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## Article

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# Monetary policy and transaction costs: Empirical analysis of consumption function for the United States of America (1988–2014)

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## Abstract

In macroeconomic theory, different approaches discuss the ability of monetary policy to affect real variables in the long run. This research proposes the empirical application of a theoretical model that includes nominal rigidities arising from transaction costs and real rigidities arising from the firms' competition structure. Thus, based on data from the US economy we propose to test the theoretical results combining the existence of shocks arising from both real factors and factors affecting the money market, establishing tests for shocks of supply and aggregate demand. The concern is to investigate if the economic policy is capable of affecting the long run (average) values of the real private consumption. Time series analysis methodology of Structural Vector Autoregressive (SVAR) models was used to test long run relationship for US economy. The ability to establish the long run relationships between these aggregates with some degree of confidence, allow simulating shocks by impulse response functions and variance decomposition. The theoretical results of the model indicate that productivity, transaction costs (number of transactions with credit/debit cards) and currency money tend to positively influence consumption, whereas delinquency have a negative effect on consumption. We tested two empirical specifications and both confirmed the theoretical results for the US economy and, therefore, the research can help policymakers to measure the long run consequences of their decisions, that is, the results converge on the non-neutrality of money in the long run in the US economy.

**Keywords:** Monetary policy; Policymakers; Transaction costs; SVAR; US economy

**JEL classification:** C32; E21; E52

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## 1. Introduction

Throughout the evolution of macroeconomic theory, different approaches have been discussing the ability of monetary policy to affect real variables in the long run. In general, monetary policy can affect indicators of production, employment and consumption in the short run through shocks. If the economic system has rigidities or imperfections, the difficulty of automatic adjustment could insert relevant action for the policymakers in the short run.

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This research proposes the empirical application of the macroeconomic model of [Dias \(2002\)](#),<sup>1</sup> which includes nominal rigidities arising from transaction costs and real rigidities arising from the firms' competition structure. As a theoretical result, the currency would affect the consumption and purchasing power of agents in both the short and long run. Transaction costs play a prominent role in this analysis and may alter the effects of monetary policy on economic aggregates. Still on the theoretical model, it should be emphasized in its derivation that the representation of the agent, which is homogeneous, follows the presentation of [Blanchard and Kiyotaki \(1987\)](#), in which the agent produces the goods and also purchase them.

Based on data from the United States economy from 1988 to 2014, the purpose of this study is to test the theoretical results of [Dias \(2002\)](#), which combine shocks from both real factors (productivity, technology, real incomes and market structure) as well as factors related to the money market (currency and transaction costs), establishing tests for shocks of supply and aggregate demand.

Thus, the research intends to contribute to the academic debate of macroeconomic approaches and to the analysis of shocks in the North American economy stemming from economic policy or structural factors of the system. In particular, this research proposes to identify the effect of long run monetary policy on consumption, considering transaction costs, competition structure (market power), productivity and prices. Therefore, indicators for transaction costs (such as the number of transactions with credit/debit cards and delinquency rates) and productivity were used to achieve the proposed objectives.

In this context, the research is based on the new macroeconomic theories of contract rigidities and imperfect competition to verify the theoretical model and to find the economic relations on the effects of the shocks of demand and supply to be tested by the empirical methodology.

In order to reach the goals, the empirical analysis uses the time series methodology of Vector Autoregressive (VAR) models and Structural Vector Autoregressive (SVAR) models. As it is intended mainly to test the long run relationships of variables, SVAR models are appropriate because they have the capacity to establish the long run relationships between these aggregates, allowing the analysis of shock simulation through impulse response functions, in addition to analysis of variance decomposition.<sup>2</sup>

Several studies on monetary policy were performed using SVAR such as of [Carlino and DeFina \(1999\)](#); [Di Giacinto \(2003\)](#) for the United States; [De Lucio and Izquierdo \(1999\)](#) for Spain; [Beenstock and Felsenstein \(2005\)](#) who used the VAR for Israel; among others. [Barro \(1977, 1978\)](#) conducted empirical tests and concluded that the party does not expect the currency affects the product. [Mishkin \(1982\)](#) repeated the Barro test and found similar results and also concluded that the expected part of the currency has a positive correlation with economic activity. Several New Keynesian authors assert that in the long run, money has the ability to change real variables.

