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March 2018

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Keywords: flow-of-funds, financial crisis, Brazilian economy, asset–liability matrix, input-output

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

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Abstract

This paper applies the flow-of-funds (FOF) framework proposed by Tsujimura and Mizoshita (2004) to investigate the structure of financial system in the Brazilian economy. The study presents the compilation process of the asset–liability matrix (ALM) and then develops an ALM with six institutional sectors (households, non-financial firms, government, the rest of world, financial firms and the Central Bank of Brazil) for the years 2004 to 2014. From the Brazilian ALM, FOF indexes are calculated (the power of dispersion, the sensitivity of dispersion and the discrepancy of dispersion). For selected years, the structural decomposition of change in the discrepancy index is calculated and an additional expansion presents an ALM with four additional financial firms: three government-sponsored banks—Banco do Brasil, Caixa Econômica Federal, and Banco Nacional de Desenvolvimento Econômico e Social—and one private bank—Itaú. The role of each institutional sector in the Brazilian financial system is illustrated and the discrepancy of dispersion is highlighted with a good indicator of economic problems showing that the origin of recessions in Brazilian economy was almost in the structure of the financial system.

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1. Introduction

Recent financial crises have shown that shocks in financial markets trigger significant effects on the real side of the economy. The Brazilian economy suffered at least two periods of recession in the last decade exemplified by a decrease in the total Gross Domestic Product (GDP) in the years 2009 and 2014 (IBGE, 2017). It is not a coincidence that in the prior year of each downturn, there was a high dispersion between asset and liability discrepancy.

A particular feature of FOF analysis is its ability to show the linkage between financial and objective economy because excess assets in the financial account represent excess saving in the current account and excess liabilities in the financial account represent excess investments in the current account. Thereafter, the sequence of the accounts is not a one-way relation but consists of a loop. This loop explains the feedback process between real and financial markets.

The FOF framework originates from Copland's (1952) description of money flow. From that four-entry system extracts an asset table and a liability table to derive an asset-liability matrix (ALM). An ALM is a sector-by-sector square matrix, so input-output (IO) methodology can be applied to extract information about a financial market. However, one of the leading peculiarities of the FOF analysis is that two distinct sector-by-sector ALMs can be derived from a single set of balance sheets. The first one describes the propagation process of raising funds (the liability side) while the other one describes the employment of funds (asset side). According to Tsujimura and Mizoshita (2004), when there are discrepancies in the valuation of assets and liabilities, the magnitude of the dispersion could be different in different systems. This magnitude will give us a clue to the generation mechanism of financial bubbles.

Since developed countries have more detailed FOF accounts data compared with developing countries, previous studies primarily used data from developed countries. For examples, Zhang (1996) analyzed FOF of Japan and China. Nishiyama (2008) examined a financial macroeconomic model using FOF of the United States. Kim (2008) compared the financial systems of Japan and Korea, rearranging institutional sectors in ALMs of the two countries. Moreover, Kim (2017) subdivided the non-financial private corporations sector in a Korean ALM into *chaebol* (large-scale, family-run management enterprises) and small- to medium-sized corporations. Some researchers have examined international FOF analyses. Tsujimura and Tsujimura (2008) constructed financial

transactions tables between multiple countries. Zhang (2009) built a model of the global-FOF and estimated several multiple-equation models. However, case studies of developing countries are scarce because of lack of data availability.

This study presents the details of the process of compiling an asset–liability matrix (ALM) of the Brazilian economy from 2004 to 2014. The Brazilian ALM has six institutional sectors (household, non-financial firms, the government, the rest of the world, financial firms, and the central bank of Brazil) on both the liability side and the asset side for the years 2004 to 2009 and 2009 to 2014. These two periods are defined because of the availability of the data sources. For the period 2004–2009, the data came from Brazilian Institute of Geography and Statistics (IBGE) and Central Bank of Brazil (BCB); for the period 2009–2014, the data came from Organization for Economic Co-operation Development (OECD) and BCB.

From Brazilian ALM, the Leontief inverse was calculated, and FOF indexes were extracted. The power of dispersion and the sensitivity of dispersion indicate the role of each institutional sector and its fluctuation in the financial market.

The discrepancy of dispersion indicates that 2009 and 2014, years of a high decline in the GDP in the objective economy, were preceded by a high increase in the difference of ALM total sum between the asset and liability side (2008 and 2013) and that this great increase in discrepancy is concomitant of an increase in the interest rate controlled by the monetary authority. Figure 1 plots the observed SELIC rate¹, the discrepancy of dispersion and the GDP fluctuation between 2004 and 2009.

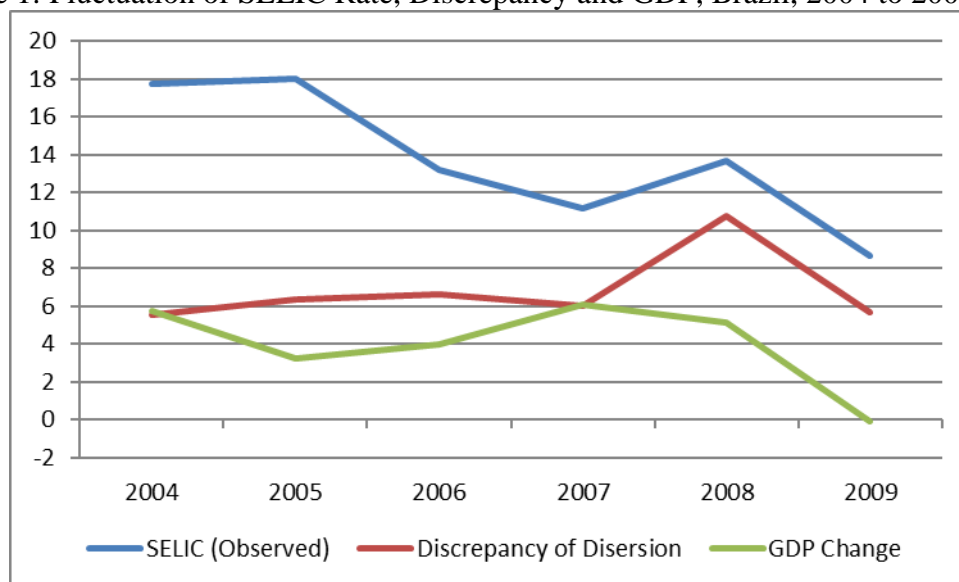
The total sum of FOF in the years that presented the highest differences between the total sum of ALM in the asset and liability side (2007 to 2008, and 2012 to 2013) was decomposed to access the contribution from the financial structure and contribution from the objective economy to total change in discrepancy. Moreover, an expanded ALM was developed to include some important financial institutions to have a wide view of the Brazilian financial system in 2009.

The novelty of the research is applying a FOF framework to the Brazilian economy and corroborating that idea that FOF can be a useful tool to predict an economic recession.

¹ SELIC is the nominal interest rate of financing in the interbank market related to one day trade operations (overnight rate), which are coverage by the national treasury bonds, which are listed and traded in the Special System of Settlement and Custody (SELIC).

Beyond this introduction, the paper presents the FOF analysis, including the methodology to develop ALM, in calculating the indexes and the structural decomposition analysis. Next, the methodology of empirical analysis, Brazilian data and the results are presented.

Figure 1: Fluctuation of SELIC Rate, Discrepancy and GDP, Brazil, 2004 to 2009



Source: BCB (2017), IBGE (2017) and authors' data

2. Flow-of-Funds

The FOF analysis was stimulated by the four entries system proposed by Copeland (1952). Called the “system of money flow,” the four-entry system intended to presents financial transactions using a table that records financial assets and liabilities, organized with financial instruments (in the rows) held by each institutional sector (located in the column). For each agent there are two columns: one for assets and other for liabilities. With this model, it is possible to visualize the total assets, the total liabilities, and the excess of assets and liabilities of institutional sectors and of a wide economy.

Since all financial transactions occur between at least two agents and for management accountability each asset (liability) needs a corresponding liability (asset) in the same amount, so financial transactions are registered in four accounts. Figure 2 represents Copland's four-entry system, using financial assets and liabilities of Brazilian institutional sectors in the year 2004.

Copeland's four-entry system provides evidence solely for the financial assets and liabilities. Since the balance sheet from business accounting method of any entity represent all of the firm's assets (financial and fixed) and liabilities (required and equity) with a double entry, the excess of financial assets and excess of liabilities in the FOF accounts represent respectively the excess of savings and the excess of investments in the current account. In this way, FOF analysis can offer evidence of linkages between the objective economy (production, income, gross fixed capital formation, and savings) and the financial economy (employment of excess savings in financial asset and raising liability to finance excess investment).

The FOF analysis evolves the application of the IO methodology to square matrices, which represent the financial assets and liabilities transacted between the institutional sectors (the ALM), which behaves as an IO matrix. In the ALM, however, intermediate consumption refers to funds (financial assets and liabilities), rather than goods and services. An IO matrix shows the demand (input) and the supply (output) of goods, services and factors of production (intermediate production flow), while the ALM shows the supply and demand of financial assets and liabilities (the "intermediate financial flow").

Although assets and liabilities represent counterparts of the same accounting entry, changes in assets and changes in liabilities have distinct origins and effects. This is one of the most important properties of FOF analysis (Tsujiura & Mizoshita, 2003b).

Table 1 represents the four-entry system proposed by Copeland (1952). It shows the interrelation between the flow of financial assets and liabilities in the Brazilian economy, the financial transactions of each agent and the transactions that occurred among them. The vertical double entry ensures the internal consistency within an institutional unit. For example, in the last row in Table 1 is observed that there is consistency across entries (total assets + excess liability = total liability + excess assets in each institutional sector).

Since each financial transaction involves at least two different agents, a creditor and a debtor, the horizontal double entry assures the inter-consistency between institutional units. In the last two columns in Table 1, the consistency is maintained throughout the financial market (total assets = total liability and total excess = total assets of the total economy).

Table 1: Representation of Quadruple-Entry-System to Brazilian Economy, 2004 (R\$ 1,000,000)

Institutional Sectors	Financial Firms		Central Bank		Enterprises		Government		Household		ROW		Total (Instruments)	
	ASSET	LIABILITY	ASSET	LIABILITY	ASSET	LIABILITY	ASSET	LIABILITY	ASSET	LIABILITY	ASSET	LIABILITY	ASSET	LIABILITY
Cash and Depósitos	227,228	864,157	76,836	179,795	206,243	0	381,815	0	228,661	0	7,824	84,655	1,128,607	1,128,607
Bonds	942,146	340,188	384,828	13,644	100,487	112,963	40,952	1,228,089	46,959	0	281,205	101,693	1,796,578	1,796,578
Loans	819,069	264,712	22,869	228,167	110,422	461,218	461,639	518,530	9,514	193,655	244,521	1,752	1,668,034	1,668,034
Shares	814,491	1,336,120	0	0	1,220,302	1,765,791	219,413	0	411,859	0	588,038	152,192	3,254,102	3,254,102
Tecnical Insurance	1,481	316,383	0	3,831	4,932	0	142	0	312,953	0	706	0	320,214	320,214
Other Deb./Credit	293,387	347,769	110	677	735,382	1,196,085	724,958	233,824	357,063	346,889	62,465	48,122	2,173,366	2,173,366
Difference	371,528	0	0	58,529	1,158,289	0	151,522	0	0	826,466	0	796,345	1,681,339	1,681,339
Total (Sector)	3,469,329	3,469,329	484,643	484,643	3,536,057	3,536,057	1,980,442	1,980,442	1,367,009	1,367,009	1,184,760	1,184,760	12,022,240	12,022,240

Source: Elaborated by authors from the Financial Balance Sheet of Brazil (2011) and Balance Sheet of Central Bank of Brazil (2004)

2.1 E & R-Table

To develop the ALM and analyze the structure of financial flows, it is necessary to first obtain the asset table and the liability table.

The asset table is composed by one matrix (the E-Matrix) with various assets negotiated by various sectors and by additional vectors, which represent the excess of liabilities in relation to the assets and the total by instrument and total by sector.

Where n is the number of financial instruments and m is the number of institutional sectors, Equation 1 expresses the elements contained in the table of assets (Tsujimura & Mizoshita, 2003a):

$$E = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1m} \\ e_{21} & e_{22} & \cdots & e_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ e_{n1} & e_{n2} & \cdots & e_{nm} \end{bmatrix} \quad \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_m \end{bmatrix} \quad S^E = \begin{bmatrix} S_1^E \\ S_2^E \\ \vdots \\ S_n^E \end{bmatrix} \quad Z = \begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_m \end{bmatrix} \quad (\text{E. 1})$$

where:

e_{ij} = amount of funds allocated to i -th financial instrument by the j -th institutional sector.

