restrictions on their ability to raise funds being present. Lastly, foreign economies were shown to receive a significant portion of Brazilian domestic savings.

Additionally, there are a number of imbalances in the Brazilian economy's FOF during the observed period. The total TVFT grew more than 300% from 2004 to 2015, but with a decreasing growth rate, and with a heterogeneous distribution of growth occurring between institutional sectors.

Most importantly, it was observed that the lowest rates of TVFT growth were accompanied by a significant increase in the DDI and occurred in the previews periods of economic default in Brazil. This situation happened in both 2008 and 2014. The Brazilian economy had a decrease in the GDP growth rate in 2009, and a decrease in the total amount of GDP in 2015 and 2016.

Structural decomposition showed that changes in the real economy were the primary contributor to the changes that occurred in the discrepancy of dispersion. Changes in the real economy were always in the same direction as the discrepancy, while changes in the financial market were usually in the opposite direction as the discrepancy.

Additionally, the difference between financial firms' total financial transactions and enterprises' total financial transactions grew in the years before economic default (2005 to 2008).

In 2008, changes in the financial portfolio were crucial to the economic default, as the difference between financial firms and enterprises' total financial transactions was extremely high. The decomposition showed that in this year, the greatest contribution to the high discrepancy dispersion came from financial changes.

In the next year (2009), the decline of the previously seen discrepancy was almost entirely caused by the real economy, with just the small contribution of the financial market being in the same direction of the discrepancy's decline. The high growth of enterprises' transactions greatly contributed to a decrease in the discrepancy.

Again, it was observed that the differences between financial firms and enterprises' total financial transactions also grew between 2010 and 2013, with the smallest rate being seen in 2013.

After three years of declining discrepancy, it began to grow again in 2014. At the smallest level of discrepancy in 2014, rather than in 2008, there was an effect of enterprises' financial transactions growing more than financial firms' financial transactions and for which the difference then declined in 2014.

Even with the observed decrease in discrepancy, attention should be drawn to the fact that the difference between financial firms and enterprises' financial transactions is still growing in the most recent data.

Going forward, there is a continued need for updated data of the NFB, especially in order to apply the FOF method alongside with the SNA, which would allow policy makers to keep up with any dramatic changes with the FOF. Consequently, by using these insights,

they could better understand the systemic risks and vulnerabilities expressed in FOF indices, power of dispersion, and differences between financial and enterprises (economic and financial) transactions, in time to control imbalances and hopefully to prevent or lessen the impact of defaults.

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Table 1 Brazilian economic index, 2004–2016.

Year	GDP change in volume %	GDP current value R$1,000,000	Exchange rate USD/BR	SELIC rate	IPCA
2004	5.76	1,957,751	2.93	17.74	7.6
2005	3.2021	2,170,585	2.43	18	5.69
2006	3.962	2,409,450	2.18	13.19	3.14
2007	6.0699	2,720,263	1.95	11.18	4.46
2008	5.0942	3,109,803	1.83	13.66	5.9
2009	-0.1258	3,333,039	2	8.65	4.31
2010	7.5282	3,885,847	1.76	10.66	5.91
2011	3.9744	4,376,382	1.68	10.9	6.5
2012	1.9212	4,814,760	1.96	7.14	5.84
2013	3.0048	5,331,619	2.16	9.9	5.91
2014	0.504	5,778,953	2.35	11.65	6.41
2015	-3.7693	6,000,570	3.33	14.15	10.67
2016	-3.5947	6,266,895	3.49	13.65	6.29

Source: BCB (BCB, 2018)

