DANIEL CARVALHO CUNHA

TRANSMISSION OF MONETARY POLICY THROUGH THE WEALTH CHANNEL IN BRAZIL: DOES PUBLIC DEBT MATTER?

Dissertação apresentada ao Curso de Mestrado Acadêmico em Economia, Universidade de Brasília, como requisito parcial para a obtenção do título de Mestre em Economia.

Orientadora: Prof. Dra. Marina Delmondes de Carvalho Rossi

BRASÍLIA

2017

FICHA CATALOGRÁFICA

Cunha, Daniel

Transmission of monetary policy through the wealth channel in Brazil: does public debt matter?– Brasília, 2017.

64 páginas

Área de concentração: Economia Aplicada.

Orientador: Prof. Dr. Marina Delmondes de Carvalho Rossi

Dissertação de Mestrado – Programa de pós-graduação do Departamento de Economia da Universidade de Brasília.

1.Public debt; 2. Wealth effect; 3. Transmission of monetary policy.

À minha esposa Samia, cujo amor e companheirismo foram fundamentais
Aos meus pais pelo amor, zelo e incentivo incondicional ao estudo
Ao meu super avô, Rosenélio, por ser grande referência na minha vida

Dedico

AGRADECIMENTOS

A todos os colegas da Secretaria do Tesouro Nacional. Em especial a Mauricio Dias Leister, Lucas Gurgel Leite, Andre de Araújo Melo e Giovana Leivas Craveiro por toda ajuda e apoio durante Mestrado.

A todos os colegas do FMI. Em especial a Fabian Bornhorst e Ana Krohn pelo importante apoio na reta final do Mestrado.

À Professora Marina Delmondes de Carvalho Rossi e ao Professor José Luiz Rossi pela excelência e dedicação na orientação, cujo apoio constante foi imprescindível para o êxito desta Pesquisa.

Aos professores do programa de Mestrado em Economia da UNB. Em especial aos professores Gil Riella, Bernardo Muller, Rodrigo Peñaloza e Roberto Ellery pelas aulas inspiradoras.

À organização administrativa da Pós-graduação em Economia da UnB. Em especial à Carina Lima pela atenção e ajuda constante que viabilizaram a conclusão deste trabalho.

Aos colegas alunos do programa de Mestrado em Economia da UNB. Em especial aos amigos Renan Abrantes, Giovani Machado e Pedro Hernandes, companheiros de tantas horas de estudo.

“It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.”

Richard Feynman.

ABSTRACT

TRANSMISSION OF MONETARY POLICY THROUGH THE WEALTH CHANNEL IN BRAZIL: DOES PUBLIC DEBT MATTER?

We studied the transmission of the monetary policy through the wealth channel in an original way by adding several novelties on the topic in Brazil: i) public debt wealth effect at market price, ii) housing market wealth effect, iii) stock market wealth effect and iv) wealth effect estimation via structural Bayesian Autoregressive Vector (BVAR) with Cholesky factorization and sign restrictions. The results of public debt and stock market wealth effect were statically insignificant. On the contrary, we found out substantial evidence that the real estate price plays an important role in the transmission of the monetary policy through wealth channel.

Keywords: Public debt; Wealth effect; Transmission of monetary policy.

SUMMARY

LIST OF FIGURES AND TABLES

1 INTRODUCTION

1 INTRODUCTION

Broadly speaking, if the transmission channels of monetary policy are clogged, then a higher rate of interest is required to force the inflation convergence process. The wealth effect occurs when an increase in the interest rate causes the reduction in the market value of the wealth stock. If consumption depends on the stock of wealth[1] and it is perceived as wealth by individuals, then the increase in the interest rate will cause a fall in the value of the securities and, therefore, of the wealth, generating a contraction in consumption.

The interplay between wealth and consumption has been on the Brazilian macroeconomic spotlight due to a high level of the interest rate in the last two decades. However, the debate has focused on wealth effect of public debt in misalignment with international research in which the focus is the wealth effect provoked by the stock market and housing market. Moreover, even the Brazilian public debt wealth effect was not properly analyzed due to the lack of data quoting debt by market price. Thus, we studied the propagation of the monetary policy through the wealth effect in an original way by adding several novelties on the topic: i) public debt wealth effect at market price, ii) housing market wealth effect, iii) stock market wealth effect, iv) wealth effect estimation via structural Bayesian Autoregressive Vector (BVAR) with Cholesky factorization and sign restrictions.

[1] The stock of wealth can be composed of several assets, such as real estate, stocks, government bonds, private corporate bonds, cash, etc. Obviously, the impact of the wealth effect may vary according to the assumptions about how the wealth stock composition occurs. It is worth to note that such assumptions will be constructed throughout this study.

In Brazil, nonetheless, the debate was concentrated in public debt wealth effect. Especially, the focus was on the wealth effect provoked by the Letras Financeiras do Tesouro (LFTs)[2.] Nevertheless, the discussion focused on the loss of power of the monetary policy stemming from the high share of LFTs in the stock of public debt. By not considering the relevance of the wealth channel relative to other channels of monetary policy transmission, this concentration blocks the assessment of the wealth channel as a whole, as well as the wealth effect of public debt, since there is no relative analysis of the effects generated by different types of assets. To address this gap, different types of wealth were tested to measure the wealth effect in the Brazilian case through a BVAR with Cholesky factorization and sign restrictions.

In this context, the main objective of this study is to evaluate the impact of public debt management on the power of monetary policy relative to other forms of wealth, taking into account the wealth effect in the transmission of monetary policy. The work is divided into 6 sections, already taking this introduction into consideration. The second section details the theoretical framework that relates transmission of monetary policy, wealth effect ,and public debt management and also how the wealth effect debate was conducted in Brazil. The third section deals with the widening of the debate, analyzing the wealth effect of public debt by comparing it to other classes of assets. The fourth section discusses the data used in the empirical exercises. The fifth section points out the methodology used to perform the empirical exercise,

[2] LFTs are a bond type that is indexed to the Selic rate. Therefore, the bond profitability follows the variation of the SELIC rate, the basic interest rate of the economy. The profitability is determined by the variation of the daily SELIC rate recorded between the settlement date of the purchase and the maturity date of the security.

detailing the specifications of the structural BVAR with Cholesky decomposition and sign restrictions. Moreover, the fifth section presents and analyzes the results. Finally, the sixth one synthesizes the conclusions of the article.

2 LITERATURE REVIEW

2 LITERATURE REVIEW

The transmission of monetary policy through the wealth effect measures the impact of endogenous variations of private wealth due to changes in monetary policy on consumption. Initially, the wealth effect only considered how economic assets influenced aggregate demand. Pigou (1943) showed how direct deflations stimulate the economy due to the increase in the real wealth stock of individuals. Patinkin (1947) studied how the then "real balances effect" could not be used with the purposes of economic policy when analyzed dynamically.

From a macroeconomic theoretical perspective, it is important to highlight the contribution arising from the interplay between wealth and consumption designed by Ando and Modigliani (1963) through life-cycle model. According to this model, if all wealth shocks are expected, then individuals use their wealth to smooth consumption along life-cycle, implying that the latter will remain almost constant over time. Nonetheless, if wealth shocks are unpredictable, then consumption will vary over time.

Pailla (2009) summarized the theorical approach in three main channels. The first one (Direct wealth effect) is related to the impact of wealth on household’s budget constraint. The second one (Common causality) argues that wealth and consumption are driven by common macroeconomic variables. The third one (Collateralor or precautonary saving channel) states that an increase in assets prices could escalate the household’s willingness to borrow money and, as a result, boost consumer spending.

Moreover, Pailla (2009) pointed out that the empirical research on wealth channel research has focused on the dynamics between consumption and wealth via

elasticity and marginal propensity to consume. On this topic, researchers have conducted their analyses by clustering wealth in two groups: financial and non-financial wealth. The former usually studies the effects of stock market meanwhile the latter takes into account the impact of house market on consumption. Thus, as shown in table 1, most of the literature has focus on the estimation of the consumption elasticity of wealth and marginal propensity to consume.

TABLE 1: The relation between consumption and wealth according to the empirical literature.

authors	studied variable	US	UK	DE	CA	FR	IT	JAP
Labhard, Sterne and Young (2005)	elasticity (net fin. wealth)	0.12	0.16	0.13	0.19	0.10	0.08	0.16
Case, Quigley and Shiller (2005)	elasticity (housing)	0.62	0.14	0.14	0.14	0.14	-	-
Ludwig and Sløk (2004)	elasticity (equity)	0.08	0.08	0.03	0.08	0.03	0.03	0.03
	elasticity (housing)	0.04	0.04	0.02	0.04	0.02	0.02	0.02
Bertaut (2002)	elasticity (financial wealth)	0.23	0.09	-	0.16	0.10	-	0.29
	elasticity (non-fin. wealth)	0.14	0.09	-	0.16	-	-	-
	elasticity (equity)	0.10	0.16	-	0.14	-	-	-

Source: Pailla (2009)

Furthermore, in all theories listed above, there is an underlying necessary condition to trigger the wealth effect, that is, assets must be perceived as wealth by householders. On this topic, Bernanke and Gertler (1999) do not place a heavy weight on wealth channel since some assets are not perceived as wealth in a householder's budget constraint perspective. For example, according to the authors,

the stock market wealth effect in US is not that strong because individuals hold this type of assets through pension accounts.

Tackling the transmission of monetary policy through the housing market, Aoki, Proudman and Vlieghe (2004) analyze how real estate plays an important role via the credit channel. To test that, they used a variant of the financial accelerator model calibrated to UK data, to assess the impact of monetary policy on the real economy through its effect on housing prices. The model indicates that policy-induced changes in house prices have in fact played a significant role in the transmission of monetary policy in the UK.

Moreover, Sousa (2010) empirically examines the relation between monetary policy and financial/housing wealth using quarterly data for the euro area. The author finds out that a monetary policy tightening leads to a significant reduction in wealth. However, while financial wealth effects are of short duration, housing wealth effects are very persistent.

Regarding emerging economies, Koivu (2010) studied how the monetary policy transmission channel works in China. By using the housing market and stock prices, the author analyzes the wealth channel via a structural VAR model and data for 1998-2008. The results point out that a loosening of monetary policy indeed leads to higher asset prices in China. Additionally, urban households' consumption reacts positively to a rise in either residential or stock prices, although the effects are fairly weak. However, after explicitly evaluating the existence of the wealth channel, the author concludes that changes in asset prices due to monetary policy do not affect household consumption in a robust way.

Ludwigson, Steindel, and Leltau (2002) stated that the use of wealth effect analysis was consolidated due to their intensive participation in large macroeconomic

models of the 1960s and 1970s, which gave a strong emphasis to this effect, as exposed in Table 2. These authors compared the power of monetary policy with and without wealth through three models: (i) Washington University Macroeconomic Model (WUMM); ii) Data Resources Incorporated (DRI) and iii) Federal Reserve Board Model (FRB). The three models indicated that the wealth effect is significant for the American economy.

TABLE 2: Estimation of the magnitude of the wealth effect on the transmission of monetary policy in terms of consumption loss.