ε_j = excess of liabilities in the j -th sector = total liability minus total assets of each sector, if the difference is positive; and zero, if the difference is negative. If the total assets are greater than the liabilities, there is not an excess of liabilities;

S_i^E = total of financial instruments i in terms of assets;

Z_j = total sum of assets or liabilities of sector j , whichever is bigger; the sum of the total of assets and the excess of liabilities for each agent;

Similarly, the liability table consists of a matrix (the R-Matrix) that presents the quantity of funds obtained from financial liabilities by the institutional sectors and additional vectors: the excess of assets in relation to the liabilities and the totals by instrument and by sector. The elements of the liability table are expressed in Equation 2:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad \rho = \begin{bmatrix} \rho_1 \\ \rho_2 \\ \vdots \\ \rho_m \end{bmatrix} \quad S^R = \begin{bmatrix} S_1^R \\ S_2^R \\ \vdots \\ S_n^R \end{bmatrix} \quad Z = \begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_m \end{bmatrix} \quad (\text{E. 2})$$

where:

r_{ij} = quantity of collected funds by the j -th institutional sector via the i -th financial instrument;

ρ_j = excess of assets in the sector j ;

s_i^R = total quantity of each financial instrument in terms of liabilities;

z_j = sum of assets or liabilities of sector j , whichever is bigger;

2.2 ALM in the liability-oriented & asset-oriented system

From the FOF analysis to develop the asset–liability matrix (ALM), these two presented tables: the table of assets (E) and table of liabilities (R) are combined to make two ALMs. One is the ALM in the liability-oriented system, or fund raising (Y), and the other is the ALM in the asset-oriented system, or fund-employment (ALM* = Y*).

The determination of Make and Use regarding the E and R tables (specified in Equations 1 and 2, respectively) are expressed in percentages (column share) to generate two matrices of technical coefficients.

In the liability-oriented system, defines the matrices as B and D. Matrix B is the matrix of the technical coefficients of “Use” (use of liabilities) and can be expressed by Equation 3. Matrix D is the matrix of the technical coefficients of “Make” (resources of liabilities = assets), can be expressed by Equation 4:

$$b_{ij} = r_{ij}/z_j \quad (\text{E. 3})$$

$$d_{ji} = \frac{e'_{ij}}{S_i^E} \quad (\text{E. 4})$$

According to Tsujimura & Mizoshita (2004) the “institutional sector portfolio assumption” is used to define matrix C, where $C = DB$. C is a square matrix formed by technical coefficients that indicate, in proportional terms, the quantity of funds that sector j (the sector located in the column) obtains from sector i (sector located in the row).

The “institutional sector portfolio assumption” corresponds to the “industry technology assumption” in the IO methodology, while the “financial instrument portfolio assumption” corresponds to the “product technology assumption.”

The “industry technology assumption” supposes that all products produced by an industry are produced with the same input structure. In the FOF analysis, it means that sectors allocate (or raise) funds according to a portfolio of assets (or liabilities) of the same sector.

The “product technology assumption” in the IO methodology indicates that a product has the same structures of inputs in whatever industry it is produced. Applied to financial flows, it indicates that each financial instrument has its own portfolio, no matter the institutional sector to which it is allocating (or raising) funds.

To obtain the matrix of monetary values (effectively, the FOF matrix), it pre-multiplies the matrix C by the vector that represents the total of financial resources moved by the sectors j (z_j), resulting in the matrix Y, the FOF matrix or the asset–liability matrix in the liability-oriented system, as can be expressed in Equation 5:

$$Y = \begin{bmatrix} y_{11} & \cdots & y_{1m} \\ \vdots & \ddots & \vdots \\ y_{n1} & \cdots & y_{nm} \end{bmatrix} \quad (\text{E. 5})$$

where:

$y_{ij} = c_{ij}z_j$, how many funds the sector j raises from sector i (in monetary values).

The procedure to obtain the asset–liability matrix in the asset-oriented system (ALM*), defined as Y^* , is similar to described above in the liability-oriented system.

Defines, D^* and B^* , according to what is expressed in Equations 6 and 7:

$$d_{ji}^* = r'_{ij}/s_i^R \quad (\text{E. 6})$$

$$b_{ij}^* = e_{ij}/z_j \quad (\text{E. 7})$$

Based on the “institutional sector portfolio assumption,” defines $C^*=D^*B^*$, to obtain ALM* (Y^*), as expressed in Equation 8:

$$Y^* = \begin{bmatrix} y_{11}^* & \cdots & y_{1m}^* \\ \vdots & \ddots & \vdots \\ y_{n1}^* & \cdots & y_{nm}^* \end{bmatrix} \quad (\text{E. 8})$$

where:

$y_{ij}^* = c_{ij}^* z_j$, how many funds sector j employs in sector i (in monetary values).

2.3 *Power of Dispersion and Sensitivity of Dispersion Indexes*

From the asset–liability-matrices (Y and Y *), presented in the previous section, the direct and indirect effect of changes in flow of funds can be examined.

When one agent raises new liabilities, for example, when a company obtains new bank loans, there is an increase in financial liabilities of the company and, on the other hand, an increase (of equal value) in financial assets of the other agent, in this case the bank. This would be the direct effect. To increase their financial investments (increase in banks assets), banks seek new sources of funding (increase in banks liabilities), for example, sell securities to other financial firm, rediscount with the central bank. By the way, this operation needs a counterpart, which is registered as an increase on the other agent amount of assets. Therefore, the direct effect of raising liabilities is the increase on bank assets, which will generate another effect on the financial structure of other agents. This is the indirect effect.

To analyze the direct and indirect effect of the financial transactions of a particular institutional sector, the dispersion indexes are calculated from the Leontief inverse of the two ALM (Y and Y*). The four indexes are:

- i) Power-of-Dispersion Index, Fund-Raising;
- ii) Sensitivity-of-Dispersion Index, Fund-Raising;
- iii) Dispersion-Power Index, Fund-Employing;
- iv) Sensitivity-of-Dispersion Index Fund-Employing;

To calculate the indexes, the Leontief inverse of Y and Y* will be derived. First, begin from the ALM in the liability-oriented system. Equation 9 establishes the relation behind the ALM in matrix notation:

$$C \cdot z + \varepsilon^Y = z \quad (\text{E. 9})$$

where:

C = matrix of technical coefficient fund-raising;

Z^Y = vector with sum of assets and liabilities, whichever is greater;

ε^Y = vector of excess of liabilities.

Solving the equation 9 by Z^Y (analog to IO methodology) has Equation 10:

$$z = (I - C)^{-1} \varepsilon^Y \quad (\text{E. 10})$$

The Leontief inverse for the ALM in the liability-oriented system is expressed by Equation 11:

$$\Gamma = (I - C)^{-1} = \begin{bmatrix} \gamma_{11} & \cdots & \gamma_{1m} \\ \vdots & \ddots & \vdots \\ \gamma_{m1} & \cdots & \gamma_{mm} \end{bmatrix} \quad (\text{E. 11})$$

From the Leontief inverse of the ALM in the liability system, the power-of-dispersion index for fund raising (expressed in Equation 12) and the sensitivity-of-dispersion index for fund raising (expressed in Equation 13) are derived:

$$\omega_j^Y = \frac{\sum_{i=1}^m \gamma_{ij}}{\frac{1}{m} \sum_{j=1}^m \sum_{i=1}^m \gamma_{ij}} \quad (\text{E. 12})$$

$$\varphi_j^Y = \frac{\sum_{j=1}^m \gamma_{ji}}{\frac{1}{m} \sum_{i=1}^m \sum_{j=1}^m \gamma_{ij}} \quad (\text{E. 13})$$

where:

m = is the number of institutional sectors;

γ_{ij} = are the elements of the Leontief Inverse ALM (Y);

According to Mizoshita and Tsujimura (2003a), the power-of-dispersion index for fund raising (DPI-FR) indicates the total demand for funds, direct and indirect, induced by an increase in demand for funds in a given sector j (excess of investments in terms of the real economy).

The sensitivity-of-dispersion index for fund raising indicates the direct and indirect demand for funds in a given sector j induced by increases in demand for funds from the wide economy.

Those indicators show “how far” the influence spreads when a certain economic agent raises new money in the financial market.

The liability system shows the spreading effect of funds when there are variations in the demand for funds. On the other hand, the asset system shows the effect of scattering funds when there are variations in the supply of funds.

To develop the indexes in the asset system the same algebraic procedure is applied; however it starts with the ALM* in the asset system (Y^*). The Leontief inverse of Y^* (Γ^*) is presented in Equation 14, the power-of-dispersion index for funds employing (ω^*) in Equation 15 and, the sensitivity-of-dispersion index for funds employing (φ^*) in Equation 16, as follows:

$$\Gamma^* = (I - C^*)^{-1} = \begin{bmatrix} \gamma_{11}^* & \cdots & \gamma_{m1}^* \\ \vdots & \ddots & \vdots \\ \gamma_{1m}^* & \cdots & \gamma_{mm}^* \end{bmatrix} \quad (\text{E. 14})$$

$$\omega_j^{Y^*} = \frac{\sum_{i=1}^m \gamma_{ij}^*}{\frac{1}{m} \sum_{j=1}^m \sum_{i=1}^m \gamma_{ij}^*} \quad (\text{E. 15})$$

$$\varphi_j^{Y^*} = \frac{\sum_{i=1}^m \gamma_{ji}^*}{\frac{1}{m} \sum_{i=1}^m \sum_{j=1}^m \gamma_{ij}^*} \quad (\text{E. 16})$$

where:

γ_{ij}^* = the elements of the Leontief inverse of the ALM in the asset system.

Mizoshita and Tsujimura (2003a) pointed out that the power-of-dispersion index for funds employing (DPI-FE) indicates the supply of funds to the total economy, directly and indirectly, induced by increases in the fund supply of a given sector j (excess savings in relation to current account).

The sensitivity-of-dispersion index of funds employing shows the direct and indirect effect on the funds of a given sector i induced by increases in the supply of funds from the wide economy.

In the liability system, the indexes represent the reaction caused by demand for funds (excesses of investment in terms of the real economy) and in the asset system, the indices represent the reaction originated by the supply of funds (excess savings in terms of the real economy).

2.4 Discrepancy index

The dispersion indices previously presented are obtained by normalizing either the column sum (in case of power-of-dispersion index) or the row sum (sensitivity-of-dispersion index) of the FOF Leontief inverse matrix (Γ and Γ^*). The discrepancy of the total sum of assets and liabilities not observed in the later indices is also a useful indicator (TSUJIMURA & MIZOSHITA, 2004).

Denote the sum of the elements of Γ as w^Y and the sum of elements of Γ^* as w^{Y^*} .

$$w^Y = \sum_{i=1}^m \sum_{j=1}^m \gamma_{ij} \quad (\text{E. 17})$$

$$w^{Y^*} = \sum_{i=1}^m \sum_{j=1}^m \gamma_{ij}^* \quad (\text{E. 18})$$

Call them the liability dispersion index (w^Y) and the asset dispersion index (w^{Y^*}), respectively.

The subtraction of the liability dispersion index from the asset dispersion index gives the discrepancy index, as shown in Equation 19.

$$w^{Y^*-Y} = w^{Y^*} - w^Y \quad (\text{E. 19})$$

2.5 Structural decomposition

The causes for the alteration in the Leontief inverse can be decomposed into two categories: i) the total sum of each element of the coefficient matrix, and ii) the apportionment of coefficients among them. While the latter is a purely monetary phenomenon, the former is the reflection of the objective economy, because the excess assets and liabilities correspond respectively to excess savings and investments.

This kind of decomposition is useful to determine whether the cause of financial bubbles lies in the structure of financial market itself or is merely a mirror image of the objective economy, the lack of investments in plant and equipment, and so on.