The treatment of time series has advanced considerably in the economic literature in the last decades. The empirical estimates in the literature follow the article of [Blanchard and Quah \(1989\)](#), which decompose a country's specific shocks into permanent and transitory components. Transitory or short run shocks and permanent or long run shocks can be obtained using Structural Vector Autoregressive (SVAR) models.<sup>3</sup> These empirical models allow us to identify the constraint matrices of the coefficients of the variables, according to the relationships proposed in the theoretical model. Another advantage of SVAR models is in allowing the simulation of impulse response functions of contemporary exogenous variables over endogenous variables. Specifically, this study presents an evaluation of the permanent or long run shocks arising from variations in the quantity of money offered in the United States on the consumption and purchasing power of agents, considering the presence of real and nominal rigidities.

The theoretical results of the model indicate that productivity, transaction costs (number of transactions with credit/debit cards) and real balance tend to positively influence consumption, whereas delinquency has a negative effect on consumption.

Here, transaction costs have the role of reducing the time spent on transactions and, consequently, increasing the time spent in leisure, since the time used in transactions is discounted from leisure time. In relation to the currency,

<sup>1</sup> See the derivation of the theoretical model of [Dias \(2002\)](#) in Appendix II – page 23.

<sup>2</sup> Therefore, the presented results refer to the long run SVAR, that is, the restrictions imposed were long run.

<sup>3</sup> See [Sims \(1980, 1986\)](#). The use of SVAR models to test theoretical hypotheses was widely used in the RBC – Real Business Cycles literature. This literature allows the reader to understand the relationship between theory and empirical tests using the methodology, especially in the articles by [Chari et al. \(2005\)](#); [Fernandez-Villaverde et al. \(2007\)](#) and [Dupaigne et al. \(2007\)](#).

ownership has the role of increasing the bargaining power, that is, the individual who has liquidity can bargain at the time of the transactions and, with this, the price paid for the goods/services tends to be lower. If the theoretical model results for the US economy are confirmed, the research can help policymakers measure the long run consequences of their decisions.

This paper aims to contribute to the discussion of the determinants of consumption. As such, he dialogues with the main consumer theories, such as Modigliani and Friedman, for example, but he also says that we need to consider other variables in determining consumption, such as transaction costs and money. In addition, the currency is not considered neutral in the system.

To fulfill the objective, the present work is structured in two sections, besides this introduction and the final considerations. In the first section, the methodology is presented, while the second section presents the empirical results and the discussions.

## 2. Empirical methodology

The research proposal is to investigate the extent to which nominal shocks from monetary policy can affect long run aggregate consumption in the United States through the application of Structural Vector Autoregressive (SVAR) models and analysis of impulse response functions variance decomposition.

The database for econometric applications to the US economy is based on the indicators provided by the World Bank, Federal Reserve Bank of St. Louis (FRED St. Louis), Organization for Economic Cooperation and Development (OECD) and Bank for International Settlements (BIS). The period of analysis is concentrated between 1988 and 2014.<sup>4</sup>

Time series are observations of the same variable over time, that is, they are formed by sequential observations over time, the product of a random process of data generation. The case of time series requires the stationarity<sup>5</sup> check of the series before performing any analysis, i.e., it is necessary to work with stationary series. According to [Greene \(2002\)](#), the stationarity or not of a series can imply significant characteristics in its behavior and its properties. The use of non-stationary series can lead to spurious regressions, that is, when analyzing some regression, one could find a relation between two variables that, in fact, does not exist, and could lead to the wrong conclusions. If the series takes some temporary shock, an estimation made with unitary roots will present the shock as permanent (explosive), even if it is a temporary effect.