Table 2: Account, balance, and economic aggregates of SNA

Account	Balance	Economic Aggregates
I. Current account		
I.1. Prodution account	Gross value added	GDP
I.2. Income distribution account		
I.2.1. Primary distribution of income		
I.2.1.1. Origination of income	Operational profit/mixed revenue	
I.2.1.1. Allocation of primary Income	Balance of primary income	Gross national income
I.2.2. Secondary distribution of income	Gross disposable income	National disposable income
I.2.3. Re-distribution of income in currency		National disposable income
I.3. Income use account		
I.3.1. Use of income	Gross savings	National savings
I.3.2. Use of disposable income	Savings	National savings
II. Accumulation account		
II.1 Capital account	Net capacity or borrowing requirement	National net capacity or borrowing requirement
II.2 Financial account	Net capacity or borrowing requirement	National net capacity or borrowing requirement
II.3 Other financial assets changes account	Change in net worth came from other changes in amount of financial assets	
III. Financial balance sheet account		
III.1. Opening balance sheet account	Net worth	National wealth
III.2. Changes in balance sheet account	Change in net worth came from other changes in amount of financial assets	
III.3. Closing balance sheet account	Net worth	

Source: SNA (IBGE, 2011)

Table 3: Linkage between current, capital, and balance sheet accounts in T-account format

Current account		Capital account		Financial balance sheet	
Uses	Resources	Uses	Resources	Uses	Resources
Consumption	Income	Investment	Saving	Financial assets	Financial assets - liabilities
Saving		Saving - Investment			Liabilities

Source: Developed by authors

Table 4: Possible economic result (1)

Current account		Capital account		Financial balance sheet	
Uses	Resources	Uses	Resources	Uses	Resources
Consumption	Income	Investment	Saving	Financial assets	Net capacity
Saving		Net capacity			Liabilities

Source: Developed by authors

Table 5: Possible economic result (2)

Current account		Capital account		Financial balance sheet	
Uses	Resources	Uses	Resources	Uses	Resources
Consumption	Income	Investment	Saving	Financial assets	Liabilities
Saving			Saving < Investment	Financial assets < liabilities	

Source: Developed by authors

Table 6: Assets (P-Table)

p$_{11}$	p$_{12}$	$\cdots$	p$_{1m}$	t_1^P
p$_{21}$	p$_{22}$	$\cdots$	p$_{2m}$	t_2^P
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
p$_{n1}$	p$_{n2}$	$\cdots$	p$_{nm}$	t_n^P
ρ_1	ρ_2	$\cdots$	ρ_m	ρ_n
t_1	t_2	$\cdots$	t_m	t_n

Source: Adapted from Tsujimura and Mizoshita (2003)

Table 7: Liabilities (R-Table)

r$_{11}$	r$_{12}$	$\cdots$	r$_{1m}$	t_1^R
r$_{21}$	r$_{22}$	$\cdots$	r$_{2m}$	t_2^R
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
r$_{n1}$	r$_{n2}$	$\cdots$	r$_{nm}$	t_n^R
ψ_1	ψ_2	$\cdots$	ψ_m	ψ_n
t_1	t_2	$\cdots$	t_m	t_n

Source: Adapted from Tsujimura and Mizoshita (2003)

Table 8: Codification plan between financial instruments in the national financial balance and the BCB's balance sheets, accounts

NFB	Balance sheets of the BCB
Assets	
F1 - Cash and deposits	Availability
	Deposits
	Deposits in terms of financial institutions
	Resale commitment
F2 – Bonds	Derivative
	Bonds
	Federal government bonds
F3 - Loans	Receivable credits
	Credits to the federal government
F4 - Shares	
F5 - Technical insurance	
F6 - Other debits/credits	Other credit
Liabilities	
F1 - Cash and deposits	Contracted operation to be settled
	Deposits in financial institutions Repurchase commitment
F2 – Bonds	Derivatives
F3 - Loans	Credits to pay
	Obligations to the federal government
F4 - Shares	
F5 - Technical insurance	Provisions
F6 - Other debits/credits	Others

Source: Developed by authors

Table 9: Economic positions from PDI graph

Graph position	PDI-FR	PDI-FE	Economic position
First quadrant	>1	>1	Financial intermediary
Second quadrant	<1	>1	Saving sector
Third quadrant	<1	<1	Low monetization
Fourth quadrant	>1	<1	Investment sector

Source: Developed by authors

Table 10: FOF matrix from the Stone formula, Brazil, 2015 (R$1,000,000)