In Section 2.2 the FOF technical coefficient matrices C , and C^* were defined. From Equation 5, defines:

$$c_{ij} = \frac{\gamma_{ij}}{Z_{ij}} \quad (\text{E. 20})$$

The total financial flow Z_{ij} can be written as expressed in Equation 21:

$$Z_j = \sum_{i=1}^m \gamma_{ij} + \rho_j \quad (\text{E. 21})$$

Omitting ρ_j , redefines the coefficient of Matrix C as $C^\#$, in which each element could be defined according to Equation 22.

$$c_{ij}^\# = \frac{\gamma_{ij}}{\sum_{i=1}^m \gamma_{ij}} \quad (\text{E. 22})$$

The ratio of ρ_j to Z_j is expressed in Equation 23.

$$c_{\rho j} = \frac{\rho_j}{Z_j} = 1 - \sum_{i=1}^m c_{ij} \quad (\text{E. 23})$$

Therefore the relations between c_{ij} and $c_{ij}^\#$ is expressed in Equation 24.

$$c_{ij} = c_{ij}^\# \times (1 - c_{\rho j}) \quad (\text{E. 24})$$

To decompose the differences in c_{ij} , introduces two subscripts of time t . The first one refers to the time concerning $c_{ij}^\#$ and the second one refers to the time concerning $c_{\rho j}$. Equation 25 expresses the decomposition of c_{ij} .

$$\begin{aligned} \Delta c_{ij,t,t} &= c_{ij,t,t} - c_{ij,t-1,t-1} = c_{ij,t}^\# \times (1 - c_{\rho j,t}) - c_{ij,t-1}^\# \times (1 - c_{\rho j,t-1}) \quad (\text{E. 25}) \\ &= \frac{2 \times c_{ij,t}^\# \times (1 - c_{\rho j,t}) - 2 \times c_{ij,t-1}^\# \times (1 - c_{\rho j,t-1})}{2} \\ &= \frac{c_{ij,t}^\# \times (1 - c_{\rho j,t-1}) - c_{ij,t}^\# \times (1 - c_{\rho j,t})}{2} \\ &\quad + \frac{c_{ij,t-1}^\# \times (1 - c_{\rho j,t}) - c_{ij,t-1}^\# \times (1 - c_{\rho j,t})}{2} \end{aligned}$$

In the last equality of Equation 25, the first term represents the differences in c_{ij} caused by the transition of $c_{\rho j}$ from t-1 to t, equally arithmetically weighted by $c_{ij}^{\#}$ at t-1 and t. Likewise, the second term represents the differences in c_{ij} caused by the transition of $c_{ij}^{\#}$ from t-1 to t, equally arithmetically weighted by $c_{\rho j}$ at t-1 and t.

In matrix notation re-write Equation 25 as follows.

(E. 26)

$$\begin{aligned}\Delta c_{t,t} &= c_{t,t} - c_{t-1,t-1} \\ &= \left\{ \frac{(c_{t,t} - c_{t,t-1}) + (c_{t-1,t} - c_{t-1,t-1})}{2} \right. \\ &\quad \left. + \frac{(c_{t,t} - c_{t-1,t}) - (c_{t,t-1} - c_{t-1,t-1})}{2} \right\}\end{aligned}$$

If the equation above is retained, the relation of dispersion indexes is also proved⁴ and the difference in liability dispersion index could be decomposed as follows.

(E. 27)

$$\begin{aligned}\Delta w^Y_{t,t} &= w^Y_{t,t} - w^Y_{t-1,t-1} \\ &= \left\{ \frac{(w^Y_{t,t} - w^Y_{t,t-1}) + (w^Y_{t-1,t} - w^Y_{t-1,t-1})}{2} \right. \\ &\quad \left. + \frac{(w^Y_{t,t} - w^Y_{t-1,t}) - (w^Y_{t,t-1} - w^Y_{t-1,t-1})}{2} \right\}\end{aligned}$$

Analogous to the liability procedure, the decomposition of dispersion index in the asset side can be expressed by Equation 28.

(E. 28)

$$\begin{aligned}\Delta w^{Y*}_{t,t} &= w^{Y*}_{t,t} - w^{Y*}_{t-1,t-1} \\ &= \left\{ \frac{(w^{Y*}_{t,t} - w^{Y*}_{t,t-1}) + (w^{Y*}_{t-1,t} - w^{Y*}_{t-1,t-1})}{2} \right. \\ &\quad \left. + \frac{(w^{Y*}_{t,t} - w^{Y*}_{t-1,t}) - (w^{Y*}_{t,t-1} - w^{Y*}_{t-1,t-1})}{2} \right\}\end{aligned}$$

⁴ Mizoshita and Tsujimura (2004) present the detail of this relationship in Appendix 4.

The dispersion discrepancy index was defined in Equation 19. Using Equations 27 and 28, defines the decomposition of dispersion discrepancy index.

(E. 29)

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

According to Mizoshita and Tsujimura (2004), the first term of the expanded right side of Equation 27 is the portion attributed to the changes in the objective economy (decline or increment in savings and in investments) while the second term is the segment referring to the changes in the structures of the financial market (alterations in asset-liability portfolio allocation).

3. Empirical Analysis

Brazil is a large country with population of 208,502,021 inhabitants (IBGE, January, 2018). Its economic activities are diversified, the trade sector and public administration are important in the production and generation of added value. The food and beverage manufacturing sector has a great capacity for dispersal of funds in the economy. Despite its income generation, there is a strong dependence on transfers of income distribution among domestic economic agents. In Brazil, the financial system has a great role in the economy as a support to the country's economic activities. Instead, of high volatility, the flow of financial investment is more than four times the amount of fixed investments. Financial intermediation is the fourth largest sector in terms of gross value of production; the growth of this sector in the last decade was higher than the average of the economy, and it had a significant participation in the generation of value added. (Burkowski, et al., 2016).

Regarding the structure of financial system, the distribution within type of banks stock control shows that 45% of banks operating on Brazilian economy are public (government sponsored banks), 40% are private domestic and 15% are foreign private. Although there is a large quantity and diversification of banks, there is a high concentration: 83% of total assets are concentrated in the five major banks and two of them are government sponsored banks. According to FEBRABAN (2016), there was a decrease in the amount of banks in the last decade but an increase in the amount of agencies. In 2016, there were 174 banks and 22,547 banking agencies. Table 2 presents the ten largest banks in 2016, with their total assets, total deposits, net worth, net profit, number of agencies and type of stock control.

Table 2: The 10 largest banks in Brazil, 2016 (R\$ 1,000,000)

Bank	Total Assets	Total Deposits	Net Worth	Net Profit	Number of Agencies	Type of Stock Control
BB	1,436,765	447,949	77,040	6,650	5,460	Public
ITAU	1,331,841	369,390	129,935	19,486	3,494	Private
CEF	12,56,172	513,098	27,180	3,421	3,412	Public
BRADESCO	1,081,375	235,821	101,221	13,663	5,335	Private
SANTANDER	705,061	146,963	60,009	6,205	2,763	Foreign
SAFRA	148,391	12,589	9,508	1,736	114	Private
BGT PACTUAL	131,933	10,894	17,678	2,794	13	Private
VOTORANTIM	103,005	4,578	8,426	463	95	Private
CITIBANK	72,024	19,374	8,411	1,193	134	Foreign
BANRISUL	68,235	42,783	6,441	540	539	Public
Total 10 largest	6,334,863	1,803,439	445,849	46,151	172	
National Banking System	7,009,784	1,995,174	521,904	62,301	22,899	

Source: FEBRABAN (2016)

In the 1990s, Brazil began a process of opening commercial and financial markets to foreign transactions. Foreign banks increased their participation in the Brazilian market and mergers and acquisitions intensified. However, foreign banks maintained a conservative strategy that contributed little to the expansion of credit concessions, spread reduction, or quality and diversification of financial products and services.

Even with the entry of international banks, the cost of capital, which is determined, among other factors, by the interest rate, the SELIC rate, and by the spread fixed by the banks, has remained excessively high.

In this way, the financial system is characterized as dysfunctional or of low macroeconomic efficiency, due mainly to the existing incentives: on the asset side,

investments in government bonds and on the liabilities side, raising funds from middle and high cost agencies.

Private banks display higher concentration of short-term operations, investments in securities and investments in securitization. Public banks dedicate a greater proportion of resources to credit operations.

Camargo (2009) highlights some of the characteristics of the banking sector in last decade:

- i) Banks act as financial intermediaries, with bond markets playing an almost irrelevant role in financing private activity;
- ii) A high degree of concentration in the banking sector;
- iii) The structure of the banking sector encourages the emergence of a form of oligopolistic competition, in which leading banks set the basic prices of financial services and compete with each other through service differentiation rather than price;
- iv) The performance of non-leading banks in niches not attractive to the leading banks, due to the few conditions for the former to exert more effective competitive pressures on the latter in the more attractive markets;
- v) The permanent situation of economic instability and fiscal deficits, which led successive governments to offer large amounts of government bonds, under extremely favorable conditions of return and liquidity.

Financial institutions in Brazil are ruled by the National Monetary Council (CMN) and supervised by the BCB. Figure 3 presents the composition of the Brazilian financial system.

The current economic system in Brazil, called the “Real Plan”, began in 1994. Before this date, Brazil experienced a high inflation rate. The “Real Plan” met three steps to access price stability: i) a fiscal adjustment (May 1993 to February 1994); ii) monetary reform (March to July 1994) and iii) the adoption of an anchor exchange rate (July 1994 to January 1999).

Since 1999, the Inflation Target Regime (RMI) has been adopted. The Monetary Policy Committee (COPOM) was created on June 20th 1996, and was assigned the responsibility of setting the stance of monetary policy and the overnight interest rate (SELIC rate). The BCB ensures that the target of the SELIC rate works, through open market operations. The SELIC rate is the main instrument to control the inflation rate.

Figure 3: Composition of the Brazilian Financial System

Regulating entities	National Monetary Council (CMN)			National Council for Private Insurance (CNSP)	National Council for Complementary Pension (CNPC)
Supervision entities	Central Bank of Brazil (BCB)		Securities and Exchange Commission (CVM)	Private Insurance Superintendence (SUSEP)	National Complementary Pension Superintendency (PREVIC)
Operators*	Financial institutions taking demand deposits		Commodities and futures exchanges	Reinsurance Companies	Entities operating private closed pension funds
	Other financial institutions	Foreign exchange banks	Stock exchanges	Insurance companies	
	Other financial intermediaries and entities administering financial assets of third parties			Capitalization companies	

Source: Central Bank of Brazil (2017)

The COPOM publishes a report, eight times a year, since 1998. In this report it describes the economic conditions (inflation behavior), risks around inflation, and a discussion around monetary policy conduction.

In the last decade, the inflation target is being achieved. Between 2004 and 2014 the observed inflation expressed in the General Consumer Prices Index (IPCA) stayed below the upper goal limit, except in 2015, when observed inflation was above the target. In 2014 and 2015, the SELIC rate showed an increase. However, in December 2017, the observed inflation rate was considered smaller than expected and the SELIC rate was fixed at 7% (BCB, 2017), decreasing from 14.15% in December 2015, the highest interest rate of the decade.

Despite the success in controlling inflation since its implementation in Brazil, the economy's performance was below expectations. The total GDP reveals a recession in the Brazilian economy. The GDP increased, on average, 4.8% between 2004 and 2008; decreased 0.1% in 2009, increased, on average, 4% between 2010 and 2013; increased just 0.5% in 2014; and decreased, on average, 3.8% in subsequent years. The evaluation of fixed investments in the last decade shows a movement synchronized to GDP: a high decrease in 2009, in 2014 and in subsequent years (IBGE, 2017).

3.1 Methodology

The FOF analyses was used to provide evidence of the financial structure of Brazilian economy and investigate relationship between the objective economy and the financial economy. Two sets of ALM (and ALM*) were developed: one from 2004 to 2009 and another from 2009 to 2014.

Dispersion indexes were calculate and combined as follows: i) the PDI-FR and PDI-FE give the position of the institutional sectors in the financial market and the financial intermediary—it usually shows both a DPI close to 1 and the highest indexes indicating a better ability in borrowing and lending funds; and ii) the SDI-FR and SDI-FE that are used to measure the importance of each sector as intermediaries in the financial market (how they react to changes in total demand of funds).

The evolution of the power-of-dispersion and sensitivity-of-dispersion indexes were observed to investigate if there was any changes in the behavior of institutional sectors in the financial market.

Furthermore, the discrepancy index was calculated to the years 2004 to 2014. For 2008 and 2013 a decomposition of the change in discrepancy is made, and present an expanded ALM to the year 2009, in which financial institutions are disaggregated, is presented.

3.2 Brazilian Data

The data used to apply the FOF analysis in the Brazilian economy are the Financial Balance Sheet of Brazil and the balance sheet of the BCB. The balance sheets of the BCB are available on the BCB web site.

For the period 2004–2009, the Financial Balance Sheet of Brazil is available from the Brazilian Institute of Geography and Statistics (IBGE)⁵. For the period 2009–2014, it is available from the Organization for Economic Co-operation Development (OECD).