Thus, the first step in the analysis of time series is to identify whether or not the variables are stationary. The non-stationarity of a stochastic process is generated by the presence of unit root in the autoregressive process that generates the variable. Thus, tests on unit root play an important role, as they aid in the evaluation of non-stationarity. To know if a series is stationary or not, it is consensus in the literature on the subject to perform unit root tests.<sup>6</sup>

With all the stationary series, it is possible to estimate the VAR model.<sup>7</sup> Once the VAR estimates have been made, it is necessary to verify that all the roots are within the unit circle.<sup>8</sup> If this occurs, it is understood that the model does not have unit roots and that, therefore, it is suitable for the econometric analysis (to make predictions, for example). If any root of the polynomial is on the unit circle, the model cannot be used, since it has a unit root, unless a VEC is being tested.

For [Marques \(1998\)](#), Granger's Causality can be defined as: "X is said to cause Y in the Granger sense if the past values of X contribute to improve predictions of the current value of Y, all else constant".

The Vector Autoregressive (VAR), proposed by Sims in 1980 in the article entitled "Macroeconomics and Reality", from which the analysis technique became widespread, becoming one of the most used techniques in the study of macroeconomics. In this paper, the author criticized the econometric models used until then, stating that these were not adequate to make predictions because they are static, because they do not adequately consider the autoregressive character of the series, besides being not precise with respect to the influence of the variables over the others. Thus,

<sup>4</sup> The periodicity of the data used will be monthly.

<sup>5</sup> Stationarity is an oscillation of the series around the mean and variance over time.

<sup>6</sup> For more information about unit root tests, see *Applied econometric time series*, of [Enders \(2010\)](#).

<sup>7</sup> We used the VAR methodology because we did not have cointegration – to verify the cointegration number, the following tests were performed: Eigenvalue and Trace Statistic. For more information about cointegration tests, see *Applied econometric time series*, of [Enders \(2010\)](#).

<sup>8</sup> In this case, we say that the inverse of the roots must be within the unit circle, since we are using the software EViews 7. The theory says that the root must be outside the unit circle. For further information, see [Enders \(2010\)](#).

he proposed the VAR model, which is now widely used in econometrics because of its good predictive capacity and other inferences about the relation between series. According to [Cavalcanti \(2010\)](#), the wide use of VAR as an analysis tool is in part due to the possibility of analyzing the interrelations between the variables from a set of identification restrictions, allowing the estimation of the effect of a “shock” of this variable over the others, becoming an important analysis tool.

Given this characteristic of VAR models, the vector is formed by a set of variables that are dependent on their lagged values and the lagged values of the other variables, allowing the relationships between them to be purely statistical ([Johnston and Dinardo, 1997](#)). Therefore, all variables are considered as explanatory factor of the others, that is, all variables are considered endogenous - this model assumes the existence of at least two series.

After performing all these procedures, another tool of the VAR models is the impulse response function. This impulse response function has the objective of investigating the isolated performance of the variables in the face of some shock in the innovations or residues of the model.

The variance decomposition of the prediction errors is a procedure that makes explicit the proportion of the movements generated in a variable due to the occurrence of a certain exogenous shock in itself and in the other variables over time. In other words, the variance decomposition provides information about the importance of a given variable in the changes of another variable in the model. For [Enders \(1995\)](#), the variance decomposition of the prediction errors aims to extract information about the degree of endogeneity of the variables, that is, it represents how much the variance of each variable can be explained by its own variance and how much is determined by the variance of other system variables.

Then, response impulse functions and variance decomposition analysis are the main results used from the use of the VAR models. For [Cavalcanti \(2010\)](#), its wide use in VAR and SVAR models as an analysis tool is due to the possibility of analyzing the interrelations between the multiple variables from a set of constraints. In these cases, it is possible to estimate the effect of a “shock” of this variable on the other variables of the system.

For [Janeiro \(2004\)](#), by applying the Cholesky decomposition, the ordering of the VAR may change the result, since the variable that occupies the first position has contemporaneous effects (i.e., it is the most exogenous) on the other variables of the system, while the variable that occupies the last position does not exert effects contemporaneously with the other variables (that is, it is more endogenous), being influenced by all other variables.

Still in the ideas of [Janeiro \(2004\)](#), SVAR is an attempt to reduce the problem of lack of theoretical foundations through long run constraints, in order to verify if the data are consistent with one or another class of theoretical models. Structural VAR use economic theory to isolate the contemporary connection between variables and require an assumption of identification, allowing correlations to be interpreted.