	Wealth channel on (A)			Wealth channel off (B)			Wealth effect = (A) - (B)		
Quarter	WUMM	DRI	FRB	WUMM	DRI	FRB	WUMM	DRI	FRB
EFFECT OF 100 basis points REDUCTION in the Federal Funds Rate on CONSUMPTION (%)									
1	0.1	0	N/A	0.1	0.1	N/A	0	0	N/A
4	0.5	0.2	0.3	0.2	-0.2	0.2	0.3	0.4	0.1
8	1.1	0.2	1.1	0.4	-0.3	0.5	0.7	0.5	0.6
12	1.7	0.2	N/A	0.4	-0.3	N/A	1.3	0.5	N/A

Source: Ludvigson, Steindel e Leltau (2002)

In the aforementioned article, the authors studied the transmission of monetary policy through the wealth effect. By using a structural Autoregressive Vector (VAR), they concluded that the wealth effect has a relatively small importance in the monetary policy transmission one year after the interest rate shock. The authors pointed out that the wealth effect provoked by a monetary policy shock tends to be small because the wealth effect caused by such a shock is transitory.

The fact is that consumption only responds strongly to variations in wealth when such variations are permanent[3]. In addition, the wealth effect virtually

[3] Lettau and Ludvigson (2001) show that consumption responds unequally to changes in consumer wealth, depending on whether such variations are transient or permanent. While transient variations have a low effect on consumption, permanent variations have a strong effect. It is worth to note,

disappears when the structural VAR is remodeled due to the inclusion of a commodity price index. According to the authors, it is important to include such index, since it is able to capture information almost contemporaneously with inflationary shocks about to take place. By comparing the impulse response functions with and without a commodities index, it is clear that part of the wealth effect apparently associated with an increase of the interest rate is actually derived from the reduction of the real value of the assets caused by inflation.

In this sense, the relevance of the wealth effect in the macroeconomic models of the 1960s and 1970s is largely explained by the simultaneity of inflationary and monetary shocks, since these models do not incorporate a commodity index to purge the effect. Loyo (2006) argues that several Central Banks do not take into account the wealth effect. For instance, he stated that only three (Finland, Netherlands and Italy) out of the twelve Central Banks in the Euro Zone give an endogenously treatment to the wealth effect in their macroeconomic models. It is worth mentioning that the magnitude of wealth effect in these models is quite small (between 1% and 5% of the monetary policy transmission breakdown). Therefore, one might say that, even in developed economies, there was a loss of relevance of the wealth effect in the transmission of monetary policy.

---

however, that the study did not map out whether the effects of monetary policy are transient or permanent.

The literature indicates[4] that monetary policy can affect the aggregate demand through several channels: i) credit, ii) exchange rate, iii) interest rate, iv) wealth, and v) expectations. In the Brazilian case, Minella and Souza-Sobrinho (2009) by studying the transmission channels of monetary policy found out that the exchange rate, the consumer interest rate ,and expectations are the main sources of monetary policy diffusion. Regarding the relationship between public debt management and the transmission of monetary policy, the literature emphasizes two channels of transmission that are affected by debt management: i) the term structure of the interest rate, which is one of the means of transmission of the interest rate channel and ii) the wealth effect of the public debt. We have focused on the latter effect, leaving the former one for further research.

When taking into account the Brazilian case, the following question arises: What is the relevance of the public debt wealth effect in the Brazilian economy? There is no conclusive indication in the literature about the importance of the phenomenon. On the one hand, Carneiro (2006), Franco (2006), Pastore (2006) and Pires and Andrade (2009) argued that the wealth effect IS blocked by existence of LFTs and this reduces the power of monetary policy. On the other hand, Arida (2006), Loyo (2006) and Resende (2006) pointed out that it is not possible to affirm that there is a causal relationship between the wealth effect blocked by LFTs and the power of monetary policy.

Through a qualitative analysis, Carneiro (2006) aimed to understand the role of LFTs in two anomalies that are present in the Brazilian economy: high interest rates and uncertainty in the yield curve. To understand this role, the author assessed

[4] See Mishkin (1995) and Mohanty and Turner (2008)

whether Brazil is framed by “peso problem”, which can be understood as a loss of wealth that eventually will occur. In order to analyze this problem, the author evaluates the pros and cons of LFTs. As a result, the author also highlighted the relevance of the relationship between financial normality and LFTs. Even though the causality relation is not mapped yet, it is possible to conclude that the two variables participate in the same phenomenon: the indexation to the short-term interest rate. Thus, to improve financial intermediation it is necessary to reduce the Brazilian public debt burden, which expresses the need to sell insurance against unforeseen movements in monetary policy.

Franco (2006) studied the relationship between crowding out, high interest rates, and LFTs. Although the author did not directly explore the question of the wealth effect, the article addressed the macroeconomic developments of the excessive use of LFTs. In reference to the crowding out problem, he stated that the government had created mechanisms, such as LFTs, that deepened the exclusion of the private sector from the dispute over national savings. In this context, the article aimed to investigate whether Brazil was sufficiently mature, in fiscal terms, to allow the withdrawal of such mechanisms. By analyzing the fiscal situation, however, the author argued that Brazil combines a high debt to GDP ratio with a high gross financing needs, denoting a lack of fiscal maturity.

Pastore (2006) affirmed that the creation of LFTs occurred because the market demanded an insurance against systemic crises. So that, at the time, there was no concern about the efficiency of monetary policy. That said, the article sought to assess how LFTs could reduce the power of monetary policy.

The author argued that fixed-rate debt securities are capable of diffusing changes in monetary policy. In the case of rising interest rates, the market value of

the debt stock falls. If consumption depends on the stock of wealth and public debt is perceived as wealth by individuals, then the increase in the interest rate will cause a contraction in consumption. In the case of LFTs, the wealth effect does not occur, since the present value of the bonds does not depend on the interest rate.

The latter study also evaluated the relationship between consumption and interest rate according to the model of Blinder and Solow (1973). In consonance with this model, consumption depends on disposable income and wealth stock. Even though they do not cause the wealth effect, the LFTs could increase the disposable income when an interest rate increase happens. This argument, however, does not hold in the light of the theory of life cycle and permanent income. Therefore, it is only possible to assert with certainty that LFTs do not cause wealth effect, and it cannot be said that they increase consumption by raising available income.

Pires and Andrade (2009) studied the wealth effect provoked by fixed-rate public debt securities aiming at analyzing the impact of the transmission of monetary policy through wealth effect and to evaluate the effect of the composition of the debt in this transmission.

The authors used two methods for this analysis. The first one followed the approach of Ludvigson, Steindel and Leltau (2002), who propose a counterfactual exercise to sensitize the importance of the wealth effect in the transmission of the policy through a structural VAR. This method indicated that the wealth effect is significant, but did not consistently indicate whether the indexation of debt at the short-term interest rate actually reduces the power of monetary policy. In addition, it generated a loss of long-term information in the variables of the model.

Thus, to use the long-term information, the authors used the second method, to say: a cointegrated VAR. The result of this modeling allowed the authors to

conclude that the wealth effect is significant and that indexed debt does not contribute to the transmission of monetary policy. In this sense, only fixed-rate debt would be able to transmit monetary policy. From the two methods studied, the author concludes that the non-inclusion of the wealth effect, in terms of the pre-fixed public debt, in Brazilian models may underestimate the power of monetary policy. In addition, they inferred that the wealth effect may explain part of the ineffectiveness of monetary policy due to the existence of debt indexed to the short-term interest rate.

In contrast to the four authors above, Arida (2006) defended the thesis that the stock of LFTs should not be eliminated immediately. Reducing this stock would only be feasible if risk premiums for conventional rolling instruments - such as fixed-rate securities and CPI linked bonds - are low. The author indicated that the objectives of public debt managers are: i) to minimize the risk of refinancing; ii) reduce the expected cost of debt without incurring excessive risk and iii) improve the well-being of society. The LFTs have become an important instrument for dealing with public debt refinancing crises, and it is, therefore, a relevant instrument to achieve the first goal listed. This have happened due to the LFTs attractiveness to investors. Regarding the second objective, LFTs meet the reduction criterion, since their issuance cost is lower than other types of securities. The risk criterion, however, is not met due to the volatility of the short-term interest rate to which the LFTs are indexed. Regarding the third objective (to improve the well-being of society) the issuance of long-term bonds is an interesting instrument, since it stimulates the emergence of the long-term market.

Holding the same position of Arida (2006), Loyo (2006) studied the relation between public debt and monetary policy, analyzing wealth, portfolio and volatility effect. As for the wealth effect, the author agrees with the assertion that long term

prefixed bonds enhance the wealth effect, whereas LFTs do not provoke such an effect. In this article, however, it is emphasized that the international literature points out that the relevance of the wealth effect in the transmission of monetary policy is debatable. This discussion occurs because the wealth effect is either transitory or permanent. If the effect is temporary, consumption would not increase. In addition, there is also the problem of specification errors that tend to overestimate the wealth effect. The empirical results found in the literature, however, are inconclusive about these effects.

Resende (2006) argued that the LFTs (named LBCs at the time) were created in 1986 to reduce the risk of mismatches in the remuneration of assets and liabilities of financial intermediaries. Hence, the conduction of monetary policy would be facilitated and the systemic risk would be reduced. The author acknowledged that LFTs reduce the effectiveness of monetary policy by blocking the wealth effect. This finding, nonetheless, does not imply the diagnosis that the low power of monetary policy is determined by the LFTs. For the author, the reason for the low effectiveness of monetary policy and the persistent high level of interest rates is the persistence of the fiscal imbalance. Nevertheless, the existence of LFTs currently occurs due to the high systemic risk of the Brazilian market. In this sense, the author indicated that causality occurs in the following direction: risk reduction causes a decrease in the stock of LFTs, and not the other way around.

The Brazilian case, however, has the peculiarity of the relationship between the LFTs and the Repurchase Agreements (REPOs) operations carried out by the Central Bank. These operations are the main instrument of the Brazilian monetary authority to operationalize monetary policy. Since REPOs are remunerated by SELIC in the same way as LFTs, it can be argued that there is a strong substitution between

these two instruments[5]. In this sense, when analyzing debt management and monetary policy together one may see that REPOs operations have a dual behavior. On the one hand, they act as instruments for SELIC to converge at the rate set by the COPOM. On the other hand, considering that this type of operation can be a substitute for the LFT, the REPOs operations could possibly block the wealth effect and, consequently, reduce the power of the monetary policy.

Taking into account this peculiarity of substitution of the LFTs by the REPOs operations, Barbosa (2006) studied the contagion effect of the indexation of the Brazilian public debt via LFT on the monetary policy. This contagion effect would cause, according to the author, the increase of the Brazilian short-term interest rate, because SELIC would be contaminated by the risk of the government bonds issued. Hence, the article analyzed the relation between the bank reserve market and the bond market with the risk premium of the Brazilian public debt. The latter factor would come from the underlining risk of issuing LFTs. As a result of this dynamics, the monetary authority's freedom to set the interest rate is limited by Treasury debt management.

Even though Barbosa (2006) argued that the contagion effect occurs in the direction that debt management limits monetary policy, it can be inferred that a two-way road conditioning occurs. The REPOs operations stock, which is classified as a liability in the Central Bank balance sheet, represents the excess liquidity of the financial system[6].