The financial balance sheet is an accounting statement that presents the stock of financial assets and liabilities held by economic agents in a beginning date, the variations that occurred in these assets and liabilities during the period of one year and the assets and liabilities held in the final date of ascertainment of the balance sheet. This financial

⁵ IBGE is official organization responsible to collect, organize and publish information and data to Brazilian economy, including the System of National Accounts and Input-Output Matrixes.

balance sheet was published for the years 2004 to 2009 as a part of the Integrated Economic Accounts (CEI) by the BCB, together with the IBGE.

After 2009, the publication was discontinued publication and then it was available from the OECD for the period 2009–2014. The non-consolidated SNA 2008 is used (OECD, 2018).

The financial assets and liabilities are detailed in seven main financial instruments held by five institutional sectors: non-financial firms, financial firms, households, government and the rest of the world (ROW)⁷. Below, the main financial instruments are listed:

- F1. Gold and DES*
- F2. Cash & Deposits
- F3. Bonds
- F4. Loans
- F5. Shares
- F6. Technical insurance
- F7. Others

*Gold and DES are not included in FOF BR because they refer to monetary funds.

The “financial enterprises” were disaggregated into two subgroups: the central bank and “other financial enterprises,” subtracting the flows of assets and liabilities of the BCB (obtained from its balance sheet) from the flows of financial assets and liabilities of the “financial enterprises” in the financial balance sheet.

The balance sheet of the BCB is published monthly together with other financial statements and explanatory notes. Was used the annual data related to the exercises closed in December 31th of each year between 2004 and 2014. The balance sheet is an accounting statement that represents stock accounts, indicating the stock of assets (physical and financial assets) and liabilities (obligations and equity) held by an entity on a certain date. The elaboration of the balance sheet of the BCB follows the Central Bank’s General Accounting Plan (PGC). The balance sheet of the BCB has been available monthly from 1965 until 2017. Figure 4 presents the BCB balance sheet structure.

⁷ The definitions of the institutional sectors are detailed in the Methodological Notes, IBGE (2008).

Figure 4: Accounting Structure of the Balance Sheet of Central Bank of Brazil

1.ASSET	2.LIABILITY
1.1.FOREIGN CURRENCY ASSETS	2.1.FOREIGN CURRENCY LIABILITIES
1.1.1.Available	2.1.1.Contract operations to be settled
1.1.2.Time deposits in financial institutions	2.1.2.Deposits in financial institution
1.1.3.Resale agreement	2.1.3.Repurchase agreement
1.1.4.Derivative	2.1.4.Derivatives
1.1.5.Securities	2.1.5.Credits to pay
1.1.6.Credits Receivable	2.1.6.Deposits in International Financial Organization
1.1.7.Gold	2.1.7.Other
1.1.8.Participation in International Financial Organization	
1.1.9.Other	2.2.LOCAL CURRENCY LIABILITIES
	2.2.1.Contract operations to be settled
1.2.LOCAL CURRENCY ASSETS	2.2.2.Deposits from financial institution
1.2.1.Available	2.2.3.Repurchase agreement
1.2.2.Deposits	2.2.4.Derivatives
1.2.3.Resale agreement	2.2.5.Liabilities with federal government
1.2.4.Derivative	2.2.6.Credit to pay
1.2.5.Federal public securities	2.2.7.Deposits in International Financial Organization
1.2.6.Credit with federal government	2.2.8.Provisions (Allowance)
1.2.7.Receivable credit	2.2.9.Other
1.2.8.Bens Móveis e Imóveis	
1.2.9.Other	2.3.CIRCULATING
	2.4.NET WORTH
	2.4.1.Result Reservation
	2.4.2.Revaluation Reserve
	2.4.3.Unrecognized gains / losses in income
	2.4.4.Effects of Changes in Accounting Practices
	2.4.5.Accumulated result
Total	Total

Source: Financial Statements (BCB, 2017)

For 2008 and 2009, an additional disaggregation of financial firms was made. The “other financial enterprises” were disaggregated into four financial institutions: three of them are government-sponsored financial institutions—Banco do Brasil (BB), Caixa Econômica Federal (CEF), and Banco Nacional de Desenvolvimento Econômico e Social (BNDES)—and one is the largest private bank, in terms of total assets in Brazil, the Itaú Bank. All of these financial institutions play important roles in the Brazilian economy.

The assets and the liabilities of these institutions, presented in their balance sheets, were subtracted from the flows of “other financial enterprises”. The financial statements of the financial institutions operating in Brazil are published monthly by BCB. Their structures follow the Financial Institutions Accounting Plan (COSIF), which follow the PGC. Was used the annual data related to the exercises closed in December 31th of each year from 2004 to 2009.

A “Plan of Codification” was made to link the asset and liability accounts of the BCB, the financial institutions’ balance sheets, and the financial instruments of the financial balance sheets from the PGC, COSIF and the Methodological Notes of financial balance sheet (IBGE, 2011). The “Plan of Codification” proposed is presented in Table 3.

Table 3: Plan of Codification between Financial Instruments in the Financial Equity Account, Balance Sheet of the Central Bank and the Balance Sheet of Financial Institutions

FINANCIAL EQUITY ACCOUNT	BALANCE SHEET ACCOUNT OF THE CENTRAL BANK OF BRAZIL	BALANCE SHEET ACCOUNT OF FINANCIAL INSTITUTIONS
ASSETS		
F1 - Cash and Deposits	Availability	Availability
	Deposits	
	Deposits in terms in financial Institutions	
	Resale Commitment	
F2 – Bonds	Derivative	Liquidity Interbank Investments
	Bonds	Bonds and Underlying Securities and Derivatives
	Federal Government Bonds	
F3 – Loans	Receivable Credits	Interbank Operations
	Credits to the Federal Government	Credit Operations
F4 – Shares		Investments
F5 - Technical Insurance		
F6 - Other Deb./Credit	Other credit	Other credit
LIABILITY		
F1 - Cash and Deposits	Contracted Operation to be settled	Deposits
	Deposits in Financial Institutions	Repurchase Agreements obligations
	Repurchase Commitment	
F2 – Bonds	Derivatives	Derivative Financial Instruments Funds, Acceptable Exchange, Mortgage Notes, Debentures and Similar
F3 – Loans	Credits to pay	Interdependence Relations
	Obligations to the Federal Government	On Lending Obligations
F4 – Shares		Net Worth
F5 - Technical Insurance	Provisions	
F6 - Other Deb./Credit	Others	Other Obligations

Source: Elaborated by authors

4. Brazilian Flow-of-Funds

Tables 4 and 5 presents the asset table (E-Table) and liability table (R-Table), respectively, from the Flow of Funds Account 2005. The main bloc of accounts in Table 4 represent the amount of funds that the institutional sector employed to each financial instrument in terms of all of the asset investments or the portfolio investment of each sector. These elements were defined in Equation 1: e_{ij} . The row “Diff. (Excess Liability)” expresses the excess of liabilities. Looking at each sector, the difference observed on its balance sheet reveals whether this sector has a net financing capability (net lending) which means a savings excess in the real economy. In Equation 1, it was referred to vector ε_j . In this same equation, the total of the instruments in terms of assets (vector s_i^E) is shown in the last column of Table 4 and the total of resources of each sector (vector z_j - the last row in Table 4.)

The main bloc of accounts in the R-Table (Table 5) are elements that represents the amount of funds the sector has raised from each financial instrument, representing all of financial liabilities used by this sector (the liability portfolio or capital structure of the institutional sector). The elements of R-Table described in Equation 2 are highlighted in Table 5. The row “Diff. (Excess Assets)” represents vector ρ_j , which expresses the excess of assets related to those sources of funds. In the real economy, it indicates which institutional sector has an investment excess or net financing necessity (net borrowing). The last column in Table 5 represents the vector s_i^R , which is the sum of liabilities. The last row in Table 5 represents the vector z_j , which refers to the total financial funds of each sector.

Tables 6 and 7 present the ALM in the liability-oriented system and in the asset-oriented system, respectively defined as Y and Y*. The sectors are in rows and columns, and the intersections represent the flow of funds between institutional sectors. Table 6 presents the amount of funds the sector in the column raises from the sector in the row. Table 7 presents how many funds the row sector applied to the column sector (current value).

Table 4: Asset Table (E) – Brazil, 2005

E- Table	Government	Enterprises	Household	ROW	Central Bank	Financial Firms (without BCB)	Total Financial Instruments
Cash & Deposits	847,761	419,489	459,699	9,060	32,952	740,449	2,509,410
Bonds	72,176	225,844	192,536	298,572	1,026,191	1,911,169	3,726,486
Loans	652,978	52,543	12,942	175,061	83,849	2,568,596	3,545,970
Shares	393,492	2,646,984	777,222	1,244,980	0	1,924,842	6,987,520
Technical Insurance	292	10,150	623,211	738	0	2,958	637,350
Others Deb./Credit	677,911	1,194,021	245,027	151,765	3,455	454,486	2,726,665
Differences	567,910	1,360,543	0	0	0	448,908	0
Total (w/ differences)	2,644,611	4,549,030	2,310,638	1,880,175	1,146,447	7,602,499	20,133,400
New Total	3,212,520	5,909,573	2,310,638	1,880,175	1,146,447	8,051,406	22,510,760

Source: Elaborated by authors from the Flow of Funds Account

Table 5: Liability Table (R) – Brazil, 2005

R- Table	Government	Enterprises	Household	ROW	Central Bank	Financial Firms (without BCB)	Total Financial Instrument
Cash & Deposits	0	0	0	55,170	558,475	1,895,765	2,509,410
Bonds	2,083,490	158,420	0	397,314	63	1,087,199	3,726,486
Loans	561,422	926,026	596,345	28,714	423,141	1,010,322	3,545,970
Shares	0	3,682,728	0	247,858	0	3,056,933	6,987,520
Technical Insurance	0	0	0	0	17,206	620,143	637,350
Other Debit/Credit	567,609	1,142,399	551,831	83,758	24	381,044	2,726,665
Differences	0	0	1,162,463	1,067,360	147,537	0	0
Total (w/ differences)	3,212,520	5,909,573	1,148,176	812,815	998,910	8,051,406	20,133,400
New Total	3,212,520	5,909,573	2,310,638	1,880,175	1,146,447	8,051,406	20,133,400

Source: Elaborated by authors from the Flow of Funds Account

Table 6: Asset–Liability Matrix in the Liability System (ALM), Brazil 2009

Sector	Government	Enterprises	Household	ROW	Central Bank	Financial Firms	Total
Government	6,878,877	6,495,426	1,467,414	891,357	1,314,281	8,986,602	26,033,958
Enterprises	5,790,401	17,660,747	2,273,263	1,506,109	1,804,644	14,706,529	43,741,692
Household	3,116,944	5,647,588	3,441,557	785,281	1,041,691	8,239,550	22,272,612
ROW	2,444,552	4,826,780	895,471	2,513,054	726,561	6,040,189	17,446,608
Central Bank	1,994,384	2,550,253	550,682	454,312	1,631,186	3,708,043	10,888,861
Financial Firms	10,989,200	18,525,175	4,000,611	2,632,583	3,454,753	33,068,494	72,670,817
Total	31,214,360	55,705,970	12,628,999	8,782,696	9,973,116	74,749,407	

Source: Elaborated by authors

Table 7: Asset–Liability Matrix in the Asset System (ALM*), Brazil 2009

Sector	Government	Enterprises	Household	ROW	Central Bank	Financial Firms	Total
Government	6,878,877	5,790,401	3,116,944	2,444,552	1,994,384	10,989,200	31,214,360
Enterprises	6,495,426	17,660,747	5,647,588	4,826,780	2,550,253	18,525,175	55,705,970
Household	1,467,414	2,273,263	3,441,557	895,471	550,682	4,000,611	12,628,999
ROW	891,357	1,506,109	785,281	2,513,054	454,312	2,632,583	8,782,696
Central Bank	1,314,281	1,804,644	1,041,691	726,561	1,631,186	3,454,753	9,973,116
Financial Firms	8,986,602	14,706,529	8,239,550	6,040,189	3,708,043	33,068,494	74,749,407
Total	26,033,958	43,741,692	22,272,612	17,446,608	10,888,861	72,670,817	

Source: Elaborated by authors

Overall, the tables show that households employ funds mainly in the form of shares, “other credit” and insurance technical reserve and their ratio of cash & deposits is relatively low. Shares include listed stocks and shares in investments funds (the largest portion) and insurance technical reserve includes life insurance and pension funds. Most of these financial instruments are available from financial institutions.

Moreover, “other credit” includes trade credit and advances. The high ratio of other credit together with the low ratio of cash & deposits indicate there is a huge amount of informal financial activity.