Y^S	Government	Enterprises	Households	Rest of the world	Central bank	Financial firms	Total
Government	333,573	947,808	443,256	152,170	304,673	1,470,104	3,651,584
Enterprises	348,226	2,220,580	463,737	424,196	298,244	2,607,687	6,362,670
Households	425,852	1,068,489	108,813	382,764	342,368	3,801,321	6,129,607
Rest of the world	586,009	1,440,677	363,305	367,581	405,871	1,545,354	4,708,796
Central bank	1,285,577	115,636	8,594	426,220	197,043	693,790	2,726,861
Financial firms	2,214,956	4,025,561	926,298	1,354,760	1,235,607	8,449,088	18,206,270
Total	5,194,192	9,818,751	2,314,003	3,107,691	2,783,806	18,567,344	41,785,787

Source: Developed by authors from OECD and Balance Sheet of BCB

Table 11: FOF matrix from the Klein formula Brazil, 2015 (R$1.000.000)

Y^K	Government	Enterprises	Households	Rest of the world	Central bank	Financial firms	Total
Government	333,573	348,226	425,852	586,009	1,285,577	2,214,956	5,194,192
Enterprises	947,808	2,220,580	1,068,489	1,440,677	115,636	4,025,561	9,818,751
Households	443,256	463,737	108,813	363,305	8,594	926,298	2,314,003
Rest of the world	152,170	424,196	382,764	367,581	426,220	1,354,760	3,107,691
Central bank	304,673	298,244	342,368	405,871	197,043	1,235,607	2,783,806
Financial firms	1,470,104	2,607,687	3,801,321	1,545,354	693,790	8,449,088	18,567,344
Total	3,651,584	6,362,670	6,129,607	4,708,796	2,726,861	18,206,270	41,785,787

Source: Developed by authors from OECD and Balance Sheet of BCB

Table 12: DDI

Year/ index	Asset dispersion	Liability dispersion	DDI	CDI
2004	40.16	34.64	5.52	0
2005	45.02	38.65	6.37	0.85
2006	47.01	40.38	6.63	0.27
2007	47.54	41.5	6.04	-0.6
2008	61.83	51.05	10.77	4.74
2009	52.95	47.26	5.69	-5.09
2009*	39.31	36.19	3.12	-2.57
2010	38.49	35.78	2.72	-0.4
2011	41.24	38.71	2.53	-0.18
2012	42.38	40.1	2.28	-0.25
2013	44.12	41.95	2.17	-0.11
2014	47.45	45.05	2.4	0.23
2015	46.06	44.6	1.46	-0.94

Source: Developed by authors from OECD and Balance Sheet of BCB

(DDI: discrepancy of dispersion, CDI: annual change in DDI)

Table 13: Structural path decomposition of DDI, Brazil, 2005–2015

Year	Total	OE	FM	OE%	FM%
2005	0.85	4.15	-3.3	56	-44
2006	0.27	1.41	-1.15	55	-45
2007	-0.6	-1.92	1.32	59	-41
2008	4.74	1.88	2.85	40	60
2009 *	-5.09	-4.46	-0.62	88	12
2010	-0.4	-5.56	5.15	52	-48
2011	-0.18	-1.66	1.48	53	-47
2012	-0.25	-1.45	1.19	55	-45
2013	-0.11	-1.1	0.99	53	-47
2014	0.23	3.72	-3.49	52	-48
2015	-0.94	-8.11	7.17	53	-47

Source: Developed by authors from OECD and Balance Sheet of BCB

(OE: objective economy, FM: financial market)

Table 14: TVFT, Brazil, 2004–2015 (R$1,000,000)