---

[5] The LFTs are not a perfect substitute for repurchase operations, as they enable the investor to carry out directional trades, such as taking a short position in the bond received as collateral.

[6] For more details see Pellegrini (2017).

Thus, in the Brazilian case, there are four ways to wipe out the liquidity of the system and, consequently, the REPOs operations stock: i) increase of the rate of rollover of Treasury bonds; ii) increase in the primary surplus; iii) definitive sale of government securities of the Central Bank portfolio and iv) reduction of international reserves. Therefore, since the REPOs operations stock is a response to the liquidity of the system, it can be said that the amount of repo operations depends on the public debt rollover rate. However, it can also be said that the debt rollover rate depends on the amount of debt repurchased, due to the substitutability between these two instruments. So, the choice of public debt composition also takes into account the REPO operations. In this context, to evaluate the impact of LFTs on the obstruction of transmission channels of monetary policy, it is necessary to analyze, in addition, the volume of REPOs operations carried out by the Central Bank.

3 THE WEALTH CHANNEL AND THE PUBLIC DEBT

3 THE WEALTH CHANNEL AND THE PUBLIC DEBT

In order to understand the relative relevance of the public debt's wealth effect when compared it to other securities, the following question emerges: What is the relative importance of the public debt's wealth effect compared to the effect caused / blocked by other assets?

By analyzing the literature, one can see that the debate about the relevance of the wealth effect in Brazil is still limited due to: i) the scarcity of consolidated wealth stock data and ii) the concentration of the debate about the wealth effect of public debt, ignoring the wealth effect of other relevant assets.

As for the scarcity of data, Costa (2013) conducted a research to check the availability of statistical sources on personal wealth in Brazil. The author concluded that there is no indicator in Brazil that measures the level of wealth of families neither their composition. As a result of this scarcity, the author emphasizes the importance of creating an agenda to disseminate indicators of this nature.

The Federal Revenue Service (RFB) provides the general statistics of Individual Income Tax (IRPF) tax returns, although it is not intended to measure the stock of wealth.

According to the RFB[7], in 2016, 38.31% of the declared assets and rights are classified as real estate. It should be noted that this percentage is underestimated, since real estate is registered by the acquisition price. Therefore, it is not quoted by market prices, which tends to higher. The registration for the purchase price also

[7] http://idg.receita.fazenda.gov.br/dados/receitadata/estudos-e-tributarios-e-aduaneiros/estudos-e-estatisticas/11-08-2014-grandes-numeros-dirpf/grandes-numeros-dirpf-capa

occurs in the declaration of vehicles, which represent 6.66% of the Personal Income Tax (IRPF), and equity, corresponding to 10.36% of the Personal Income Tax (IRPF).

The non-financial assets, which are represented by the 3 assets listed above, make up 55.34% of the IRPF. Financial assets, in turn, account for 30.20% of the assets and rights declared in the IRPF. In this category, we highlight the investment funds, fixed income, and shares segments, which represent 7.94%, 7.45% and 4.72% of the IRPF, respectively.

It should be noted that both fixed income and investment funds are recorded at the market value of the final year of the year evaluated. In contrast, the shares are marked by the purchase price. Even though RFB data provide a glance of the individuals wealth breakdown, the fact that several assets are recorded at acquisition cost, without market price valuation, impairs the analysis of the assets that make up the stock of goods and rights of agents.

In relation to the concentration on the wealth effect of public debt, Bernanke and Gertler (1999) argued that the validity of the effect in question arise from the premise that the public debt is **perceived** as wealth by the agents. It should be noted, however, that public debt represents just one component of agent's wealth stock.

In this sense, the discussion of the wealth effect in Brazil focused on one of the inputs and forgot the big picture. That said, in order to understand the wealth effect in the Brazilian case, it is necessary not only to identify the magnitude of the wealth effect of the public debt, but also to compare it with the effect caused by other assets. Due to the concentration of the debate, the role of assets that blocks the wealth effect has not yet been mapped in the literature, nor which asset is sensitized by the wealth effect. In this context, the following questions arise:

i)Does the LFTs block the public debt wealth effect?

The increase of the interest rate causes the reduction of the market value of the security for a regular fixed rate bond. For example, taking into account the case of a perpetual bond B that pays an interest rate r for each unit of time t, the market price of such bonds is equal to the present value of the cash flow of the securities discounted by a short-term interest rate i, so that the pricing formula can be represented by the following formula:

$$P_t = \sum_{t=1}^{\infty} \frac{rB}{(1+i)^t} = \frac{rB}{i} \quad (1)$$

The Equation (1) denotes that an increase in the short-term interest rate causes a reduction of the bond market price. That is,

$$\frac{dP_t}{di} = -\frac{rB}{i^2} < 0 \quad (2)$$

The LFTs, however, has a different effect than the one discussed above. Taking into account a number of LFTs in perpetual perspective that pays a short-term interest rate i for each unit of time t in a daily basis, the market price of these securities is equal to the present value of the cash flow of the securities discounted by a short-term interest rate i, so that the market value of these securities can be synthesized by the following formula:

$$P_t = \sum_{t=0}^{\infty} \frac{iB}{(1+i)^{1+t}} = \mathrm{B} \quad (3)$$

Therefore, if there is an increase in the short-term interest rate, the LFT price will not decrease. Thus, considering that consumption depends on the stock of wealth, raising the interest rate will not have the desired effect of decreasing consumption, since the stock of wealth will not be affected.

ii) Do the REPOs operations block the public debt wealth effect?

The repo operations are a type of open market operation carried out by the Central Bank. In the Brazilian case, once the SELIC rate has been set by the COPOM, the Central Bank undertakes REPO operations, reducing or increasing market liquidity, in order to induce the convergence of the SELIC rate to the rate set by the COPOM. To that end, the monetary authority acts to eliminate the daily market's excess / scarcity of liquidity.

If there is excess liquidity, the monetary authority sells a government bond with the commitment to repurchase it at a future date and the counterparty is remunerated by the SELIC rate. If there is a shortage of liquidity, the Central Bank buys a government market bond with a commitment to sell it at a future date, so that the monetary authority is remunerated by the SELIC rate.

It happens that the SELIC is also the reference rate of the remuneration of the LFTs. Therefore, the REPOs operations could be interpreted as a good substitute to the LFTs. In this sense, an increase in the interest rate does not cause the market value of the repurchase transactions to decline in a similar way to the LFTs and, consequently, does not change the consumption.

iii) What are the assets that potentialize wealth effect?

Real Estate: According to data from the RFB, real estate is the main component of the wealth stock of Brazilians. As a result, real estate is expected to be perceived as wealth by agents and, consequently, to increase the power of monetary policy.

Equity (stock market): According to information from the RFB, equity holdings have the third largest participation in the category of financial assets of Brazilian families. Hence, equity holdings are expected to be capable of boosting the transmission of the monetary policy through the wealth effect.

4 DATA

4 DATA

This section encloses a description of the dataset. The sample is restricted to 2002 onwards, when the Pesquisa Mensal do Emprego (PME) had started disclosing labor income data. That said, the model spans from 2002:1 to 2017:2 at quarterly frequency.

The wealth, labor income, consumption, interest rate and commodity index variables have been filtered to capture the cyclical component in these series by applying the Hodrick-Prescott (HP) filter. In addition, all monetary variables were calculated in real terms by using the prices of second quarter of 2017 as reference. The variables used in the BVAR model are defined as follows:

Inflation: we used the CPI index (IPCA) measured by the IBGE (1993=100). The quarter variation between two periods was calculated according to the following equation.

Labor Income: to calculate it we multiplied the real income per capita times the number of employed persons. For this variable, we used two series provides by the IBGE: PME and PNAD contínua. The former spans from 2002:1 to 2015:4 and aims to measure the labor income in six Brazilians metropolitan areas. The latter spans from 2012:1 to 2017:2 and measures the labor income in twenty Brazilians metropolitan areas. Since both series have a strong correlation (around 0.96), we created an index to extrapolate the PME labor income data from 2016:1 to 2017:2 by

using the PNAD continua quarter variation[8]. Thus, the labor income was used in the form of natural logarithm.

Consumption: the nominal consumption was collected from the national accounts data provided by IBGE. In the modeling, the consumption was used in the form of natural logarithm.

Interest rate: we use the SELIC rate at the end of the quarter, which was collected on the BACEN website.

Commodity index: the commodity research bureau spot index for all commodities collected by Bloomberg was used as reference. In the modeling, the commodity index was used in the form of natural logarithm.

Internal Federal Domestic Public Debt (DPMFi) at market prices: the DPMFi was calculated by summing the following securities: LTN, NTN-F, NTN-B and LFT. For each index of public debt, the stock was calculated by the multiplying the bond quantity by the bond market price (PU). The bond quantities were extracted from the National Treasury, while the PU was collected at ANBIMA. In the modeling, we use the natural logarithm of the DPMFi.

REPO: the stock of repo operations was collected at BACEN website. In the modeling, the natural logarithm of the stock of repo operations was used.

Real estate: we use the BACEN real estate price index. Nevertheless, the index was expressed in natural logarithm form.

Equity (stock Market): we use the IBOVESPA index as a benchmark of the stock market. This index was collected in the BACEN website and was deflated from

[8] In the empirical analysis, we also tested the PME and PNAD continua. As a result, we found out similar results when we compare it to the model output that takes this new index into account.

the IPCA of the second quarter of 2007. In the modeling process, the IBOVESPA was expressed in natural logarithm form.

Regarding the stationarity of these series, table 3 shows the ADF and Phillips-Perron unit root tests.

TABLE 3: Unit root tests of the variables used in the modeling process.

Series	ADF	Phillips–Perron	Decision
INFLATION	I(0)**	I(0)***	I(0)
LABOR INCOME	I(0)**	I(0)**	I(0)
Consumption	I(0)***	I(0)***	I(0)
Interest rate	I(0)***	I(0)**	I(0)
Commodities	I(0)*	I(0)*	I(0)
DPMFi	I(0)*	I(0)*	I(0)
DPMFi - LFTs	I(0)***	I(0)***	I(0)
DPMFi+REPOs	I(0)***	I(0)***	I(0)
REAL STATE	I(0)**	I(0)**	I(0)
EQUITY	I(0)***	I(0)***	I(0)

Source: elaborated by the authors.

5 WEALTH EFFECT EXPERIMENT

5 WEALTH EFFECT EXPERIMENT

5.1 EMPIRICAL STRATEGY

At first glance, we can summarize the wealth effect channel assessment in two parts. The first one is the definition of different compositions for the concept of wealth stock. The second one aims at mapping the effect of an interest shock on consumption with the wealth effect transmission channel on and off for each version of the stock of wealth of the first step.

As already mentioned in section 3, the first step intends to estimate the wealth effect of the public debt. In addition, this step targets to compare it with the phenomenon coming from other classes of assets. The fact that in Brazil there is no consolidated metric for wealth also reinforces the need to expand the classes of assets studied. That said, this step aims to answer the following question: is public debt an appropriate asset to gauge the wealth effect?