Non-financial firms are raising funds mainly through shares (between 50% and 60% of their capital structure). Treasury bonds (i.e., bonds issued by the government) are the main fund-raising instruments of the government (e.g., 62.0% in 2004 and 64.9% in 2009). The ALM reveals that these funds come from foreign funds, from BCB, and from financial institutions, which have increased their employment of funds in governments bonds.

To begin the analyses, the FOF Leontief inverse was obtained, from which the FOF indexes were extracted. The discrepancy index revealed two important changes: i) two dates when there was a “collapse” in the financial system (in 2008 and 2013); and ii) one date when there was a change in the signal of discrepancy (2010).

Table 8 presents the asset dispersion, liability dispersion and discrepancy of dispersion to Brazilian FOF from 2004 to 2014 (obtained with Equations 17 to 19).

Table 8 shows two years (2008 and 2013) with a higher discrepancy of dispersion. These high discrepancies occur in different contexts, in 2010, there was a modification in the sign of the discrepancy index and the total sum of the Leontief inverse in the asset system became smaller than in the liability system. This context extended to the following years. Looking at the asset table and the liability table (E, R) together, it is observed that in a wide economy there are excess assets and the amount of savings are greater than the amount of fixed investments in the objective economy until 2010. After 2010, there is excess liability in the financial system, which means savings are smaller than investments in the objective economy.

Table 8: Asset dispersion, liability dispersion and discrepancy of dispersion, Brazil, 2004 to 2014

Year/ Index	Asset Dispersion	Liability Dispersion	Discrepancy	Change in discrepancy
2004	40,16	34,64	5,52	–
2005	45,02	38,65	6,37	0,85
2006	47,01	40,38	6,63	0,27
2007	47,54	41,50	6,04	-0,60
2008	61,83	51,05	10,77	4,74
2009	52,95	47,26	5,69	-5,09
2009*	39,36	35,41	3,95	-1,73
2010	24,59	29,51	-4,92	-8,87
2011	28,46	33,11	-4,64	0,28
2012	28,46	34,90	-6,43	-1,79
2013	26,24	44,80	-18,56	-12,12
2014	28,46	38,79	-10,32	8,24

* The two set of Brazilian ALM include the year 2009.

Source: Elaborated by authors.

Around 2007, there was a rumor of an international financial crisis. Institutional sectors, i.e., entrepreneurs, for fear of making physical investments, responded with an increase in interest rates, and excess savings accumulated in the financial system.

The year 2008 was the crucial point where the growth in excess assets was so great that it caused a high discrepancy index (concomitant to Lehman Brothers bank breakdown). In the next year, 2009, the Brazilian GDP effectively fell.

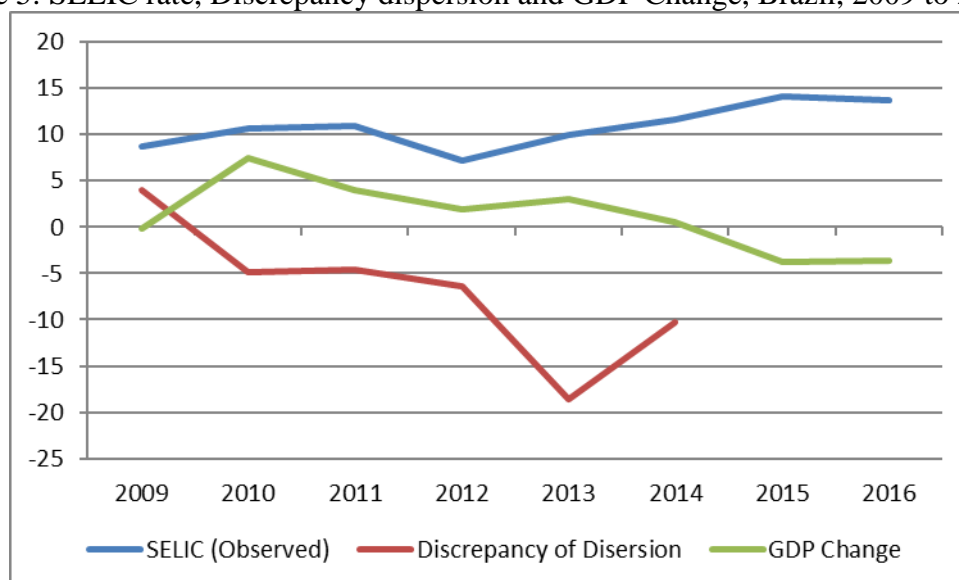
In 2009 and in subsequent years, CMN adopted set of anti-cyclical measures, as well as fiscal, monetary and credit policies. The effect was a change in the financial behavioral in the economy, and since 2010, there has been a change in the signal of discrepancy of dispersion. Meanwhile, the remedy was excessive, and in 2013 there was another collapse in the financial system; however with excess liabilities this time and at the same time, it is observed an increase in the interest rate. As a consequence, the GDP of 2014 shows a decrease in the growth rate and in the subsequent years (2015 and 2016) the GPD effectively decrease. Figure 5 presents the evolution of the SELIC rate, the discrepancy dispersion and the change in GDP from 2009 to 2014.

The structure of the Brazilian financial market, illustrated by power-of-dispersion-index fund-raising and fund-employment, shows that households and the ROW are mainly “saving sectors” (the DPI-FE is higher than the DPI-FR). They are saving and accumulating financial assets. Meanwhile, enterprises and government are mainly “investor sectors” (the DPI-FE is lower than the DPI-FR); they usually raise funds to

finance excess investments in the objective economy. The Brazilian Central Bank is in the middle of the financial market, while other financial firms are a little below, which means that they have more difficulty employing funds.

In the first part of the period 2004–2009, these indexes are interesting in pointing out that the government and the central bank take on more important roles, with greater influence in the financial market, over financial firms (the financial sector without the central bank). The government borrows new sources of financing by issuing treasury bonds and/or borrowing new loans and BCB provides funds to ultimately finance the needs of all other financial institutions as well as the government's deficits. This highlights the great power of the government and the central bank in the Brazilian economy and raises a question in relation to their financial intermediation performance.

Figure 5: SELIC rate, Discrepancy dispersion and GDP Change, Brazil, 2009 to 2014



Source: IBGE; BCB and Brazilian FOF

The BCB has low SDI-FE, indicating that it does not immediately react to savings increases. However, the financial firms, government and enterprises are strongly influenced by increases in total savings.

In this sense, enterprises and the government seem to work as financial intermediaries, because they generate great influence when borrowing and are strongly affected when there are excess investments in the wide economy.

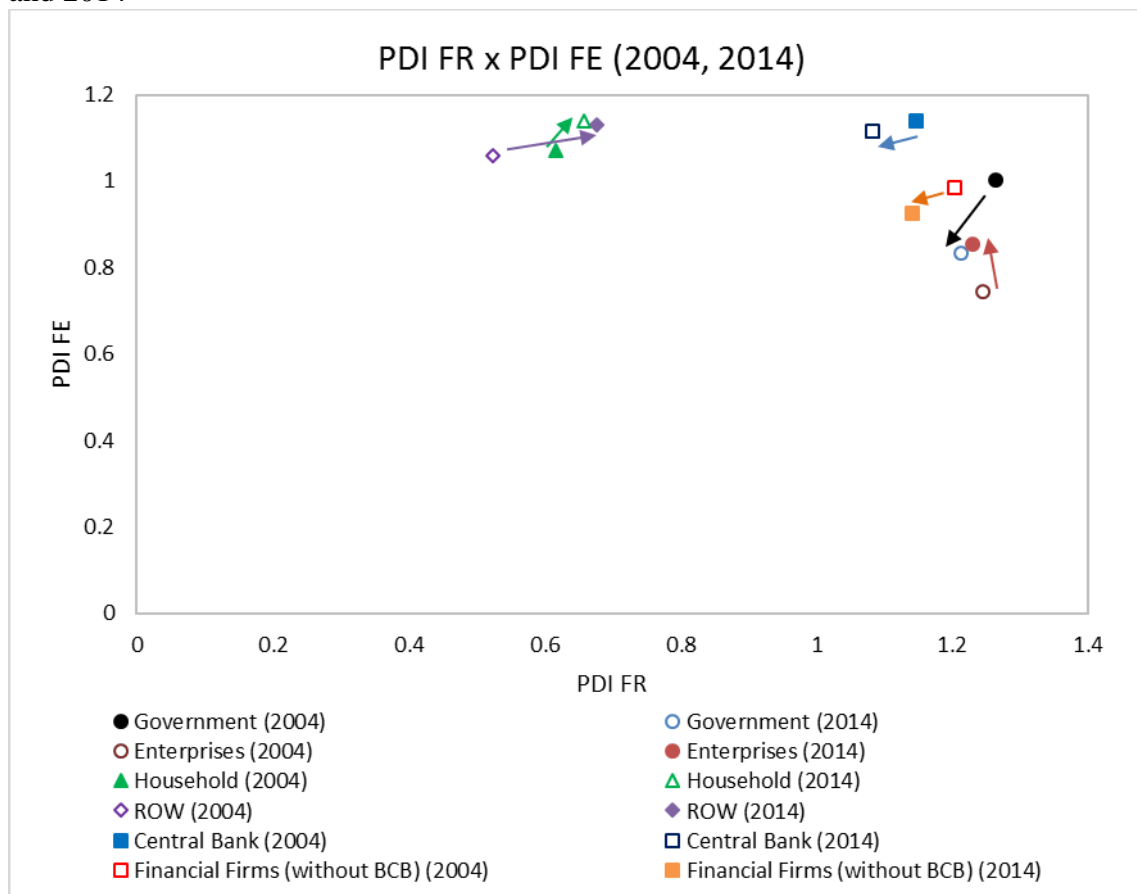
The evolution of the power of dispersion indexes from 2010 to 2014 shows that the household and enterprise sectors are moving toward the middle (1, 1), indicating that households are increasing their investment and firms' net investment is decreasing. The

ROW stays in the second quadrant, near households, and plays an important role as a supplier of funds.

The government stays in the fourth quadrant, proving that its role in the financial market is not much different from that of enterprises; the government is actively investing. Financial firms are still situated in the fourth quadrant, indicating that they are better at borrowing than lending.

Figure 6 plots the graphics with the power-of-dispersion-indexes from the year 2004 to 2014. The DPI-FR assumes values in the abscissa (horizontal axis) and the DPI-FE in the ordinate (vertical axis). The center of the graphic assumes the value of 1.

Figure 6: The position shifts of institutional sectors in the PDI diagram, Brazil, 2004 and 2014



Source: Elaborated by authors

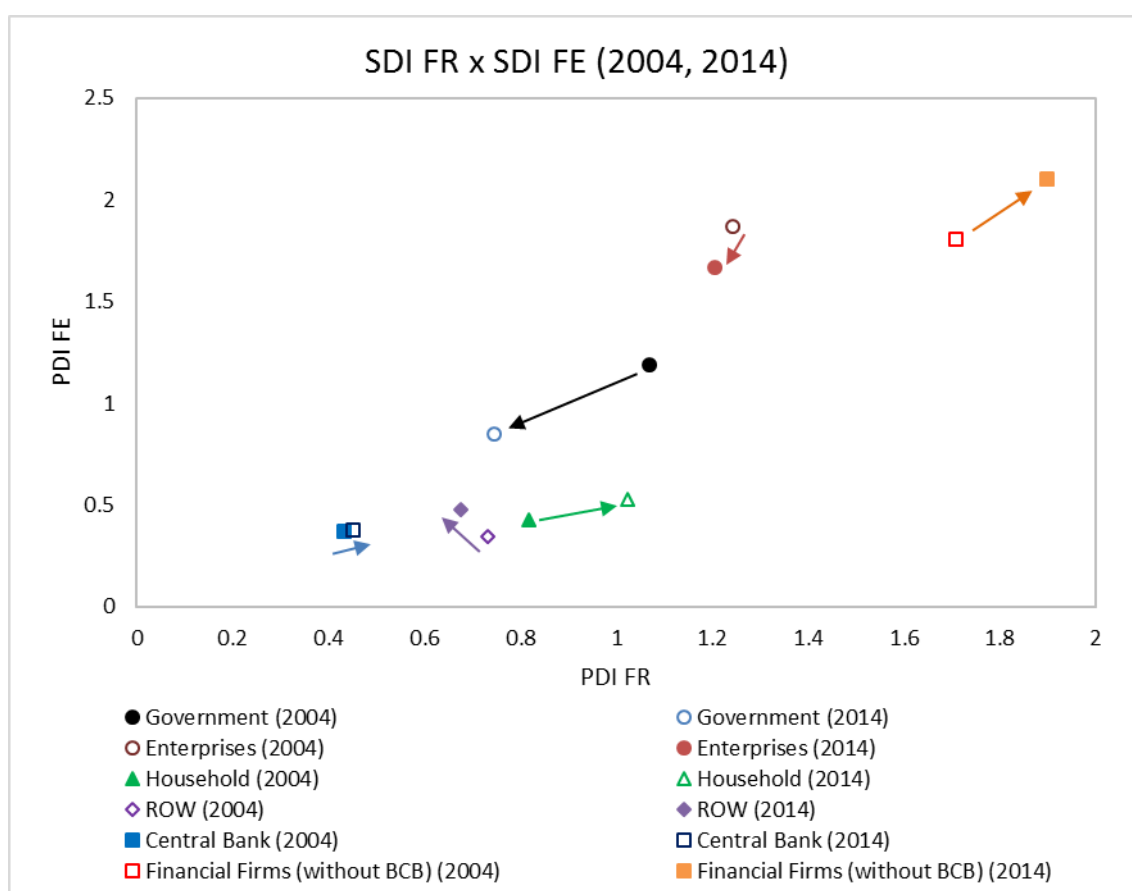
Households moved a little north-east in the diagram, suggesting the sector has become a dominant player as a funds supplier. Similar, although more intense, movement is observed in the rest of world, implying that Brazilians are finding their investment opportunities abroad.