	GOV	Enterp.	HH	ROW	BCB	FF	Total
2004	1,980,442	3,536,057	540,543	388,415	425,708	3,469,735	10,340,901
2005	2,103,258	3,974,336	624,785	389,198	405,336	4,263,382	11,760,296
2006	2,294,311	4,560,828	684,147	506,128	434,918	5,143,296	13,623,628
2007	2,514,400	5,390,525	818,788	664,828	653,817	6,329,344	16,371,702
2008	2,850,115	4,961,657	987,557	948,506	906,049	6,735,164	17,389,048
2009*	2,898,063	7,132,866	782,385	813,614	1,157,572	7,628,623	20,413,123
2010	3,261,163	6,606,889	1,099,216	949,984	1,290,269	10,975,660	24,183,181
2011	3,528,978	7,047,736	1,404,167	1,201,977	1,583,378	12,232,893	26,999,129
2012	3,993,067	7,819,786	1,723,474	1,483,512	1,808,919	14,095,092	30,923,850
2013	4,147,845	8,536,494	2,047,522	1,749,859	1,907,649	15,066,712	33,456,082
2014	4,623,150	10,530,203	2,210,815	2,003,950	2,156,982	16,823,190	38,348,291
2015	5,194,192	9,818,751	2,314,003	3,107,691	2,783,806	18,567,344	41,785,787
Δ %	162	178	328	700	554	435	304

Source: Developed by authors from OECD and Balance Sheet of BCB

(GOV: government, Enterp.: non-financial firms, HH: households, ROW: rest of the world, the non-Brazilian economy, BCB: the Brazilian Central Bank, FF: financial firms)
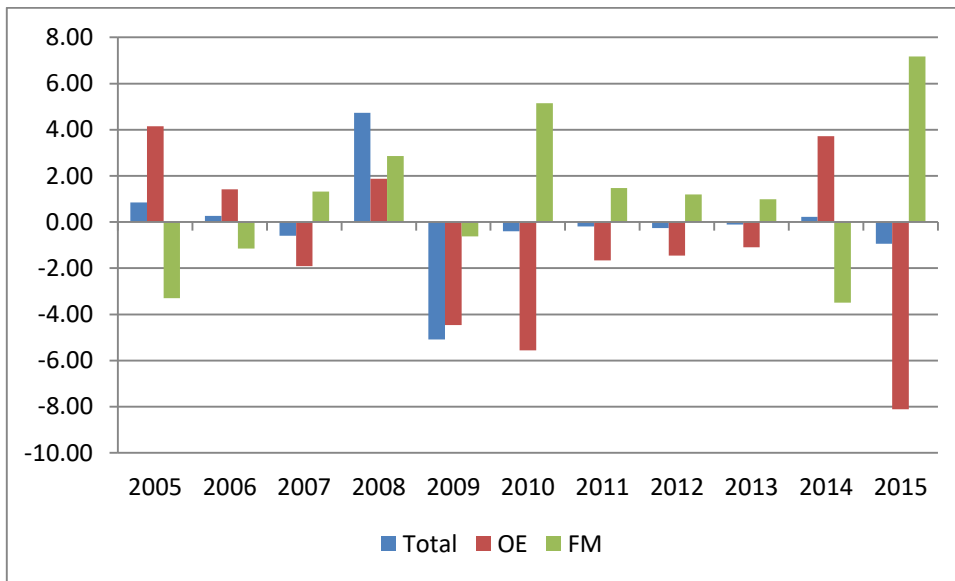
Figure 1: Economic FOF position of institutional sectors, Brazil, 2004–2015
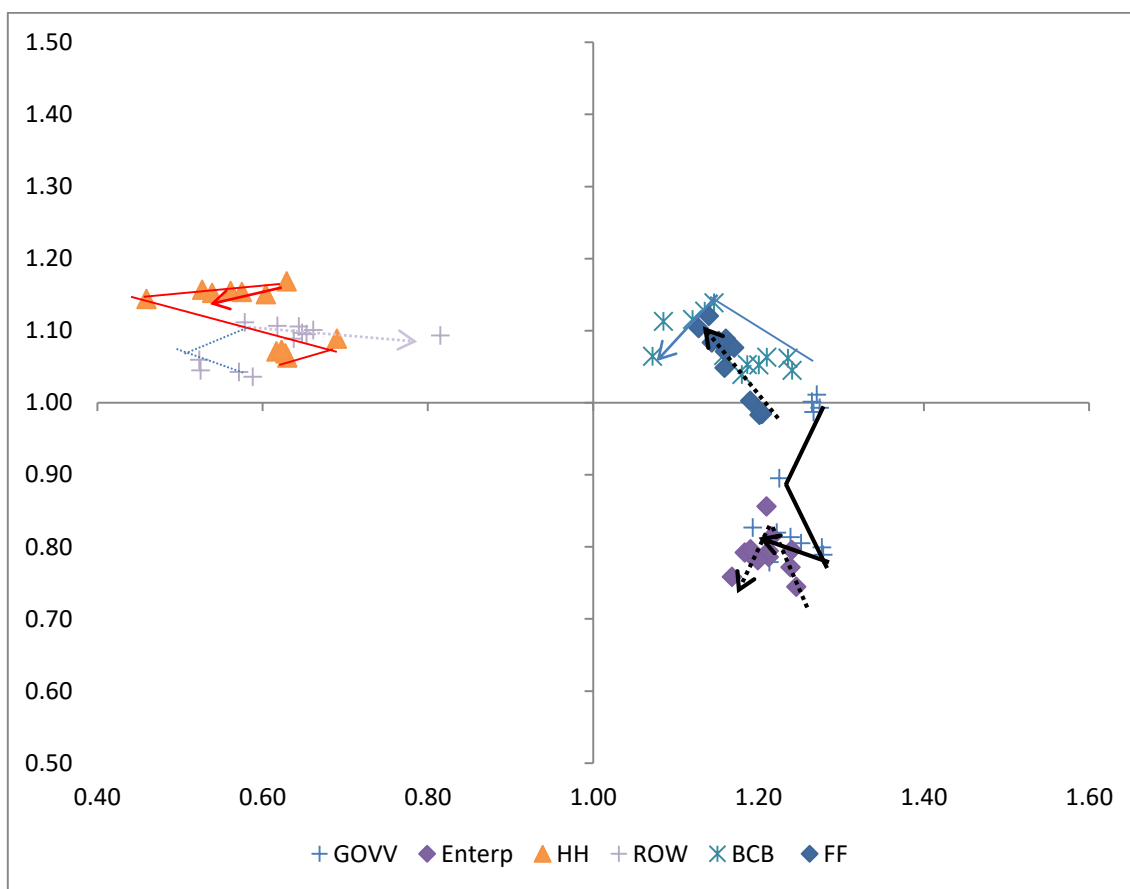
Source: Developed by authors from OECD and Balance Sheet of BCB