Once we have defined the different categories of wealth to be tested, we seek, for each one of them, to perform a comparative static exercise (second step), isolating the wealth effect provoked by different classes of assets through the method proposed by Ludvigson, Steindel and Leltau (2002). Thus, in the second stage, for each asset class, the reduction in consumption caused by an interest rate shock will be measured. So that, at the end of the simulation exercise, it is possible to order the magnitude of the wealth effect of the various assets. Furthermore, this step aims to answer the following question: what is the magnitude of the wealth effect for the different classes of assets studied?

In order to isolate the wealth effect, separating it from other transmission channels, it is necessary to carry out an exercise of decomposing the shock of monetary policy over consumption. In order to carry out this exercise, we analyzed how consumption responds to a shock of 1 standard deviation in the interest rate in 2 situations, namely: i) the shock response to the connected wealth channel and ii) the shock response with the wealth channel turned off.

Regarding the empirical strategy to measure the wealth effect, we will follow the methodology proposed by Ludvigson, Steindel and Leltau (2002). Nonetheless, we improve this methodology by using a structural BVAR instead of a traditional VAR.

As Robertson and Tallman (1999) demonstrated, BVARs give greater accuracy and better forecasting power than Autoregressive Integrated Moving Average (ARIMA) models and traditional multivariate simultaneous equations. Moreover, Canova (2007) has argued that BVARs models reduce the dimensionality of the problem imposing probability distributions on the coefficients of the VAR. Thus, the latter author showed that, on average, BVARs perform better than other econometric models, such as AR, ARIMA and VAR.

We choose the Minessota prior to estimate the BVAR, which was introduced by Litterman (1986). He introduced prior distributions that induced random walk prior mean for coefficients with a set of hyper-parameters, which drive their variance. Thus, Litterman's prior sets that variables behave like a random walk with an unknown deterministic component. Therefore, the systematic variation is relatively small, when we compared it to the random one. According to Dieppe et al (2016), the Minessota prior assumed that the VAR residual variance-covariance matrix is known.

To estimate it, we use the entire variance-covariance matrix of a VAR estimated by OLS.

Moreover, as Marimon and Scott (2001) indicated, the Litterman prior prevents the misspecification of coefficients due to the use of time varying as substitute of constant coefficients. In addition, it free from error the possible presence of serial correlation within the error terms provoked by over parametrization.

However, The Ludvigson, Steindel and Leltau (2002) approach was built through a Cholesky factorization. To test if this decomposition affects the wealth channel evaluation, we did an extra exercise, in which we replace the Cholesky factorization by a sign restriction framework[9].

Therefore, the analysis is constructed in 2 parts. In the first one, we study the results derived from standard BVAR with Cholesky identification. Some problems arise from the Cholesky factorization. For instance, the impulse response functions tend to depend on the specific set of identifying restrictions. In the second one, we study wealth effect channel through a sign restriction identification methodology.

Ludvigson, Steindel and Leltau (2002)[10] constructed a Structural VAR. The VAR models were created in order to reduce the high number of constraints imposed by macro-structural models. For this purpose, dynamic models with the minimum of

[9] Migliardo (2010) studied the transmission of monetary policy by comparing a BVAR with Cholesky decomposition with a BVAR with sign restrictions. Even though he hadn't aimed to assess the wealth effect, the idea to evaluate a structural specification as robustness test is a good additional exercise.

[10] In addition, the robustness test proposed by Ludvigson, Steindel and Leltau (2002) was run by including the commodity index in the BVAR. The results of the robustness test confirmed the results found in structural BVAR.

restrictions were developed, in which all economic variables were treated endogenously. In this line, the VAR models evaluate linear relations between each variable and their respective lags, as well as the relation with the lags of the other variables of the model. The two main constraints of the VAR model are as follows: i) the choice of the relevant set of economic variables and ii) the choice of the maximum number of lags in the variables. In the specific case of the model constructed in the article under analysis, the authors chose the following variables to compose the VAR: i) inflation (π); ii) real labor income (y); iii) real consumption (c); iv) real wealth (a) and v) interest rate (i).

$$B_0 Z_t = \text{k} + B_1 Z_{t-1} + B_2 Z_{t-2} + \ldots + B_P Z_{t-P} + u_t \quad (4)$$

Where Z_t= (π, y, c, a, i).

According to the proposed identification, we calibrate the structural BVAR, so that consumption is simultaneously affected by wealth.

$$B_0 = \begin{matrix} 1 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & 1 \end{matrix} \quad (5)$$

According to the proposed method, the interest rate (selic) reacts contemporaneously to shocks in consumption and labor income, but these variables are sensitized with the lag of a period due to the planning process and the lag of production. Therefore, $\beta_{35} = 0$. Additionally, it is assumed that wealth is not affected contemporaneously by consumption, so that $\beta_{43} = 0$. Finally, the assumption is made that the Central Bank's goal is price level and real variables, not the value of assets.

Thus, $\beta_{54} = 0$. When assuming these hypotheses, the structural VAR is identified as follows:

$$B_0 = \begin{matrix} 1 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & \beta_{34} & 0 \\ \beta_{41} & \beta_{42} & 0 & 1 & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & 0 & 1 \end{matrix} \quad (6)$$

Through this methodology, it is possible to breakdown the transmission of monetary policy on consumption to isolate the wealth effect. To assess the transmission in the absence of the wealth channel, the model needs to be re-specified. In fact, consumption does not depend on wealth, that is, $\beta_{34} = 0$, as well as its lags. In this way, to promote a counterfactual exercise, the model will be specified as follows:

$$B_0 = \begin{matrix} 1 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & 0 & 0 \\ \beta_{41} & \beta_{42} & 0 & 1 & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & 0 & 1 \end{matrix} \quad (7)$$

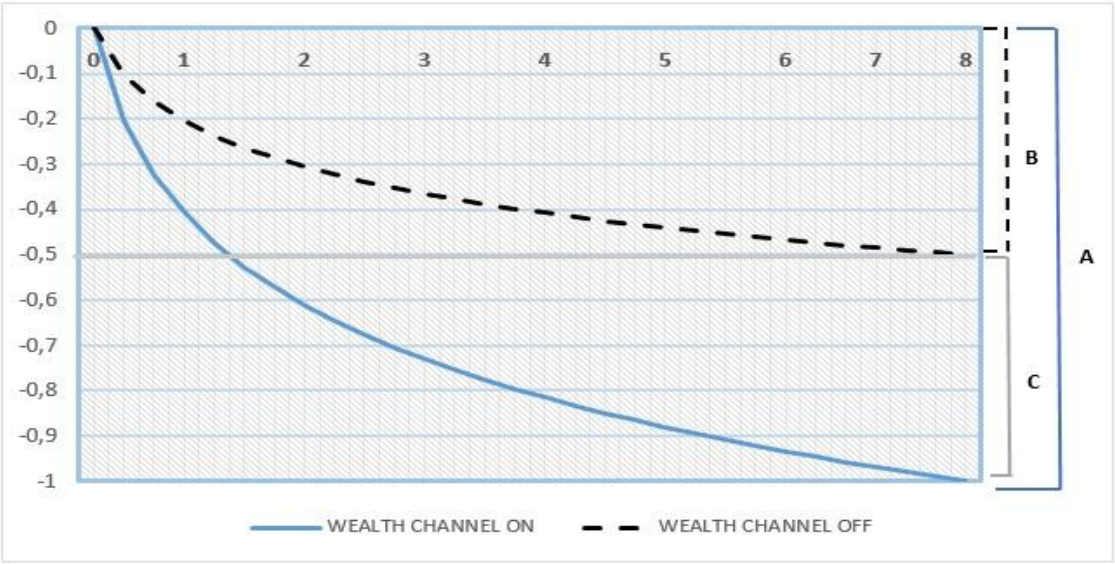
As we intend to evaluate different types of wealth, it is necessary to relativize the impact of the wealth effect in order to facilitate the comparative analysis. In this sense, the purpose of the empirical exercise is to measure, through the decomposition exercise, the contribution of the wealth effect to increase or reduce the potency of the monetary policy.

In the hypothetical situation shown in Figure 1, by fixing the valuation in 8th quarters after the monetary shock, it is noticed that with the wealth channel on the shock in the interest rate reduces consumption by 1% (segment A). On the other hand, the interest rate shock with the wealth channel off reduces consumption by

only 0.5% (segment B). In fact, the isolated contribution of the wealth effect on shock transmission is illustrated by segment C, so that C = segment A - segment B. Thus, in this example, the wealth effect accounts for 50% (C / A) of transmission of monetary policy on consumption.

It should also be pointed out that we aim to compare the contribution of wealth to the spill over of monetary policy over consumption. In this sense, this decomposition exercise will be replicated for each type of wealth studied, by fixing the valuation in 20th quarters after the monetary shock.

Figure 1: Example of the decomposition exercise of monetary policy transmission on consumption.



Source: elaborated by the authors.

The evaluation of the effects can be divided into two groups, namely: i) Internal Federal Domestic Public Debt (DPMFi); ii) real estate and equity.

In the specific case of public debt, for each set of assets studied (main argument), a counterfactual exercise was carried out, aiming to capture the impact of debt composition on the wealth effect.

By comparing the main and counterfactual arguments, it is possible to size whether the magnitude of the wealth effect changes and whether such effects are

statistically different. Thus, if the diffusion of the interest rate shock on the consumption of the main argument is statistically different from that of the counterfactual, it can be said that the change in the composition of the debt changes the transmission of monetary policy over consumption. Otherwise, it can be seen that the change in the debt composition does not statistically modify the spill over of monetary policy over consumption. This comparison aims to answer the following question: does the composition of public debt statistically change the wealth effect? To tackle this issue, two simulations were performed.

First, we compare the consolidated stock of DPMFi with the stock of DPMFi without LFTs, in order to measure the impact of the withdrawal of the indexation instrument on the wealth effect.

The second simulation follows the same logic as the first one, except that, in this case, the DPMFi stock is evaluated in a consolidated manner with the REPO operations. The counterfactual exercise of this simulation aims at capturing the effect of the withdrawal of the stock of repo operations, in such way the wealth is gauged once more by the DPMFi.

In both simulations, if the wealth effect of the counterfactual is statistically smaller than the main effect and these effects are statistically different, it can be affirmed that the indexation, whether through LFTs or through REPO operations, compromises the transmission of monetary policy.

Regarding the non-public debt assets, we have measured the wealth effect of real estate and equity holdings (stock market). Although we do not have an official indicator for the stock of wealth and its composition, according to data from the RFB of the year 2016, approximately 38% of the assets and rights declared in Personal Income Tax (IRPF) are real estate. It should be noted that the property and rights of

the IRPF are recorded at acquisition cost, so that they are not adjusted for market values. As for the equity holdings, it represents the third largest non-financial wealth group. Hence, it is expected that both the real estate and stock market wealth effects will be significant.

In theory, when interest rates rise, real estate prices tend to decrease, as real estate financing lines increase, reducing the demand for real estate. Given that the supply of real estate shows little flexibility in the short term, it is highly likely to happen, *ceteris paribus*, a cool down in real estate prices.[11]

Similarly, the rise in interest tends to cause downward pressure on stock prices as the aggregate demand for the economy tends to lower down with rising interest rates, reducing overall sales volume and consequently projected corporate profits.