Enterprises moved northward, implying that their presence as a fund supplier rose during the observation period.

The government moved to the south-west, suggesting that the private sector has taken over the economic dominance.

Figure 7 plots the graphics with the power-of-dispersion-indexes from the year 2004 to 2014. The SDI-FR assumes values in the abscissa (horizontal axis) and the SDI-FE in the ordinate (vertical axis). The center of the graphic assumes the value of 1.

Figure 7: The position shifts of institutional sectors in the SDI diagram, Brazil, 2004 and 2014



Source: Elaborated by authors

Looking at the sensitivity-of dispersion-indexes, financial firms stay in the first quadrant and their position is moving toward the right, suggesting that there is considerable improvement in their performance as intermediaries.

As a consequence, the financial firms can absorb the household savings more effectively; households moved eastwards in the diagram from the third quadrant to the fourth quadrant.

Enterprises and the government moved to south-west, implying that they are no longer active as financial intermediaries.

On the other hand, the central bank and the government move left, showing that their role as intermediaries is decreasing. Notwithstanding, enterprises are situated in the first quadrant, suggesting trade credit is an essential tool of finance in Brazil.

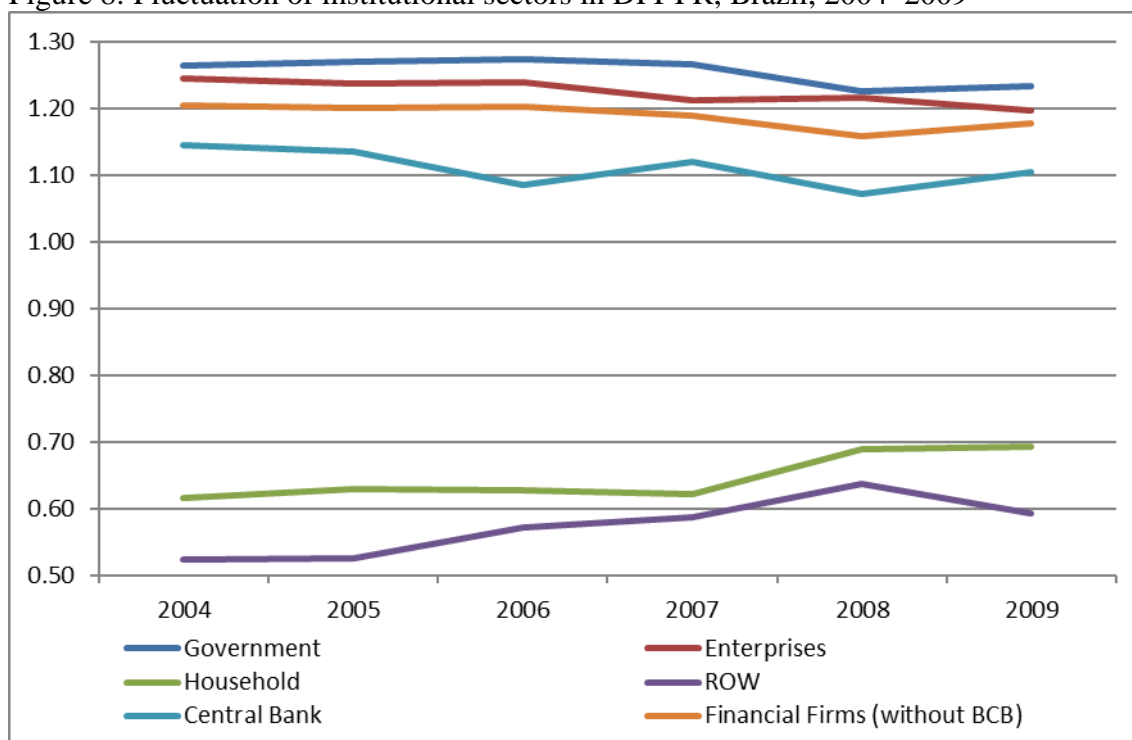
According to the order of the SDI-FRs, individuals tend to borrow first with financial firms (which means the financial system without the central bank), then with enterprises and then from the government.

Figures 8 and 9 present the fluctuations in FR-PDI from 2004 to 2009 and from 2009 to 2014, respectively.

Households' FR-PDI significantly rose in 2008 and showed a moderate rise in subsequent years. From 2008, the mortgage and consumer-finance market was heated in Brazil because of anti-cycle policies as a consequence of the credit crunch. As well as households', the rest of world's FR-PDI significantly rose in 2008, however the index dropped in 2009 and 2010.

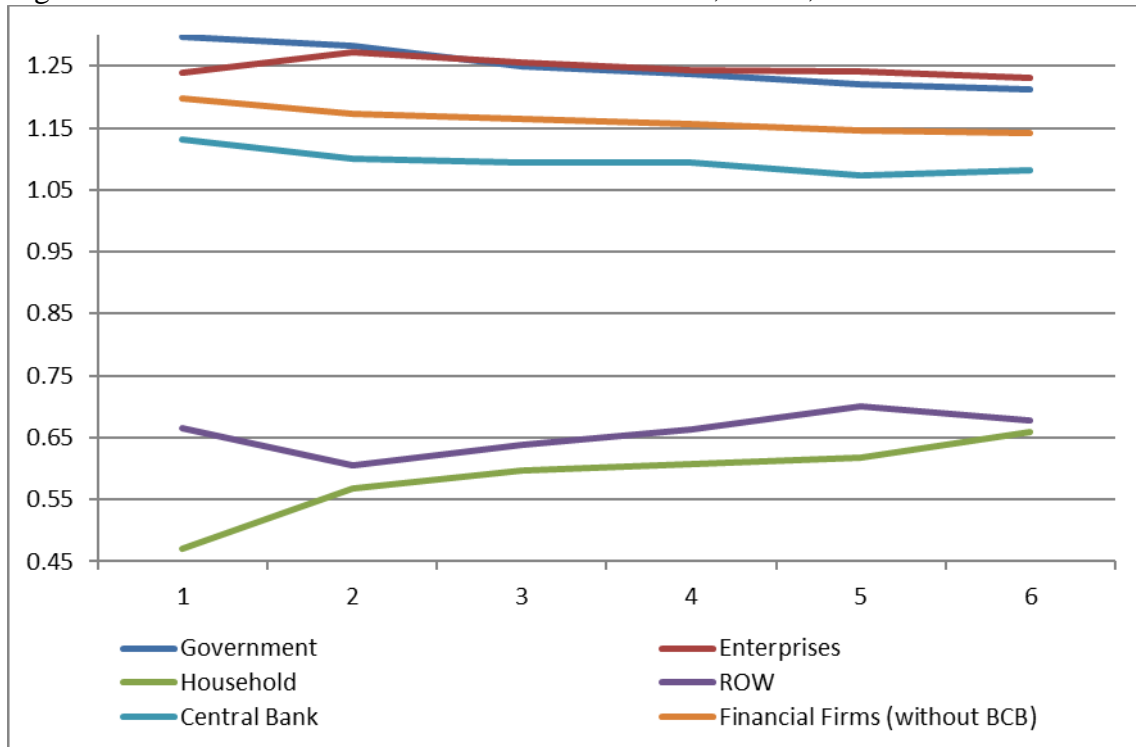
Enterprises, government, financial firms, and the BCB's FR-PDI show a downward trend, although the enterprise sector showed a small growth in 2010.

Figure 8: Fluctuation of institutional sectors in DPI-FR, Brazil, 2004–2009



Source: Elaborated by authors

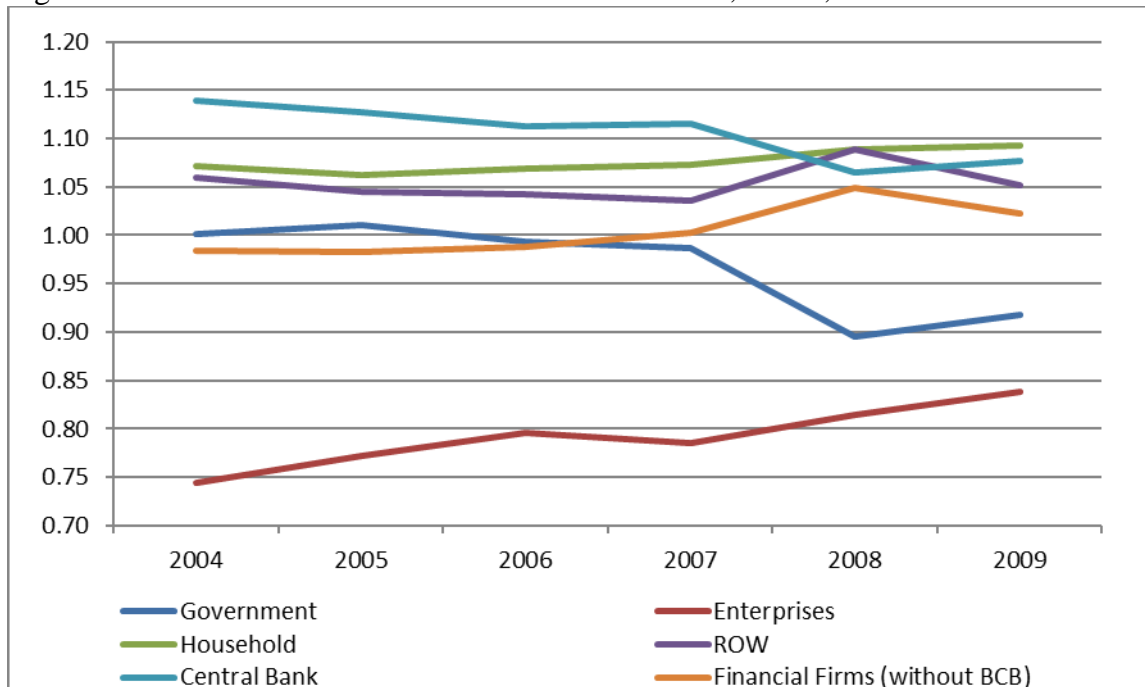
Figure 9: Fluctuation of institutional sectors in DPI-FR, Brazil, 2009–2014



Source: Elaborated by authors

Figures 10 and 11 presents the fluctuations in FE-PDI from 2004 to 2009 and from 2009 to 2014, respectively.