The SVAR models developed by [Sims \(1980\)](#) and [Bernanke \(1986\)](#) had as main proposal to model innovations using economic analysis, that is, the relationship between error predictions and structural innovations<sup>9</sup> with the objective of incorporating economic sense into the constraints that are imposed on the VAR model.

### 3. Econometric analysis for us private consumption from 1988 to 2014

The database for the econometric estimation was extracted from the World Bank, Federal Reserve Bank of St. Louis (FRED St. Louis), Organization for Economic Cooperation and Development (OECD) and Bank for International Settlements (BIS). The period used was from January 1988 to December 2014, that is, the periodicity used of the data was monthly. It should also be noted that the data were transformed into an index beginning in January 1988 (except for those already in index), in order to standardize the unit of measure and, consequently, to facilitate the interpretation of the data. Some data obtained did not have the desired periodicity and therefore were interpolated<sup>10</sup> to become monthly data. All data were seasonal adjustment using the X12 method. The software used for the estimations was EViews 7 and the for Unit Root Tests, STATA 13.

The variables used in this study were:

<sup>9</sup> See a formal presentation in [Enders \(1995\)](#).

<sup>10</sup> The classic definition of Thiele *apud* [Sadosky \(1980\)](#) for interpolation is that it is able to read the values of a table. [Stark \(1979\)](#) says that interpolation is the mathematical process/method that allows the construction of intermediate values from a discrete set of known data.

- Real Household Consumption (RHC): Expenditure on goods and services performed by households; values of 2010. This data is provided by the World Bank;
- Inflation (CPI): Consumer Price Index. Data available at OECD;
- Card Payments (CP): Total number of transactions made with credit card and debit card – Committee on Payments and Market Infrastructures: Red Book. Note: Except e-money. Data provided by the Bank for International Settlements (BIS);
- Delinquency (DEL): Delinquency is the sum of unpaid loans (after ninety days) divided by total loans, considering the end of the period. An individual is considered to be in default when he or she has a debt past due for at least ninety days. This data comes from FRED St. Louis;
- M1R (*narrow money*) “Real Balance”: includes currency, i.e. notes and coins, and overnight deposits – discounting inflation, i.e. M1 in real terms. Data available by OECD;
- Productivity (PRODU): GDP divided by hours worked, that is, a measure of productivity. Data available by OECD.

For empirical analysis of the theoretical model, which was developed for the stable state, the Euler equations were used because, through the first-order equations, it is possible to verify the behavior at the theoretical level of the variables used in the empirical test as explanatory variables and, thus, enable a robust empirical test. This technique was used by Cukierman et al. (1992), who carried out a study on seigniorage and political instability. In this study, the authors’ objective was to explain the importance of seigniorage in relation to other sources of government revenue – which is different between countries. To do so, they used a tax reform model, along with Euler’s equations (i.e., first-order equations) to perform the empirical tests. In this sense, the empirical test of the macroeconomic model of Dias (2002), carried out for the stable state, will also make use of Euler’s equations.

Consider the proposal to identify the effects of shocks arising from variations in the quantity of money offered on the consumption in the US economy. For example, the theoretical model indicates that aggregate consumption depends on consumption itself over time, productivity, transaction costs and real balance, considering the technology stage. The higher the productivity and the currency, the higher the equilibrium consumption, given a technology stage, and the higher the transaction costs, the lower the long run equilibrium consumption. In addition, we intend to test the direction of causality among the variables involved in the system of equations of the structural vector autoregressive. In the case of real balance, or purchasing power of the currency, we would have to include an indicator of real income, currency growth and prices and transaction costs, in particular. The proof of the effects of this structural alteration can be done by means of the SVAR – Structural Vector Autoregressive model. Thus, our main long run SVAR system has the following specification for the consumption equation:<sup>11</sup>