Last, but not least, we did an additional exercise to test the robustness of findings derived from model design by Ludvigson, Steindel and Leltau (2002). According to this structural specification, the impulse response functions are drawn through Cholesky decomposition. However, in this exercise, we use a BVAR sign restriction specification to test if the response of consumption to a shock in interest rate is statistically different from zero. Sign restriction represents the action of constraining the response of a variable to a specific structural shock to be positive or

[11] It is worth to note that we did the robustness exercise proposed by Ludvigson, Steindel and Leltau (2002) to assess if results driver is the reduction of the real value of the assets caused by inflation or the interest rate shock.

negative. To do that, we use the Gibbs sampling algorithm showed by Dieppe et al. (2016)[12]:

Following the authors approach, first, we have to draw a vector β, which is a set reduced form VAR coefficients A_1, A_2, ..., A_p, and a residual covarience matrix Σ from their posterior distributions. From that, we present the following BVAR model:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + ... + A_P y_{t-P} + \varepsilon_t \quad (8)$$

From (8), one can obtain the impulse response functions Ψ_0, $\Psi_1, \Psi_2, ...$ Then define a preliminar structural matrix h(Σ), where h() is any continuously differentiable function of symmetric positive define matrices such that h(Σ)x h(Σ)= Σ. From this preliminar structural matrix, we obtain a first set of structual impulse response functions $\overline{\Psi_0}$, $\overline{\Psi_1}$, $\overline{\Psi_2}$, ...

$$\overline{\Psi_i},=\Psi_i h(\Sigma) \quad (9)$$

Nonetheless, these preliminary impulse functions are not drawn from the correct distribution. To draw it from the correct one, an additional orthogonalisation step is required. So that, one has to draw a random matrix Q from a uniform distribution and define:

$$D= h(\Sigma)Q \quad (10)$$

The main goal of this transformation is to draw such a Q matrix which would be orthogonal to preserve the following structural BVAR property:

$$D\Gamma D, = DID, = DD, = h(\Sigma)QQ,h(\Sigma), = h(\Sigma)Ih(\Sigma), = h(\Sigma)h(\Sigma), = \Sigma \quad (11)$$

In order to obtain an orthogonal matrix Q from the uniform distribution, first, we have to draw a n x n random matrix X, for which each entry is derived from an

[12] For more details, see Arias et al (2014).

independent standard normal distribution. Thus, we need to use a QR decomposition of X, such that X = QR, with Q an orthogonal matrix and R an upper triangular matrix. Then, it is possible to obtain the definitive structural impulse response functions:

$$\widetilde{\Psi_i} = \Psi_i D = \Psi_i h(\Sigma)\mathrm{Q} = \overline{\Psi_i} Q \quad (12)$$

After these procedures, the stacked structural matrix can be written as:

$$\mathrm{X}\begin{pmatrix}\widetilde{\Psi_{p1}}\\ \vdots \\ \widetilde{\Psi_{pn}}\end{pmatrix} = \begin{pmatrix}\overline{\Psi_{p1}}\\ \vdots \\ \overline{\Psi_{pn}}\end{pmatrix} Q = \bar{f}(D, D_1, \dots, D_P)\; x\; Q \quad (13)$$

with

$$\bar{f}(D, D_1, \dots, D_P) = \begin{pmatrix}\overline{\Psi_{p1}}\\ \vdots \\ \overline{\Psi_{pn}}\end{pmatrix} \quad (14)$$

If these restrictions are satisfied, then the sign restrictions hold for all structural shocks. If this does not happen, then we should restart the whole process all over again. Following these steps, we are able to use the Gibbs sampling algorithm proposed by Dieppe et al (2016):

1. Define the sign restrictions matrices for all structural shocks j= 1, 2, …, n.
2. Define the number of successful iterations of the algorithm. So that, we choose a total of 10000 iterations with 1000 burn-in iterations.
3. At iteration n, draw the reduced form VAR coefficients from their posterior distributions.
4. At iteration n, obtain $\Psi_0^{(n)}$, $\Psi_1^{(n)}, \Psi_2^{(n)}, \dots$
5. At iteration n, calculate $h(\Sigma_n)$ and generate $\overline{\Psi_0^{(n)}}, \overline{\Psi_1^{(n)}}, \overline{\Psi_2^{(n)}}, \dots$ and create the preliminary stacked matrix $\bar{f}(D, D_1, \dots, D_P) = \begin{pmatrix}\overline{\Psi_{p1}}\\ \vdots \\ \overline{\Psi_{pn}}\end{pmatrix}$

6. At iteration n, draw a random matrix X for which each entry is drawn from an independent standard normal distribution. Then, use a QR decomposition of X to obtain the structural matrix Q.
7. At iteration n, compute the candidate stacked structural impulse response function matrix $f(D, D_1, \ldots, D_P)$
8. At iteration n, verify that the sign restrictions hold. If yes, keep the matrix Q and go for the next iteration. If not, repeat steps 3 to 8 until a valid matrix Q is obtained. Then go for the next iterations.
9. Repeat steps 3 to 8 until reach 10000 successful iterations with 1000 burn-in iterations.

The table 4 shows the description of sign restrictions used in the model. We choose to control a positive interest rate shock, so that it causes a decline in inflation, labor income and wealth for four quarters. According to the theory, it is expected that an interest rate hike causes a contraction on inflation, labor income, consumption and wealth. As we are not controlling the consumption response to an interest rate shock, we aim to test if the consumption impulse response function is statistically less than zero.

TABLE 4: Summary of sign restrictions.

		shock of				
		inflation	**labor income**	**consumption**	**wealth**	**interest rate**
response of	**inflation**					-
	labor income					-
	consumption					?
	wealth					-
	interest rate					+

Source: elaborated by the authors.

5.2 EMPIRICAL RESULTS

In line with the empirical exercises described in the latter subsection, among the different possible wealth compositions, the results were estimated for 6 different wealth stocks. In such a way that 4 of them are strictly linked to Public Debt and the last 2 are related to real estate and stock market.

It should be noted that the valuation of the public debt as a stock of wealth can take place by marking prices at the curve or by marking to market value. Pires and Andrade (2009), for example, evaluated the wealth effect of public debt composition through data from the stock of government bonds marked on the curve. Under this method, the securities are priced according to the respective issuance Internal Rate of Return (IRR). Thus, according to this methodology, the stock becomes less sensitive to the interest rate oscillations, since the change in the interest rate only modifies the prices of the new bonds in issue, not affecting the prices of the old bonds, those that were issued prior to said change. In contrast, in the marked-to-market securities, the securities are priced based on the market rate, which is calculated daily by ANBIMA. As a result, the stock tends to be more sensitive to changes in the interest rate, since the price of all the securities that belong to the stock are changed. In this sense, we used the concept of market rates.

In order to measure how interest rate indexation through the LFTs affects the transmission of monetary policy on consumption, two models were constructed. In the first, wealth is represented by the DPMFi. In the second, the wealth corresponds to DPMFI with the subtraction of the LFTs stock. This exclusion was made in order to gauge the role of LFT in the spread of monetary policy transmission over

consumption. In both models, a BVAR with 1 lag was used[13]. Although the magnitude of the impact on the consumption of interest rate shock is different in the two models, it is not possible to state that the two propagations are statistically different at the 95% confidence level.

Regarding the decomposition exercise[14] in the first model, in one hand, the median impulse response function of consumption to a shock in interest rate with the wealth channel on shows a negative output as expected. In the other hand, the median impulse response function with the wealth channel off shows a positive result. Therefore, as these two impulse response functions have different signs, the decomposition exercise does not make sense in this case.

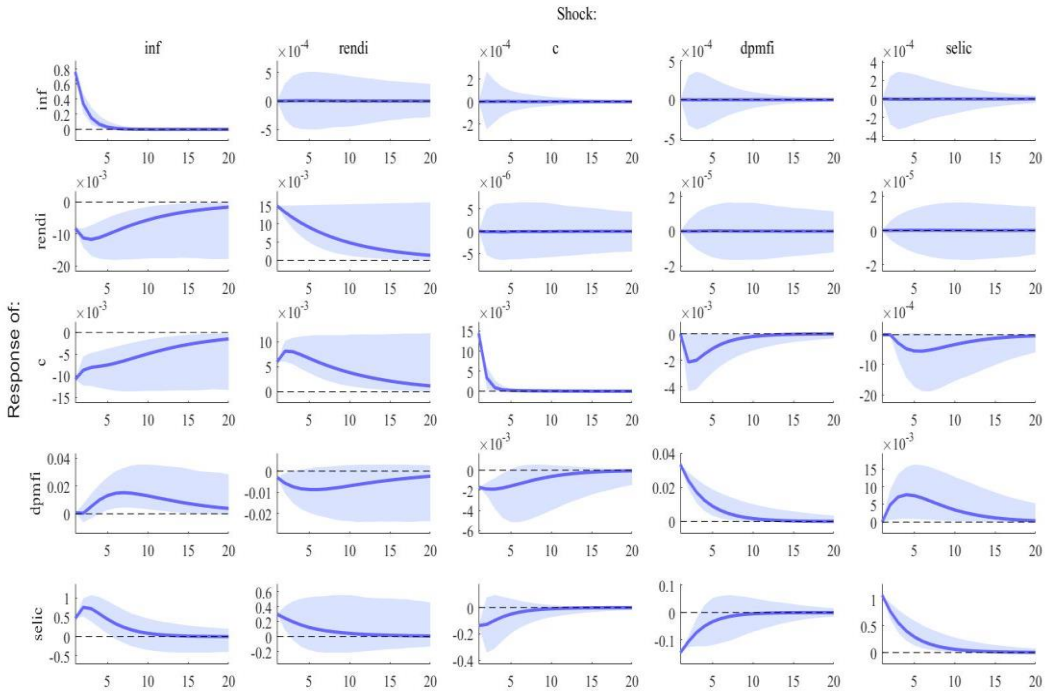
In the first model, the null hypothesis is that the main argument (DPMFi) has a positive wealth effect, that is, its contribution to monetary policy transmission is greater than zero. Furthermore, by analyzing the model output shown in Figure 2, it is easy to see that the null hypothesis does not hold, as the response of consumption (c) to a shock in interest rate (selic) is not statistically different than zero. In fact, according to the model, there is any evidence that the wealth effect is transmitted through the DPMFi. According to the theory, the wealth effect occurs when an increase in the interest rate causes the reduction in the market value of the wealth

[13] The lags of the BVARs estimated in this study were selected using the Schwarz (SC) criterion. The choice of this criterion is more conservative, as it is not affected by the number of lags to be tested *ex-ante*.

[14] The decomposition exercise aims to isolate the participation of the wealth channel in the transmission of the monetary policy. This is done by mapping the response of consumption to a shock in the interest rate with the wealth channel on and then turning it off. However, it is important to point out that this exercise does not make sense if the impulse response function sign with the wealth channel on is different from the one with wealth channel off.

stock. So, this wealth contraction is the transmission vessel that provokes the reduction on consumption. Nonetheless, as Figure 2 shown, the interest rate hike causes an increase the wealth stock, which is measured by the DPMFi.

Figure 2: BVAR with Cholesky factorization impulse response functions taking into account the DPMFi as the wealth variable.