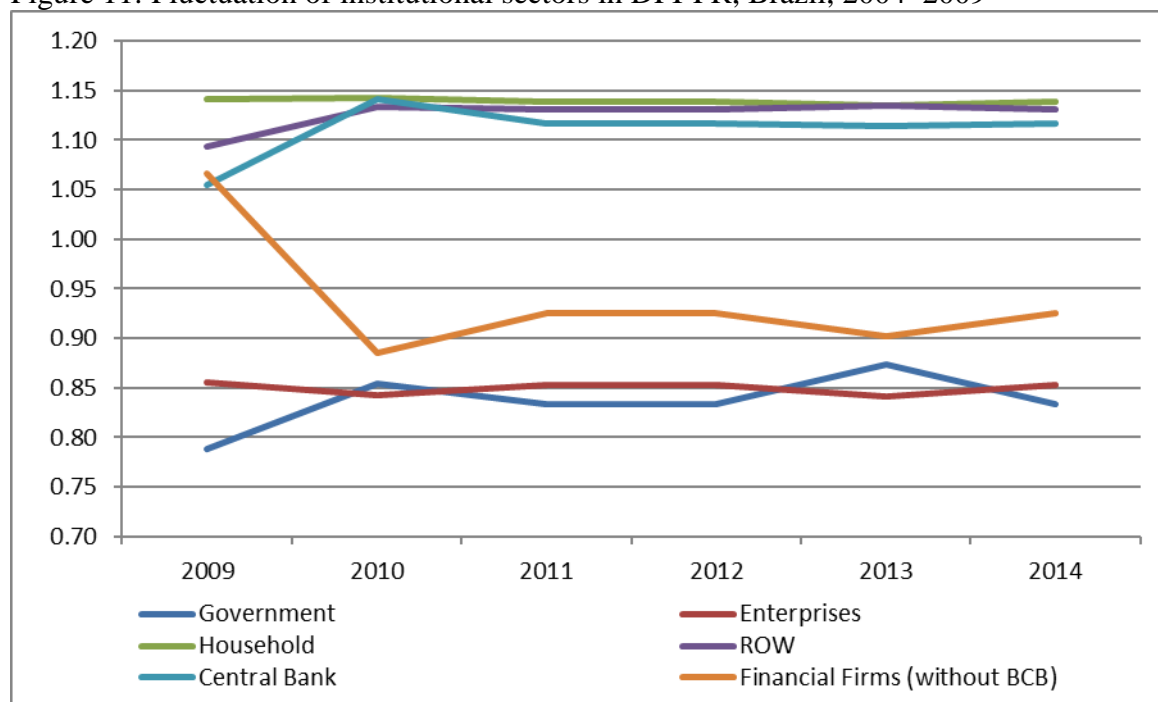
Figure 10: Fluctuation of institutional sectors in DPI-FR, Brazil, 2004–2009



Source: Elaborated by authors

The government's and central bank's FE-PDI declined significantly in 2008 while the ROW and financial firms' indexes grew. In the previous year, there was an excess inflow of financial funds from abroad, as observed in the discrepancy indexes, there were excess assets in the economy. However, funds were almost all concentrated in financial firms, not allocated to productive sectors.

Figure 11: Fluctuation of institutional sectors in DPI-FR, Brazil, 2004–2009

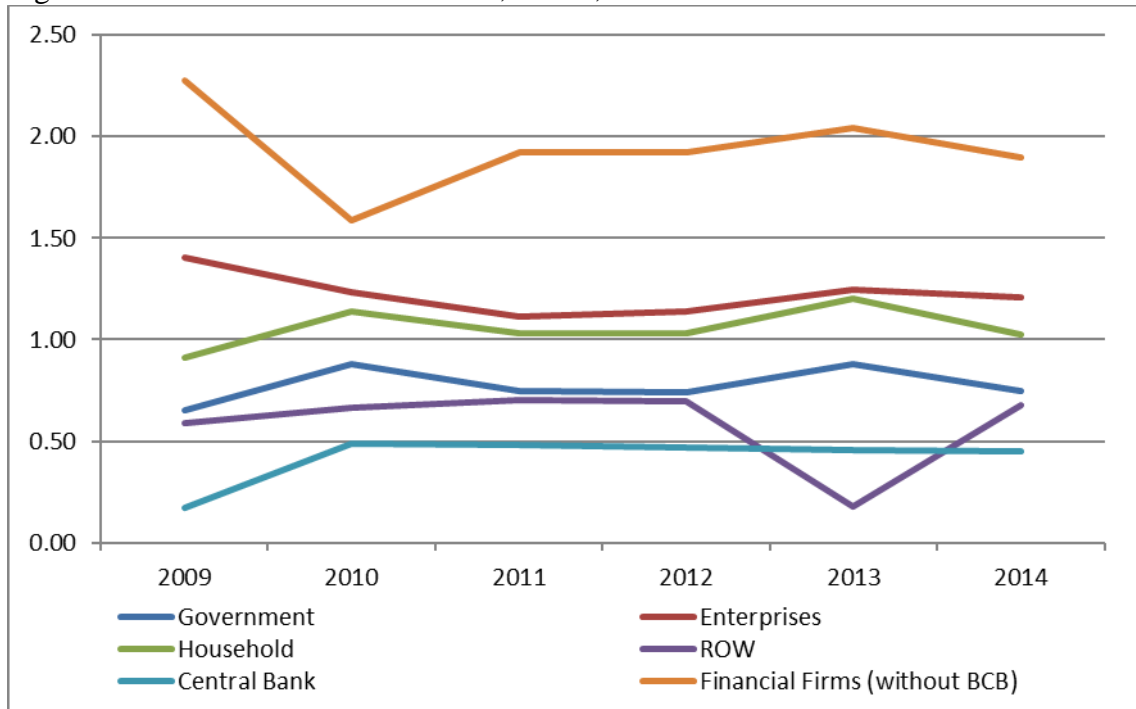


Source: Elaborated by authors

Financial firms' FE-PDI dropped sharply in 2010, while the government and the central bank's FE-PDI rose, suggesting that the credit crunch was triggered by the reluctance of banks to extend new loans; instead, the government and central bank took on anti-cycle politics to help the economy out of the crisis.

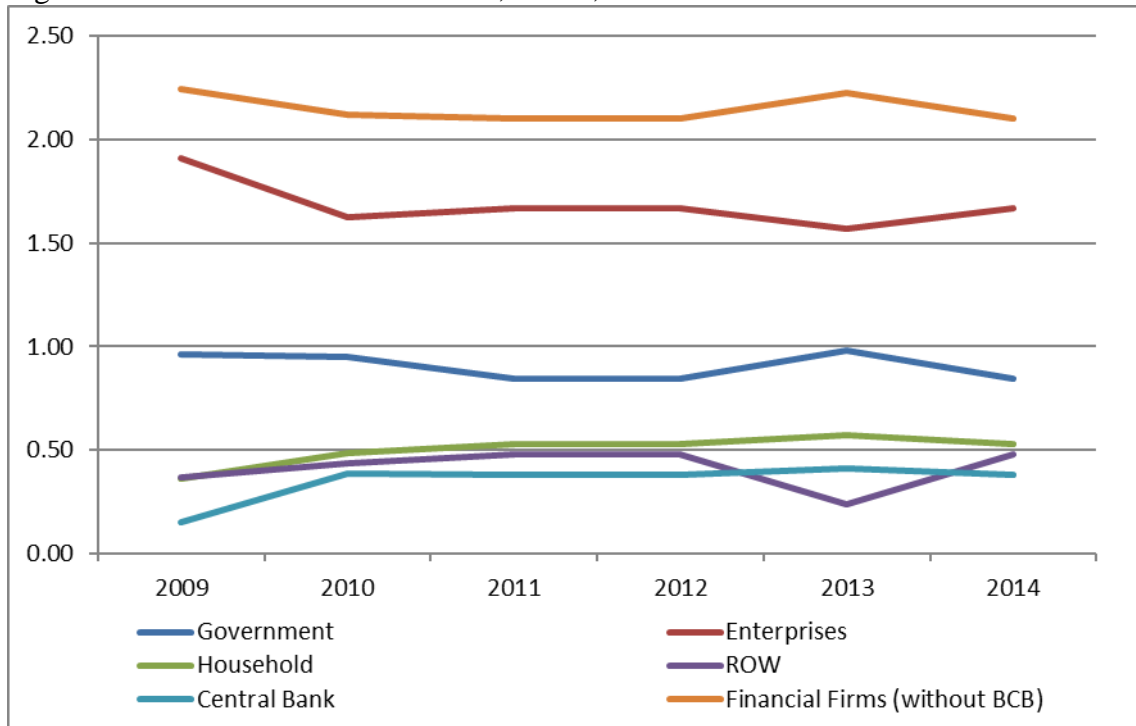
Figure 12 presents the fluctuations in FR-SDI from 2009 to 2014 and Figure 13 presents the fluctuations in FE-SDI from 2009 to 2014. Figure 12 reveals that financial firms absorbed most of the fluctuations in the demand for funds in the Brazilian economy. However, financial firms' FR-SDI dropped sharply in 2010, showing that the credit crunch was a factor. Moreover, it should be noted that the FR-SDI of the government and central bank dropped one year earlier; the credit crunch must have been caused by economic-tightening policies.

Figure 12: The fluctuations in FR-SDI, Brazil, 2009–2014



Source: Elaborated by authors

Figure 13: The fluctuations in FE-SDI, Brazil, 2009–2014



Source: Elaborated by authors.

The rise in households' FR-SDI suggests that the fund raisers found a last resort in the sector. Another problem is that the rest of world's FR-SDI declined sharply in 2013; the exchange rate had been in a growth trend since 2011. In 2012, 2013, and 2014, the growth rate was 13% each year, which could have generated distortions in imports and exports.

Figure 13 shows that the FE-SDI of enterprises rose while that of the central bank dropped in 2009, suggesting that enterprises mutually gave credit among them to continue their day-to-day business under economic tightening.

The dispersion indexes in the years 2008, 2009, and 2010 that a lot of changes occurred in the behavior of institutional sectors in the financial market. Remembering that according to discrepancy index, the year 2008 was a crucial year, demonstrating higher discrepancy.

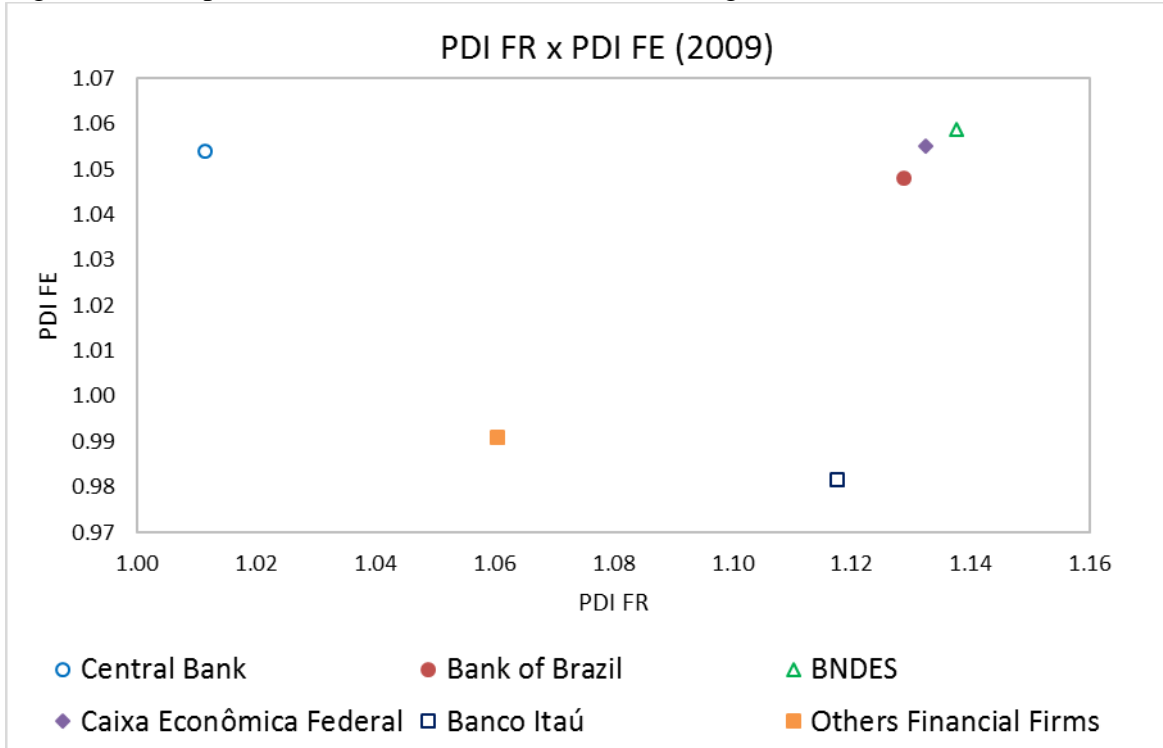
Figure 14 presents a diagram of the Brazilian financial system with the additional disaggregation in the financial firms (for BCB and the three government-sponsored financial institutions: BB, CEF, and BNDES; Itaú Bank, the largest private bank; and the group of "other financial firms"). It shows FR-PDI and FE-PDI in the year 2009. Figure 15 shows FR-SDI and FE-SDI to this additional disaggregation.

The wide view presented in Figure 14 shows that BB, CEF, and BNDES are higher than "other financial firms" and the private bank, indicating that government-sponsored banks showed greatest ability to spread funds. However they did not show ability to absorb changes in demand. Figure 15 reveals that other financial firms have the ability to absorb demand (they are in the upper and right side of the graph) than government-sponsored banks.