$$\mathbf{y}_t = \begin{bmatrix} \Delta (PRODU) \\ \Delta (M1R) \\ \Delta (DEL) \\ \Delta (CP) \\ \Delta (RHC) \end{bmatrix} \mathbf{C} = \begin{bmatrix} C_1 & 0 & 0 & 0 & 0 \\ C_2 & C_3 & 0 & 0 & 0 \\ C_4 & C_5 & C_6 & 0 & 0 \\ C_7 & C_8 & C_9 & C_{10} & 0 \\ C_{11} & C_{12} & C_{13} & C_{14} & C_{15} \end{bmatrix} \mathbf{e}_t = \begin{bmatrix} \omega_t \\ \mu_t \\ s'_t \\ s_t \\ \eta_t \end{bmatrix} \quad (1)$$

In the case of the empirical SVAR model, the shocks could be of four types<sup>12</sup>:

- Shocks arising from productivity gains ( $\omega_t$ );
- Permanent ( $\mu_t$ ), changes in the amount of money offered;
- Permanent resulting from changes in transaction costs ( $s_t$ ) and ( $s'_t$ ), for which we use indicators of use of credit/debit cards, such as shocks of reduction in transaction costs and indicators of delinquency for shocks of increase in transaction costs;

<sup>11</sup> Other variant systems can be tested according to the statistical results of the estimated coefficients, based on the theoretical model, which may include number of firms for market structure of firms and market power.

<sup>12</sup> In this case, we use only real variables. If we used nominal variables, inflation should appear, which would negatively impact the consumption and purchasing power of households.



Table 1  
Signs expected for the empirical estimation.

Variable	Abbreviation	Expected sign
Real household consumption	RHC	Positive (+)
Card payments	CP	Positive (+)
Delinquency	DEL	Negative (–)
Real balance	M1R	Positive (+)
Productivity	PRODU	Positive (+)

Source: Prepared by the authors.

iv Shocks arising from consumption itself or preferences ( $\eta_t$ ). For the currency purchasing power equation, a specification for the SVAR system would also be used based on the theoretical model.

We tested two empirical specifications aiming to verify a robustness in the results.<sup>13</sup> Thus, Specification 1 presents the most complete model, with all the variables of interest; while Specification 2 provides only one proxy for transaction cost, being the number of transactions with credit and debit cards. In Specification 1, the variable of interest is D1\_RHC (real household consumption), and the other variables are: D1\_CP (card payments), D1\_DEL (delinquency), D1\_M1R (real balance) and D1\_PRODU (productivity). In Specification 2, the variable of interest is D1\_RHC (real household consumption), and the other variables are: D1\_CP (card payments), D1\_M1R (real balance) and D1\_PRODU (productivity).

$$\begin{aligned}
 D1\_RHC_1 = & C_1 + \beta_1 \sum_{j=1}^k D1\_RHC_{t-j} + \beta_2 \sum_{j=1}^k D1\_CP_{t-j} + \beta_3 \sum_{j=1}^k D1\_DEL_{t-j} \\
 & + \beta_4 \sum_{j=1}^k D1\_M1R_{t-j} + \beta_5 \sum_{j=1}^k D1\_PRODU_{t-j} + \mu_{t1}
 \end{aligned} \quad (2)$$

$$\begin{aligned}
 D1\_RHC_2 = & C_2 + \beta_6 \sum_{j=1}^k D1\_RHC_{t-j} + \beta_7 \sum_{j=1}^k D1\_CP_{t-j} + \beta_8 \sum_{j=1}^k D1\_M1R_{t-j} \\
 & + \beta_9 \sum_{j=1}^k D1\_PRODU_{t-j} + \mu_{t2}
 \end{aligned} \quad (3)$$

In which:

$C_1$  is the constant of Specification 1;

$C_2$  is the constant of Specification 2;

$\beta_1, \beta_2, \beta_3, \beta_4$  and  $\beta_5$  are the parameters estimated for Specification 1;

$\beta_6, \beta_7, \beta_8$  and  $\beta_9$  are the parameters estimated for Specification 2;

$\mu_{t1}$  is the error of Specification 1;

$\mu_{t2}$  is the error of Specification 2.

Table 1 lists the expected results for the empirical tests of the long run SVAR model. It is worth mentioning that these results are based on the results of the theoretical model of Dias (2002).