(GOV: government, Enterp.: non-financial firms, HH: households, ROW: rest of the world, the non-Brazilian economy, BCB: the Brazilian Central Bank, FF: financial firms)

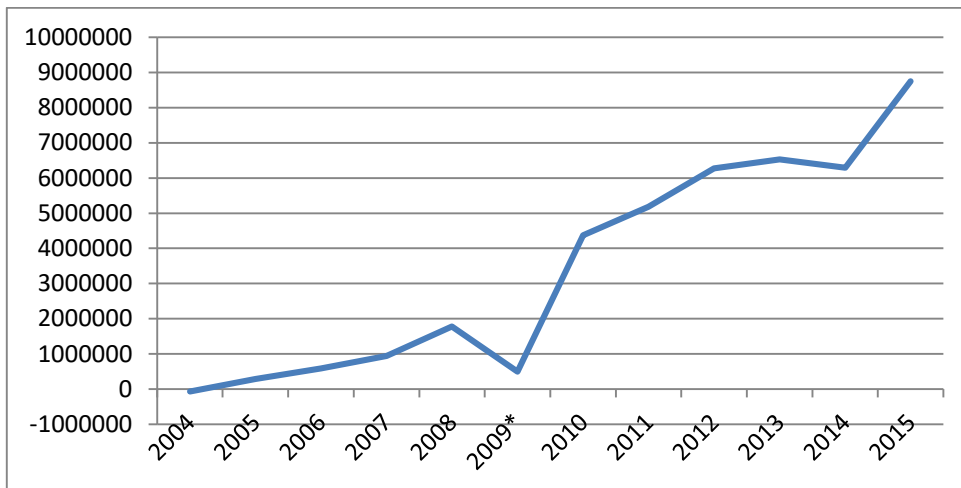Figure 2: Structural path decomposition of DDI, Brazil, 2005–2015