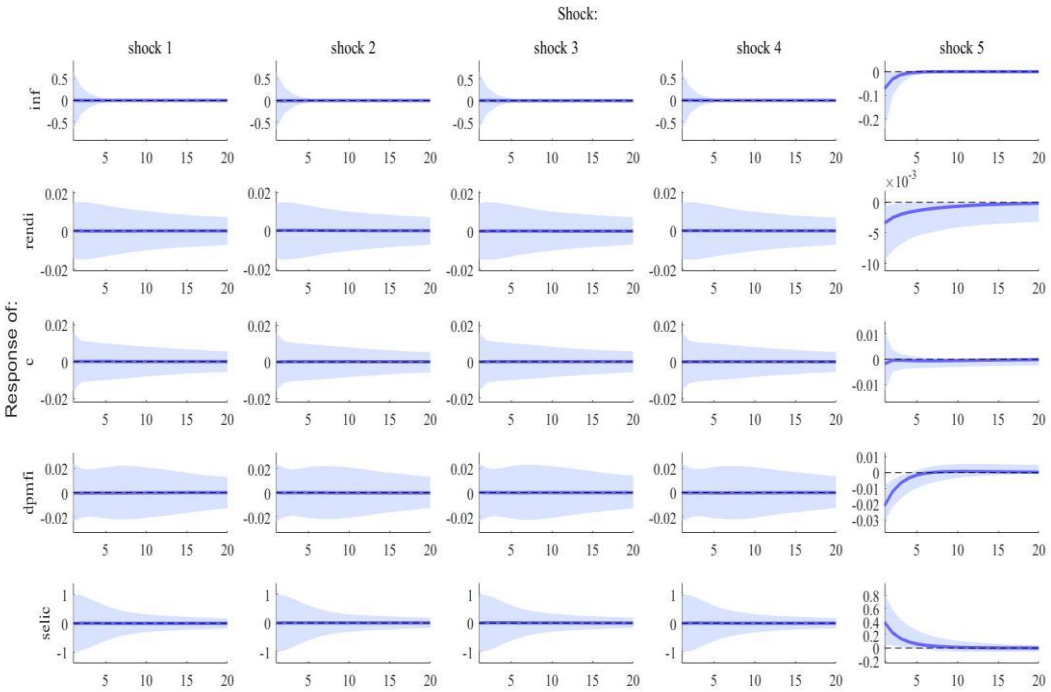


Source: elaborated by the authors.

To evaluate the BVAR with sign restrictions impulse response functions, we are interested in understand the consumption reaction (c) to a shock in interest rate (shock 5). As Figure 3 shown, the consumption response is statistically equal to zero.

Therefore, we haven`t found any evidence that the DPMFi plays an important role in the transmission of the monetary police through wealth channel.

Figure 3: BVAR with sign restrictions impulse response functions taking into account the DPMFi as the wealth variable.

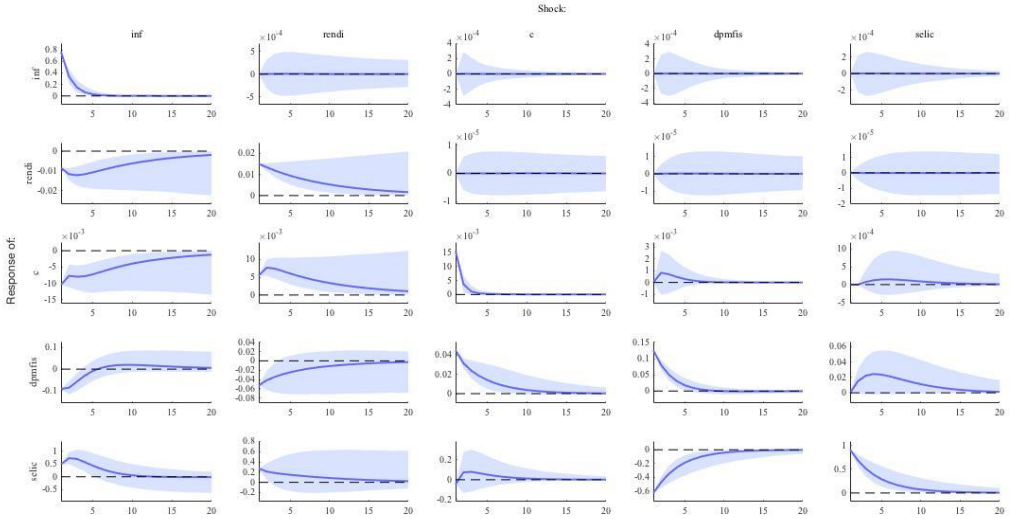


Source: elaborated by the authors.

In the counterfactual exercise, the wealth is represented by the proper exclusion of the stock of LFTs from the stock of the DPMFi. The null hypothesis is that the wealth effect has a positive impact on the transmission of monetary policy.

Since, according to the literature, the LFTs would block the wealth effect, it is expected that with the withdrawal of this type of bond there will boost the wealth effect. According to the decomposition exercise, this channel accounts for 97% of the effect of monetary policy on consumption. However, by evaluating the results (Figure 4), we cannot see that the wealth effect broadens the potency of monetary policy over consumption. Moreover, the wealth channel is statistically equal to zero. As a result, even with the exclusion of LFTs, the wealth effect of the DPMFi is zero. Such conclusion refutes the argument that the LFTs responsibility for blocking the wealth effect of the DPMFi.

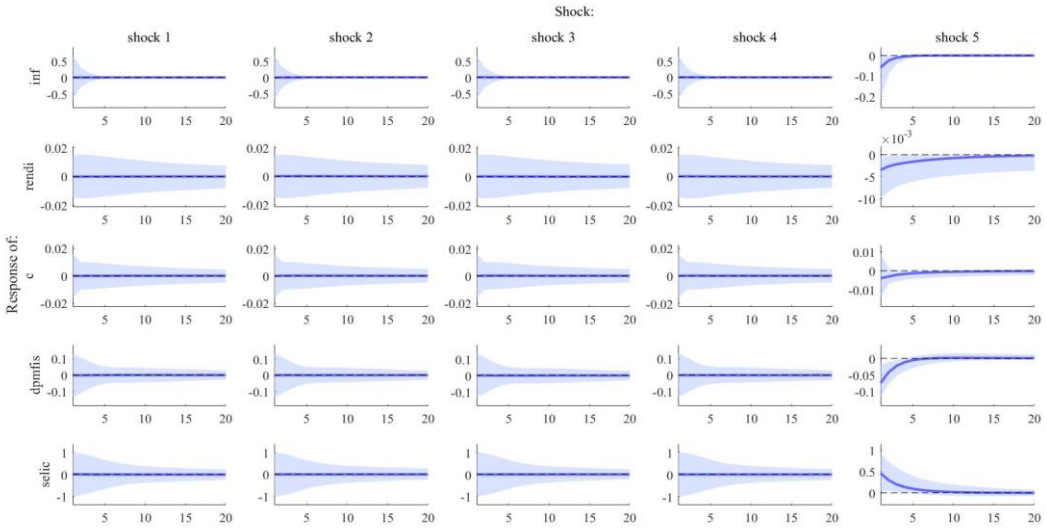
Figure 4: BVAR with Cholesky factorization impulse response functions taking into account the DPMFi minus LFTs as the wealth variable.



Source: elaborated by the authors.

Figure 5 details the output of the BVAR with sign restrictions. In consonance with results presented in Figure 4, the wealth effect seems to be irrelevant as the consumption (c) response to an interest rate shock (shock 5) is statistically equal to zero.

Figure 5: BVAR with sign restrictions impulse response functions taking into account the DPMFi minus LFTs as the wealth variable.



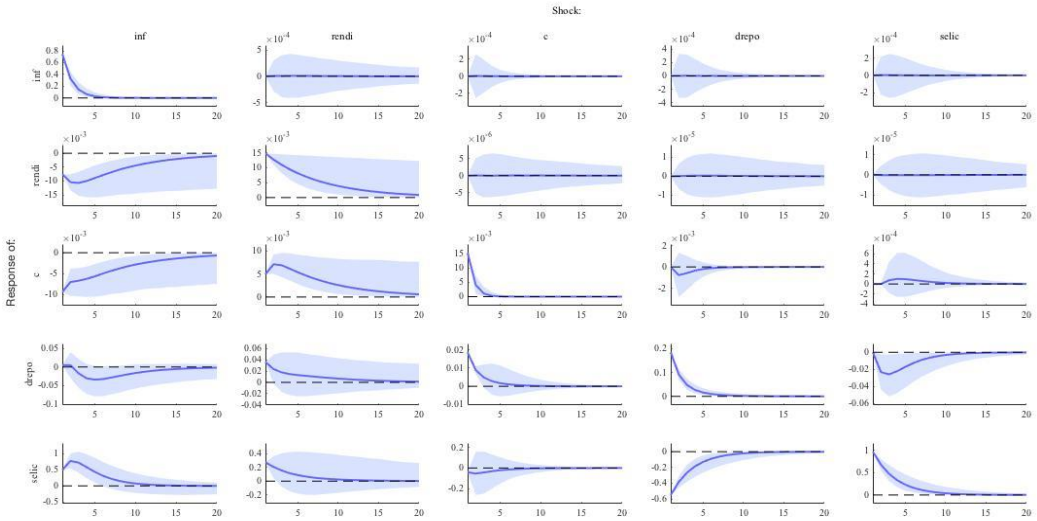
Source: elaborated by the authors.

In order to understand how the REPOs and the DPMFi impact the monetary policy power, we design two different models. The first one is specified in such a way that the wealth is represented by the sum of the stocks of REPOs and DPMFi. The second one displays the model considering the DPMFi model as wealh. As we have already described the latter model, we are going to focus on the description of the former. In both models, we use a BVAR with 1 lag. By comparing these models, it is not possible to say that the two propagations are statistically different at the 95% confidence level.

The null hypothesis is that the main argument (REPOs+DPMFi) have a positive wealth effect due to the reduction of LFTs shares on the DPMFi, which have occurred in the last decade. According to the decomposition exercise, the wealth channel provokes a sharp decrease in the monetary policy power over consumption (-99%). Nonetheless, this result is not robust, since it is possible to affirm that the effect is null. By analyzing the response of consumption to a shock in interest rate

(Figure 6), one can easily note that the consumption is insensitive to monetary policy decisions. So that, the wealth effect is statistically equal to zero.

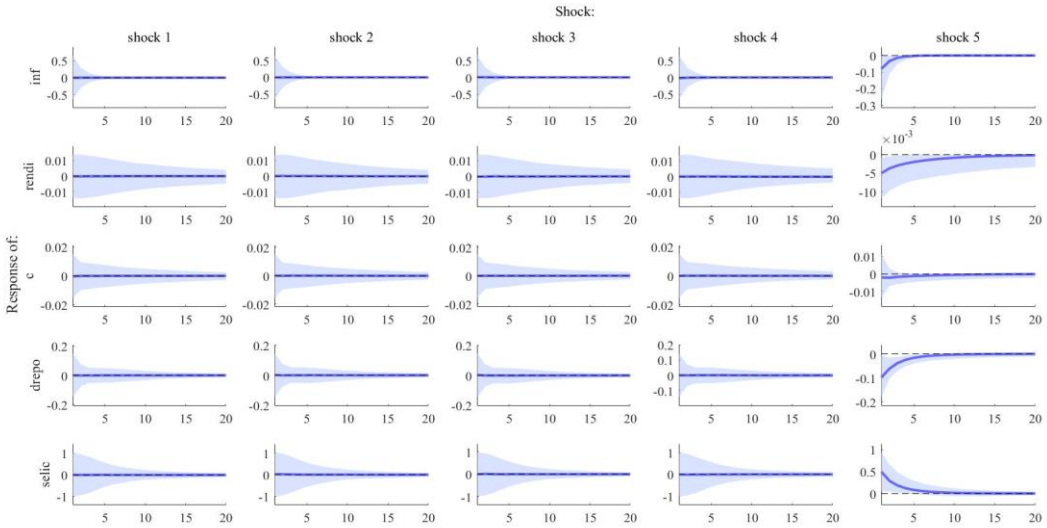
Figure 6: BVAR with Cholesky factorization impulse response functions taking into account the DPMFi plus REPOs as the wealth variable.