Therefore, one part of the demand for funds is supplied by "other financial firms," who do not effectively pass on these funds and the other part of the demand is supplied by the informal market.

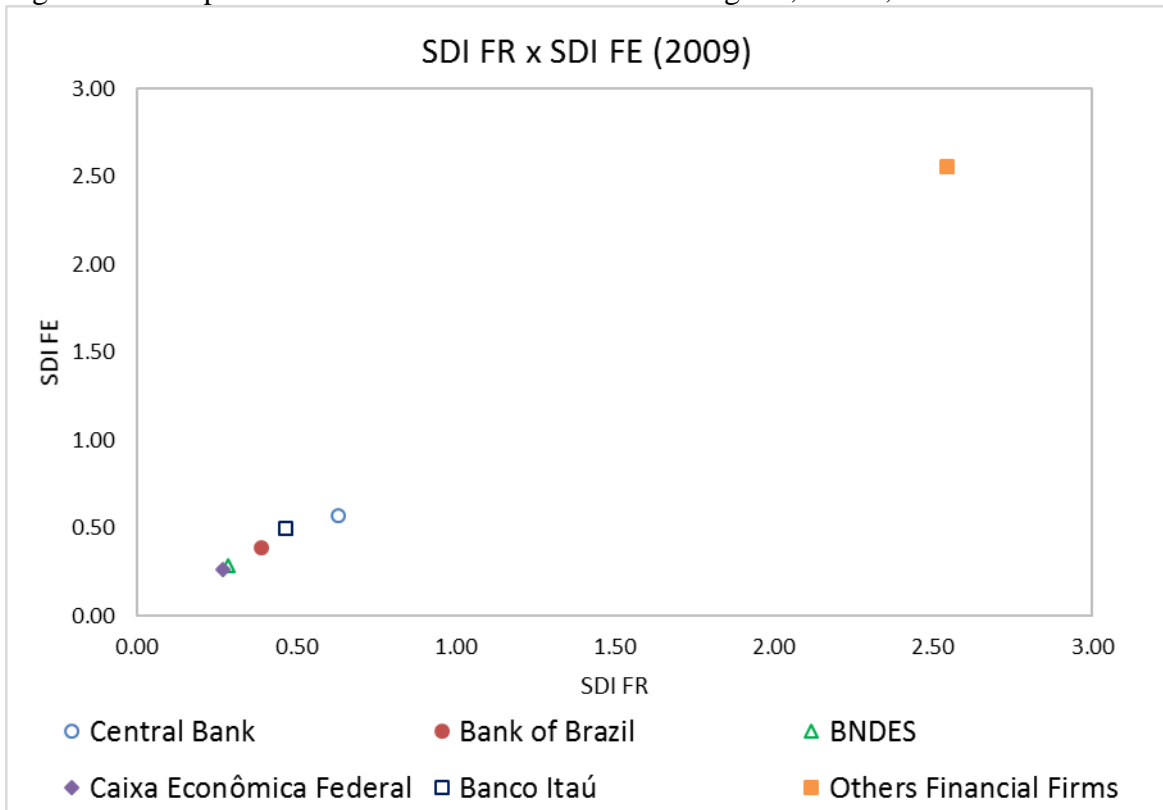
In the next sequence, the decomposition of change in the discrepancy of dispersion is presented. Table 9 presents the decompositions of the change in the discrepancy index within the contributions of the objective economy and contributions of the financial system to the years 2008 and 2013.

Figure 14: The position of financial firms in the PDI diagram, Brazil, 2009



Source: Elaborated by authors

Figure 15: The position of financial firms in the SDI diagram, Brazil, 2009



Source: Elaborated by authors

Table 9: Decompositions of the change in the discrepancy index to the years 2008 and 2013

	2007 - 2008			2012 - 2013		
	Tot Cg	OE %	FM %	Tot Cg	OE %	FM %
Government	1.52	34.35	65.65	-1.97	28.3	71.7
Enterprises	0.22	55.35	-44.65	-3.74	28.76	71.24
Household	0.81	-19.91	80.09	-2.97	21.77	78.23
ROW	0.2	-34.79	65.21	1.53	-11.02	88.98
Central Bank	0.39	7.07	92.93	-0.68	31.49	68.51
Financial Firms	1.6	41.84	58.16	-4.3	38.71	61.29
Wide Economy	4.74	39.74	60.26	-12.12	36.07	63.93

Source: Elaborated by authors

It was verified that 61% and 64% of the total change in discrepancy, respectively to the years 2008 and 2013, was caused by changes in financial market structure. In 2008, the enterprises' decomposition shows higher contribution of objective economy, while changes in the others institutional sectors contributions of financial market structure to the change in discrepancy was higher. In 2013, the change of all sectors' discrepancy shows higher contribution of financial structure. In this way it is clear that savings was not allocated to productive sectors and financial firms maintained their excess funds in treasury bonds, which are more profitable and have smaller risk. This financial behavior is the most important cause of change in 2008 and 2013.

From this, it is likely that the peaks of the crisis, reflected in the decrease in GDP in the year 2009 and 2014, had a financial origin in the previously years (2008 and 2013). Excess assets were not allocated to productive sectors neither than excess liabilities.

5. Concluding Remarks

In this paper, the FOF analysis is applied to investigate the Brazilian economy between 2004 and 2014. Two sets of asset–liability matrices are developed and FOF indexes (power-of-dispersion index, sensitivity-of-dispersion index and discrepancy-of-dispersion index) in the asset-oriented system and in the liability-oriented system are derived.

It is observed that household and the rest of world are saving sectors, their funds are allocated to enterprises, the government and financial firms by shares (investment funds and direct foreign investments), but funds also go to investor sectors through informal markets by other forms of debt and credit.

It is also observed that the government and the central bank have played important roles in the financial market—both have high power-of-dispersion indexes. Another remark is that the government, central bank and the enterprises work as financial intermediaries in the Brazilian economy; however over the years, their involvement has decreased. There was a relevant change in the financial market in the period, with a high monetization of assets and, in the same way, other financial firms increased their ability to collect funds.

There is a difference between the behavior of government-sponsored banks and other financial firms. The former has the ability to spread funds and the latter has the ability to absorb demand. In this sense, it is clear that there is a strong possibility that households' and rest of worlds' savings are not being allocated to productive sectors.

The discrepancy index is a good indicator of economic behavior, because a high increase in the discrepancy is followed by a fall in GDP. Decomposition of change in the years 2008 and 2013 showed that the financial crisis in the Brazilian economy had origins almost in the structure of financial market. The FOF framework showed that excess assets stayed accumulated in financial system instead of going to productive sectors, generating the collapse in the financial system.

Our advice is that policy makers should pay attention that: improved financial intermediation in the Brazilian financial system is important for sustainable growth. One of the primary concerns is to look for financial instruments that could facilitate the mobilization of households' savings and allocations to enterprises.

The limitations of this paper relate to the IO methodology assumption of fixed coefficients, which is especially important when working with financial flows, because financial funding usually has higher volatility than the consumption of goods and services.

For future work, we intend to expand the institutional sectors, and include balance sheets for the financial institutions in the “other” category of financial institutions, for example, commercial banks, investment banks and financial cooperatives, and analyze the asset portfolios and liability portfolios of institutional sectors in many different time periods in order to propose effective monetary and credit policies.

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Appendix: The accounts of the Balance Sheet of the Central Bank of Brazil

Assets in foreign currency:

1.1.1. Available:

Available (foreign currency): refers to a share of foreign exchange reserves maintained by Central Bank with short and very short term.

1.1.2. Time deposits in financial institutions:

Time deposits in financial institutions (foreign currency): refers to a share of foreign exchange reserves maintained by Central Bank with medium term.

1.1.3. Resale agreement

Resale agreement (foreign currency): operations in which a spot purchase occurs concurrent with the assumption of the resale commitment (repo) or a spot sale assumption of the repurchase commitment at a future date (reverse repo).

1.1.4. Derivatives

Derivatives (foreign currency): refers to operations with the objective to administration of international reserves and exposure to risk. Works as a hedge of short term external liability. The financial instrument derivatives are: Forward of currency, Forward of interests and securities.

1.1.5. Securities

Securities (foreign currency): refers to free bonds and bonds linked to repurchase agreements, issued from foreign national treasures.

1.1.6. Credits Receivable

Credits Receivable (foreign currency): refers to loans transactions in foreign currency made by BCB to provide liquidity do national financial system. Mainly instruments are Global Bonds, ACC and ACE, credit agreement.

1.1.7. Gold

Gold: refer to a share of the international reserve. Monetary financial asset.*

1.1.8. Participation in International Financial Organization

Participation in International Financial Organization: refer a share of participation into the International Monetary Fund (FMI) and in the Bank for International Settlements (BIS).*

1.1.9. Other

Assets in local currency:

1.2.1. Available

Available (local currency): refers to amounts receivable arising from operations to be settled under the Local Currency Payment System - SML.

1.2.2. Deposits

Deposits (local currency): The deposits are constituted by legal determination, linked to lawsuits for which there is recognition of a provision (note 23.1) or a court order to pay

(note 19.2). They are remunerated by the Referential Rate - TR and, due to this linkage, are unavailable until the judicial decision.

1.2.3. Resale agreement

Resale Agreement (local currency): operations in which a purchase occurs concurrent with the assumption of the resale obligation (Resale Commitment) or a sale assumption together with the repurchase obligation at a future date (Repurchase Commitment). In these operations, in view of their characteristics, the assets traded are accounted for as collateral, except in the case of foreign currency purchase and sale operations, since only against payment on the agreed date, i.e., the actual receipt of the negotiated currency settled operation. In the foreign market, the Central Bank of Brazil usually contracts with the same counterparty a repurchase agreement (repo) at the same time as a reverse repo, with independent financial settlement.

1.2.4. Derivative

Derivative: refer to Swap: used to execute the monetary and exchange policy, hedge to financial institutions; Currency equalization: daily balance operation between BCB and National Treasury. Purchased position.

1.2.5. Federal public securities

Federal public securities: refer to federal public bonds. They are National Treasury Letters (LTN), Financial Treasury Letters (LFT), National Treasury Notes (NTN).

1.2.6. Credit with federal government

Credit with Federal Government: currency equalization and “Single Account of National Treasury.” It is the account that registry all transaction between the BCB and Federal Government.

1.2.7. Receivable credit

Receivable credit (local currency): refers to credits of BCB with institutions in liquidation originated from financial assistance transactions (Proer) and balance from balance due on overdrafts in the Reserves Accounts.

1.2.8. Furniture and Real Estate*

1.2.9. Other: Other credits

Liabilities in foreign currency:

2.1.1. Contracted operations to be settled

Contracted operations to be settled (foreign currency): refer to not yet paid contracted transactions, which will be paid in two or three days.

2.1.2. Deposits from financial institution

Deposits from financial institution: refers to deposits in the BCB from foreign financial institutions.

2.1.3. Repurchase agreement

2.1.4. Derivatives

Derivatives (foreign currency): means the reverse operation of 1.2.4.Derivative. Sold position.

2.1.5.Credits to pay

Credit to pay (foreign currency): refers to allocation of Special Withdrawal Deposits (DES). Funds from International Monetary Funds (FMI).

2.1.6.Deposits in International Financial Organization

Deposits in International Financial Organization: refers mainly to deposits from FMI*.

2.1.7.Other: Other (foreign currency)

Liabilities in local currency:

2.2.1.Contract operations to be settled

Contracted operations to be settled: refer to not yet paid contracted transactions, which will be paid in two or three days.

2.2.2.Deposits from financial institution

Deposits from financial institution: refers, mainly, to compulsory deposits, which represent monetary policy instrument.

2.2.3.Repurchase agreement

Repurchase agreement: refer to the reverse operation corresponding to the asset account
1.2.3. Resale agreement.

2.2.4.Derivative

Derivative (foreign currency): Refer to the reverse operation of 1.2.4.Derivative. Sold position.

2.2.5.Liabilities with federal government

Liabilities with federal government: refer to the “Single Account of the National Treasure”.

2.2.6.Credit to pay

Credit to pay: Refers to judicial orders to pay (precatory).

2.2.7.Deposits in International Financial Organization

Deposits in International Financial Organization: refer mainly to FMI deposits*.

2.2.8.Provisions (Allowance)

Provisions: refer to retirement benefits and health care benefits.

2.2.9.Other: Other

2.3.CIRCULATING: refer to balance of paper-currency and metal currency with people and financial institutions.*

2.4.NET WORTH: net worth of BCB.

These accounts do not enter in the FOF.*

*These accounts are not included in FOF BR because they refer to monetary funds.