Source: FOF BR

Figure 3: TVFT, Brazil, 2004–2015 (R $ 1,000,000)
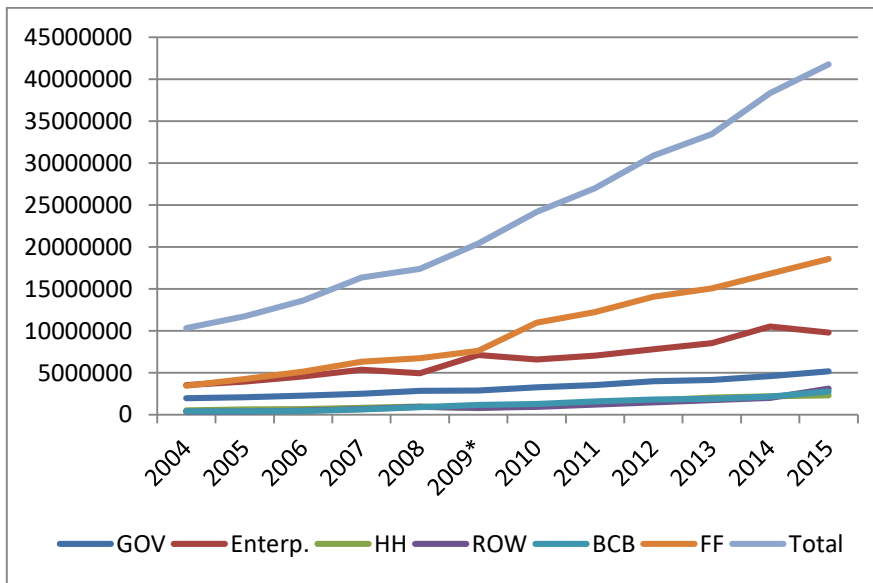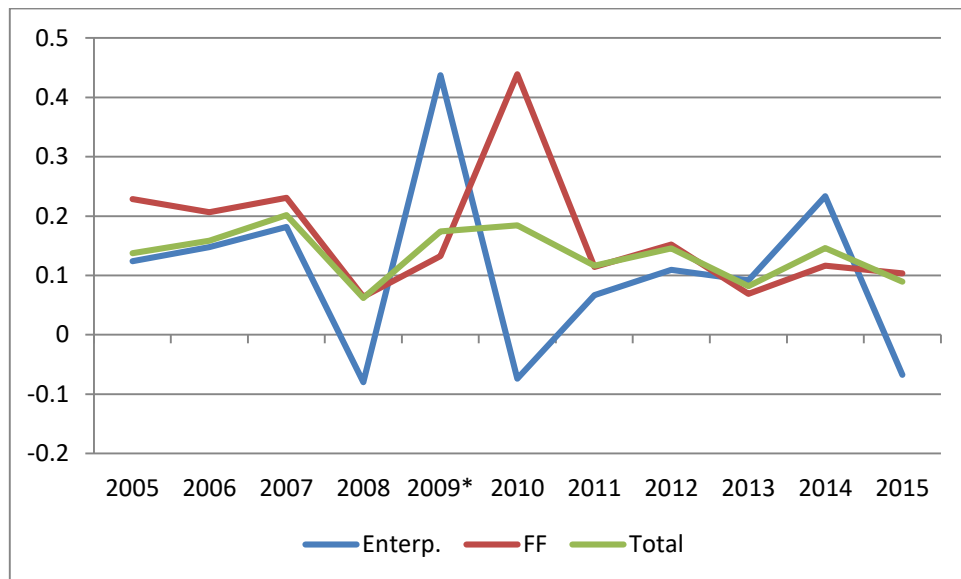

Source: FOF BR

Figure 4: Difference between TVFT of financial firms and non-financial firms

Source: FOF BR

* Beginning of the OECD series

Figure 5: Changes in the TVFT rate of financial firms (FF), non-financial firms (enterp.),

and entire economy (total), Brazil, 2005–2015

Source: Developed by authors