Source: elaborated by the authors.

Figure 7 highlights the output of the BVAR with sign restrictions. In line with results shown in Figure 6, the consumption is insensitive to an interest rate shock. Therefore, we haven't any evidence that DPMFi with REPOs work as an effective wealth channel.

Figure 7: BVAR with sign restrictions impulse response functions taking into account the DPMFi plus REPOs as the wealth variable.



Source: elaborated by the authors.

Moving on, it is worth to remember that the household wealth stock is not only composed by government debt securities. Hence, it is important to measure the impact, in terms of wealth effect, of assets that traditionally have not been contemplated by empirical studies in Brazil. Thus, due to the relevant participation in the stock of wealth measured by the RFB, real estate and equity (stock market) were the target of the study.

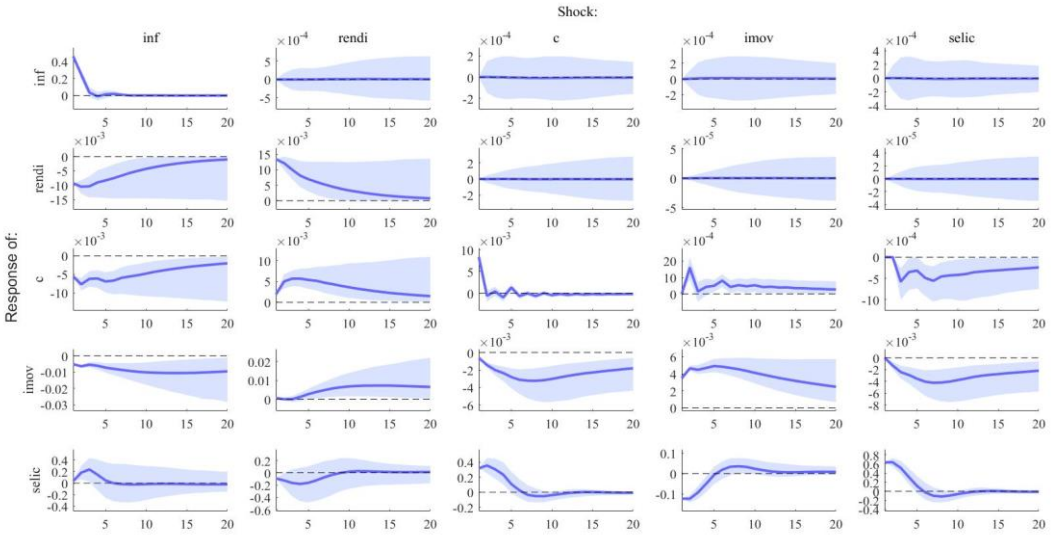
According to RFB data, real estate is the main component of the wealth stock of Brazilians. Thus, the fluctuations in real estate prices due to interest rate shocks are expected to be an effective channel for the transmission of monetary policy over consumption. Thus, the initial hypothesis is that the wealth effect is positive.

To test this hypothesis, a BVAR with 4 lags was constructed in which the wealth variable is priced according to the variations of the real estate price index[15] calculated by the BACEN.

By assessing the results of the BVAR with Cholesky factorization, it is straightforward to see that the wealth effect is statistically different from zero. Furthermore, this is a robust conclusion since there is a strong evidence that the wealth effect is transmitted through the real estate variable. In line with the theory, the wealth effect happens when an increase in the interest rate provokes the reduction in the market value of the wealth stock. This wealth contraction is the transmission mechanism that causes the reduction on consumption. Thus, as Figure 8 shown, the interest rate shock causes a decrease in the wealth stock, which is gauged by the real estate price index. Besides, it is meaningful to mention that we did the robustness proposed by proposed by Ludvigson, Steindel and Leltau (2002) to find out what is the main driver of the consumption contraction. As a consequence, the test pointed out that the interest rate shock is the factor that provoke the wealth reduction.

Figure 8: BVAR with Cholesky factorization impulse response functions taking into account the real estate price index as the wealth variable.

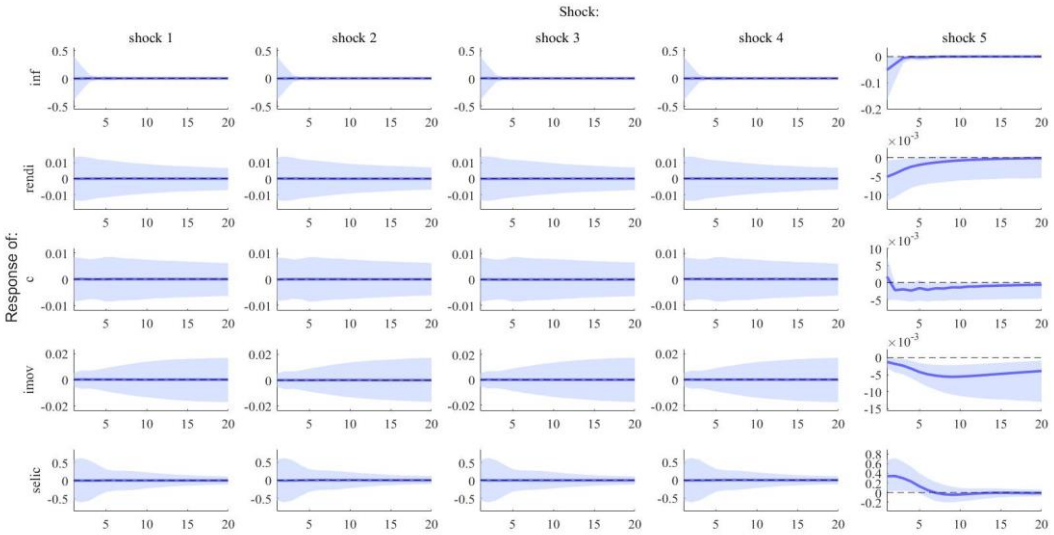
[15] This is a proxy to gauge the real estate wealth, since we are unable to measure the real estate wealth as a quantum time's price variable.



Source: elaborated by the authors.

Moreover, to assess the BVAR with sign restrictions impulse response functions, we are interested in find out how the consumption reacts (c) to a shock in interest rate (shock 5). As Figure 9 shown, the consumption reaction is statistically different from zero in agreement with the wealth effect theory.

Figure 9: BVAR with sign restrictions impulse response functions taking into account the real estate price index as the wealth variable.



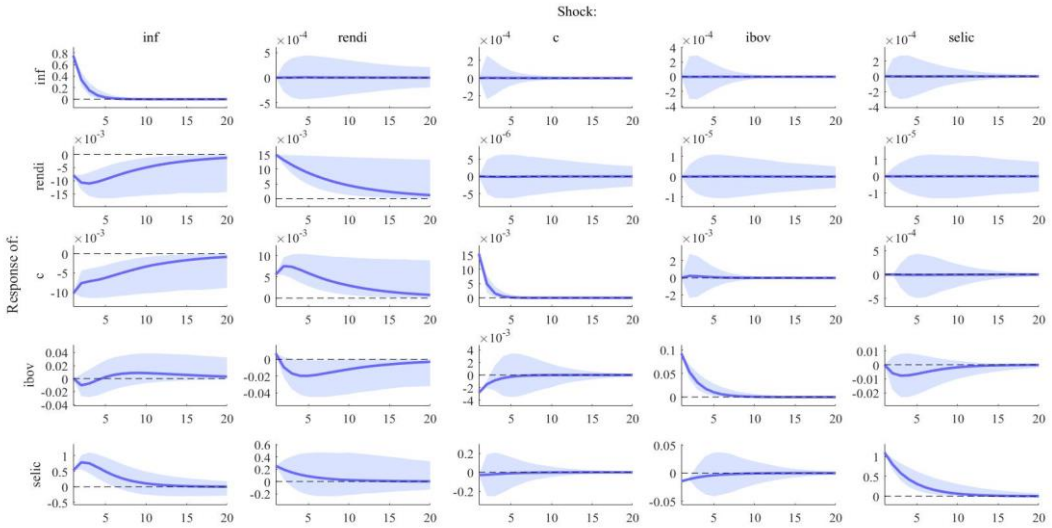
Source: elaborated by the authors.

Accordingly, in both models, we have found strong evidences that the real estate price plays an important role in the transmission of the monetary police through wealth channel.

Finally, as reported by the RFB, the equity holdings have the third largest participation in the category of financial assets of Brazilian families. In addition, Ludvigson, Steindel and Leltau (2002) found evidence that this asset type produces a greater wealth effect than other investment classes. Hence, the null hypothesis is that the wealth effect is positive. To verify this hypothesis, a BVAR with 1 lag was used in the ibovespa index was specified as wealth variable.

By looking at the results of the BVAR model with Cholesky decomposition in Figure 10, it is not possible to reject the hypothesis that the wealth effect is equal to zero.

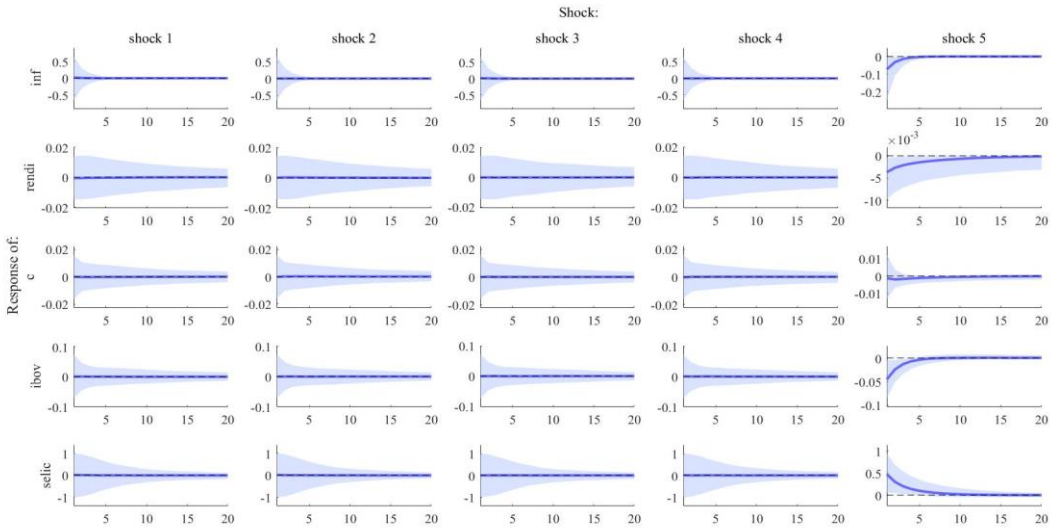
Figure 10: BVAR with Cholesky factorization impulse response functions taking into account the ibovespa index as the wealth variable.