In relation to the unit root tests, they showed that all the variables of the model are stationary in the first difference. Initially it was verified whether the series was correlated or not. When a series is autocorrelated, it is indicated to use the ADF test, but when it is not, the test used should be DF. However, the DFGLS test, which is considered more robust than the ADF test, because it makes use of the *generalized least-squares regression* method that corrects the residues.

<sup>13</sup> The objective of checking these two empirical specifications was to try to validate if the “complete” estimation would remain with the same results, in other words, if changing the composition of the variables in the model, the results would remain the same.

Table 2  
Results of empirical specifications.

Variables	Specification 1	Specification 2
Real Household Consumption (D1_RHC)	0.594002* (0.0000)	0.770089* (0.0000)
Payment Cards (D1_CP)	0.424918* (0.0000)	0.273304* (0.0000)
Delinquency (D1_DEL)	−0.169784* (0.0000)	–
Real Balance (D1_M1R)	0.446674* (0.0000)	0.108076** (0.0190)
Productivity (D1_PRODU)	0.451023* (0.0000)	0.114608** (0.0138)

Source: Prepared by the authors from EViews 7. Observations: Statistical significance level: \* = 1%; \*\* = 5%. Values in parentheses are p-values. Included remarks: Specification 1: 317; Specification 2: 317.

### 3.1. Empirical specifications

According to the variables used in the VAR model, the two empirical specifications will be presented. The first specification (considered the most complete) will be the one analyzed, and this analysis is applicable (extended) to the second specification.

After verifying the stationarity of the series, it is necessary to verify the interrelations between the variables. For this, we must analyze the causal relation in the Granger sense. This type of causality – in the Granger sense – is a test of temporal precedence, and some temporal precedence relationships – based on 10% statistical significance – were found to configure the VAR “universe”.

Then, it was verified that the optimal number of lags was 6 in the VAR model. Afterwards, the robustness analyses were implemented.

For this, the VAR stability conditions were checked, if the residuals were autocorrelated, normal, homoscedastic and if they were stationary (for the model as a whole and also for the equation of interest – consumption). In relation to the stability of the model, all the roots characteristic of the VAR was located within the unit circle, indicating that the model meets the conditions of stability. That is, this test shows the inverse of the unit root and, therefore, the roots must remain inside the unit circle and be smaller than one in module.<sup>14</sup>

Residues of the regression, whose variable of interest is “D1\_RHC”, were not correlated, i.e. there was no autocorrelation present. According to the Jarque–Bera test for normality of residues, it rejected the null hypothesis that residues (including together) follow a normal distribution. However, based on the property of large samples of the Central Limit Theorem, it can be considered that asymptotically the residues follow a normal distribution.<sup>15</sup> Despite the non-normality of the residues, they are considered homoscedastic and the tests indicated that they (the residues of the VAR as a whole and the equation of interest, consumption) are stationary.

#### 3.1.1. Results of empirical specifications

Nevertheless, the main interest of the present study is to verify the long run empirical validation (Stationary State) of the theoretical model of Dias (2002), that is, to investigate the effects of monetary policy shocks on agent consumption in the long run. For this, the results of the Structural Vector Autoregressive (SVAR) Model are presented. According to Sims (1986), it is possible to verify if the effects of explanatory variables remain in the long run. Thus, Table 2 presents the results of the two empirical specifications.

Analyzing the results demonstrated in the SVAR in Table 2 (for Specification 1), it is possible to perceive a significant long run relationship between the variables. The column of Specification 1 (as well as Specification 2) presents the empirical result including all the variables of the system, all being statistically significant, confirming empirically the results of the theoretical model of Dias (2002), and all the signs were as expected – see Table 1.<sup>16</sup> The variables that showed positive effects on consumption in the first difference were: consumption – D1\_RHC – (0.594002), number of transactions with credit/debit cards – D1\_CP – (0.424918), currency – D1\_M1R – (0.446674) and productivity –

<sup>14</sup> The theory of this test predicts that the roots need to be outside the unit circle and be larger than one in module. However, as the software used here (EViews 7), it presents the inverse of the unit root and, therefore, it must be inside the unit circle and be smaller than one in module.