Source: elaborated by the authors.

By appraising the BVAR model with sing restrictions, we reach the same conclusion of the BVAR with Cholesky decomposition. Hence, we cannot state that the wealth effect broadens the monetary policy power over consumption.

Figure 11: BVAR with sign restrictions impulse response functions taking into account the ibovespa index as the wealth variable



Source: elaborated by the authors.

Table 5 below compiles all the results. In the second column of the aforementioned table, we show the null hypothesis for the contribution of the wealth effect on the transmission of monetary policy.

TABLE 5: Summary of empirical exercises.

			BVAR Ludvigson, Steindel and Leltau (2002)			BVAR SIGN RESTRICTIONS
	WEALTH	**NULL HYPOTHESIS**	**Contribution of wealth effect to increase or reduce the potency of the monetary policy.**	**Model output at the 95% confidence level**	**Does the composition of public debt statistically change the wealth effect?**	**Model output at the 95% confidence level**
PUBLIC DEBT	**1) DPMFi (main argument)**	WEALTH EFFECT > 0	wealth effect > 0	**WEALTH EFFECT = 0**	NO	WEALTH EFFECT = 0
	2) DPMFi - LFT (counterfactual)	WEALTH EFFECT > 0	wealth effect > 0 (97%)	**WEALTH EFFECT = 0**		WEALTH EFFECT = 0
	3) DPMFi + REPO (main argument)	WEALTH EFFECT > 0	wealth effect < 0 (-99%)	**WEALTH EFFECT = 0**	NO	WEALTH EFFECT = 0
	4) DPMFi (counterfactual)	WEALTH EFFECT > 0	wealth effect > 0	**WEALTH EFFECT = 0**		WEALTH EFFECT = 0
other assets	**5) real estate**	WEALTH EFFECT > 0	wealth effect > 0 (99%)	**WEALTH EFFECT > 0**	does not apply	WEALTH EFFECT > 0
	6) stock market	WEALTH EFFECT > 0	wealth effect > 0 (100%)	**WEALTH EFFECT = 0**	does not apply	WEALTH EFFECT = 0

Source: elaborated by the authors.

It is important to note that the third, fourth and fifth columns indicate the results drawn from the BVAR following Ludvigson, Steindel and Leltau (2002) approach, which was built through a Cholesky factorization process.

The third column presents the participation of the wealth effect in the transmission of the monetary policy on the consumption for each type of wealth studied, according to the procedure explained in Figure 1. The fourth column shows whether the consumption response to the interest rate shock is statistically different from zero. The fifth column evaluates whether the arguments (main and counterfactual) tested in the public debt composition exercise are statistically different.

The sixth column, finally, describes the results drawn from the BVAR with sign restrictions. The central idea here is to test the robustness of the results derived from Ludvigson, Steindel and Leltau (2002) approach.

6 CONCLUSION

6 CONCLUSION

We sought to understand how public debt management could affect the power of monetary policy through wealth effect. In addition, we investigate if the wealth effect from the DPMFi is relevant comparing it to the effect coming from other classes of assets. To address these issues, several hypotheses have been empirically tested using a BVAR method specified according to Ludvigson, Steindel and Leltau (2002) and a BVAR with sign restrictions. Our results can be synthesized through the 3 questions listed below:

How was the debate about the wealth effect conducted in Brazil? The debate focused on the loss of power of monetary policy stemming from the high participation of LFTs in the DPMFi stock. This concentration hampers the evaluation of the wealth channel as a whole, as well as the wealth effect of public debt, since there is no relative analysis of the effects generated by different classes of assets. To address this gap, various types of wealth were tested to measure the wealth effect in the Brazilian case.

Does the public debt wealth effect matter? A total of 5 models were tested, of which 3 were aimed at sensitizing components of public debt and 2 sought to gauge other assets. In the public debt models and the stock market models, it was not possible to reject the hypothesis that the wealth effect equals zero at the 95% confidence level. Thus, for these assets, no robust evidence for the existence of the wealth effect was found. In the specific case of public debt, it cannot be said that LFT stocks are responsible for the wealth effect of public debt being nil. This is because, even removing the LFT stock from public debt, it continues to have a statistically null wealth effect.

Does the real estate wealth effect matter? By using a BVAR method specified according to Ludvigson, Steindel and Leltau (2002) and a BVAR with sign restrictions, we have found strong evidences that the real estate price plays an important role in the transmission of the monetary police through wealth channel.

Last, but not least, it is important to note that this conclusion refers to the first-order effects between wealth and consumption, so that second-order effects not captured in the model are expected to occur such as the expectations channel, which are a fertile field for further research.

BIBLIOGRAPHY

ANDO, A.; MODIGLIANI, F. 1963. The life cycle hypothesis of savings: Aggregate implications and tests. American Economic Review, 53, p. 55-84.

Arida, P. 2006. As Letras Financeiras do Tesouro em seu vigésimo aniversário. In: BACHA, E.; OLIVEIRA, L. (Org.). Mercado de Capitais e Dívida Pública. Ed. Contracapa. Pag 229-244

Arias, J. E., Rubio-Ramirez, J. F., and Waggoner, D. F. 2014. Inference Based on SVARs Identified with Sign and Zero Restrictions: Theory and Applications. Dynare Working Papers. No 30. CEPREMAP.

Aoki, K., Proudman,J and Vlieghe, G. 2004. “House Prices, Consumption and Monetary Policy: A Financial Accelerator Approach.” Journal of Financial Intermediation 13(4), pp. 414–435.

Barbosa, Fernando. 2006. “*The Contagion Effect of Public Debt on Monetary Policy: The* Brazilian Experience”. Brazilian Journal of Political Economy. Vol 26. Pag 231-238.

Bernanke, B and Gertler, M. 1999. Monetary Policy and Asset Price Volatility. Pages 77–128 of: New Challenges for Monetary Policy. Jackson Hole Symposium. Federal Reserve Bank of Kansas City

Bertaut, C. 2002. “Equity Prices, Household Wealth, and Consumption Growth in Foreign Industrial Countries: Wealth Effects in the 1990s”, Federal Reserve Board, International Finance Discussion Paper No. 724.

Blommestein, H.J and Turner, P. 2012(eds). Threat of Fiscal Dominance? BIS Papers No 65. BIS/OECD Publishing.

Carneiro, D. 2006. Letras Financeiras do Tesouro e normalidade financeira: haverá um “peso problem” .In: BACHA, E.; OLIVEIRA, L. (Org.). Mercado de Capitais e Dívida Pública. Ed. Contracapa. Pag 197-218

Case, K., Quigley, J. and R. Shiller. 2005. Comparing Wealth Effects: the Stock Market Versus the Housing Market, Advances in Macroeconomics, Vol. 5, No. 1, Article 1.

Dieppe, A., Legrand, R. and van Roye, B. 2016. The BEAR toolbox. European Central Bank working paper, No. 1934.

Franco, G. 2006. Notas sobre o *crowding out*, juros altos e Letras Financeiras do Tesouro.In: BACHA, E.; OLIVEIRA, L. (Org.). Mercado de Capitais e Dívida Pública. Ed. Contracapa. Pag 273-296

Koivu, T. 2010. Monetary policy, asset prices and consumption in China. European Central Bank Working Paper No.1240.

Labhard, V., Sterne, G. and C. Young. 2005. “The Wealth Effects on Consumption in Industrialized Countries”, Bank of England, Working Paper No. 275.

Loyo, E. 2006. A política monetária e o alongamento da dívida pública.In: BACHA, E.; OLIVEIRA, L. (Org.). Mercado de Capitais e Dívida Pública. Ed. Contracapa. Pag 297-328.

Lettau, M. Ludvigson, S. (2001). *Consumption, aggregate wealth, and expected stock returns. Journal of Finance*. Vol 56. Pag 815-849.

Ludvigson, S. Steindel, C. Lattau, M. 2002. Monetary Policy Transmission through the Consumption-Wealth Channel. FRBY Economic Policy Review. Pag 117-133.

Ludwig, A. and T. Sløk. 2004. "The Relationship Between Stock Prices, House Prices and Consumption in OECD Countries", Topics in Macroeconomics, Vol. 4, Article 4.

Mastroeni, O. 2001. The Changing Shape of Fixed Income Markets: A Collection of Studies by Central Banks Economists. Bis Papers No 5.

Migliardo, C. 2010. Monetary Policy Transmission in Italy: A BVAR Analysis with Sign Restriction. Czech Economic Review. Vol 2. Pag 139-167.

Minella, A. and Souza-Sobrinho, F. (2009). Monetary Channels in Brazil through the Lens of a Semi-Structural Model. Banco Central do Brazil, Working Paper Series, No 181. April, 2009.

Mishkin, Frederic S. 1995. Symposium on the Monetary Transmission Mechanism. Journal of Economic Perspectives. No. 4 (fall): 3-10.

Mohanty, M S and Turner, P (2008), Monetary policy transmissions in emerging market economies: what is new?, in Transmission mechanisms for monetary policy in emerging market economies, BIS Papers No. 35. Pag 1-59.

Nogueira, F. 2013. "Medição da riqueza pessoal". Texto para discussão Instituto de Economia UNICAMP.

Paiella, M. 2009. The stock market, housing and consumer depending: a survey of the evidence on wealth effects. In: Journal of Economic Surveys 23(5). 947–973.

Patinkin, D. 1947.Price flexibility and full employment. American Economic Review, 38, p. 543-564.

Pellegrini, J. 2017. "As operações compromissadas do Banco Central". Estudo especial da Instituição Fiscal Independente. No 3.

Pigou, A.1943. The Classical Stationary State. Economic Journal. 53 (212): 343–351

Pires, M. Andrade, J. 2009. Uma Análise da Transmissão da Política Monetária e o Canal da Dívida Pública com Aplicação aos Dados Brasileiros. Revista de Economia Aplicada. vol 13. Pag 439-462.

Pastore, A. 2006. As letras financeiras do tesouro e a eficácia da política monetária.In: BACHA, E.; OLIVEIRA, L. (Org.). Mercado de Capitais e Dívida Pública. Ed. Contracapa. Pag 261-272.

Reis, E. Issler, J. Blanco,F. 1999. Carvalho, Fernando. Renda permanente e poupança precaucional: evidências empíricas para o Brasil no passado recente. Ensaios Econômicos da EPGE – FGV. Vol 338.

Resende, A. 2006. Em defesa dos títulos de indexação financeira. In: BACHA, E.; OLIVEIRA, L. (Org.). Mercado de Capitais e Dívida Pública. Ed. Contracapa. Pag 219-228.

Robertson, J. C. and Tallman, E. W. 1999. Prior Parameter Uncertainty: Some Implications for Forecasting and Policy Analysis with VAR models. Atlanta, Federal Reserve Bank of Atlanta, Working Paper No. 99-13.

Sousa, R.M. Wealth effects on consumption: Evidence from Euro area European Central Bank, 5 (2010), pp. 70-78