<sup>15</sup> Further details in Wooldridge (2006).

<sup>16</sup> See page 10.



D1\_PRODU – (0.451023); while the variable that presented a negative sign for household consumption was: delinquency – D1\_DEL – (–0.169784).

The results bring the inertia of US household consumption in the long run, and corroborate [Carroll and Summers \(1991\)](#) that the hypothesis of permanent income may not apply to the case of the North American economy, in the sense that it does not is the only relevant variable for the determination of private consumption in the USA. Productivity positively influences consumption and makes the family more available, thus increasing its purchasing power and, possibly, its quality of life, since it may have more leisure time or more resources available, since its productivity has increased.

Regarding the use of cards and delinquency (proxies for the fall and increase in transaction costs, respectively), the use of cards positively change the relation of consumption of the households since they tend to facilitate at the time of the exchanges, besides that use of this tool makes the transactions faster, it is not necessary for the individual to move to a physical store, being able to make purchases through the computer, without leaving home and use this “time saving” in other activities, mainly leisure (properly speaking), since the time spent on purchases is discounted from leisure time. Another point that needs to be highlighted is that this facility helps the individual to protect from the transaction cost known as “shoe leather costs” because he can search, for example, through the internet, to buy goods/services at lower prices. These results are in agreement with the results found by [Gross and Souleles \(2002\)](#), that the use of cards positively affect consumption. In addition, the greater the use of the card, the lower the transaction costs and the greater the ease of exchanges, which translates into a greater consumption capacity.

Delinquency negatively affect households’ consumption, since they need to “regularize” their past due debts, that is, they need to separate part of the budget to pay off past due debts and, as a result, their available income for consumption decreases. Once debts are regularized, families can get credit again so that they can return to their “normal” consumption patterns in the future. The individual considered in default is deprived of some tools that can expedite the consumption – such as cards, for example – that is, these tools have the purpose of reducing transaction costs, leaving more time for leisure (other activities), since the individual in delinquency incurs costs of “shoe leather costs” to protect himself from inflation.

According to [Romer \(2012\)](#), one of the hypotheses of permanent income presupposes that interest rates, both for loans and for savings, are the same. However, the interest rates that households pay on card debt or some other type of delinquency are higher than savings rates, and not all individuals are able to lend more at any interest rate. Liquidity constraints can increase savings in two ways. The first, and most obvious, is the fall in consumption, and the second, as approached by [Zeldes \(1989\)](#), refers to binding restrictions, even if they are not binding, in the future they may be and consequently reduce consumption.

The real balance positively affects household consumption, this possibly occurs because of the adjustments of expectations that families make, in addition to which, more money in circulation in the economy tends to increase the price level (*ceteris paribus*), causing families to increase the speed of consumption in order to mitigate the loss of purchasing power with inflation. Another factor is that the more money individuals have, the more bargaining power they have, that is, they can bargain for the value paid for goods ([McCallum, 1989](#)). In addition, it is evident that the real balance does not appear as neutral in the North American economy, since it is able to change the relations of consumption. Regarding the robustness tests, the results obtained were the same as the VAR.

Therefore, according to the results found here, it is clear that other variables, besides income, are determinants of the consumption function in the long run, besides evidencing the importance of the mechanisms to reduce transaction costs and, finally, the ownership of the currency is highly important at the time of making exchanges.

### 3.1.2. Impulse response functions

[Figs. 1 and 2](#) show the impulse response functions of the SVAR model with a single and accumulated shock, respectively, considering a time horizon of 50 months.<sup>17, 18</sup>

<sup>17</sup> “Shock1” means “D1\_RHC”; “Shock2” means “D1\_CP”; “Shock3” means “D1\_DEL”; “Shock4” means “D1\_MIR”; “Shock5” means “D1\_PRODU”.

<sup>18</sup> The analysis of impulse response and variance decomposition of Specification 2 followed the same pattern presented in Specification 1. Therefore, the same analyses can be applied and, therefore, we chose not to present these results.

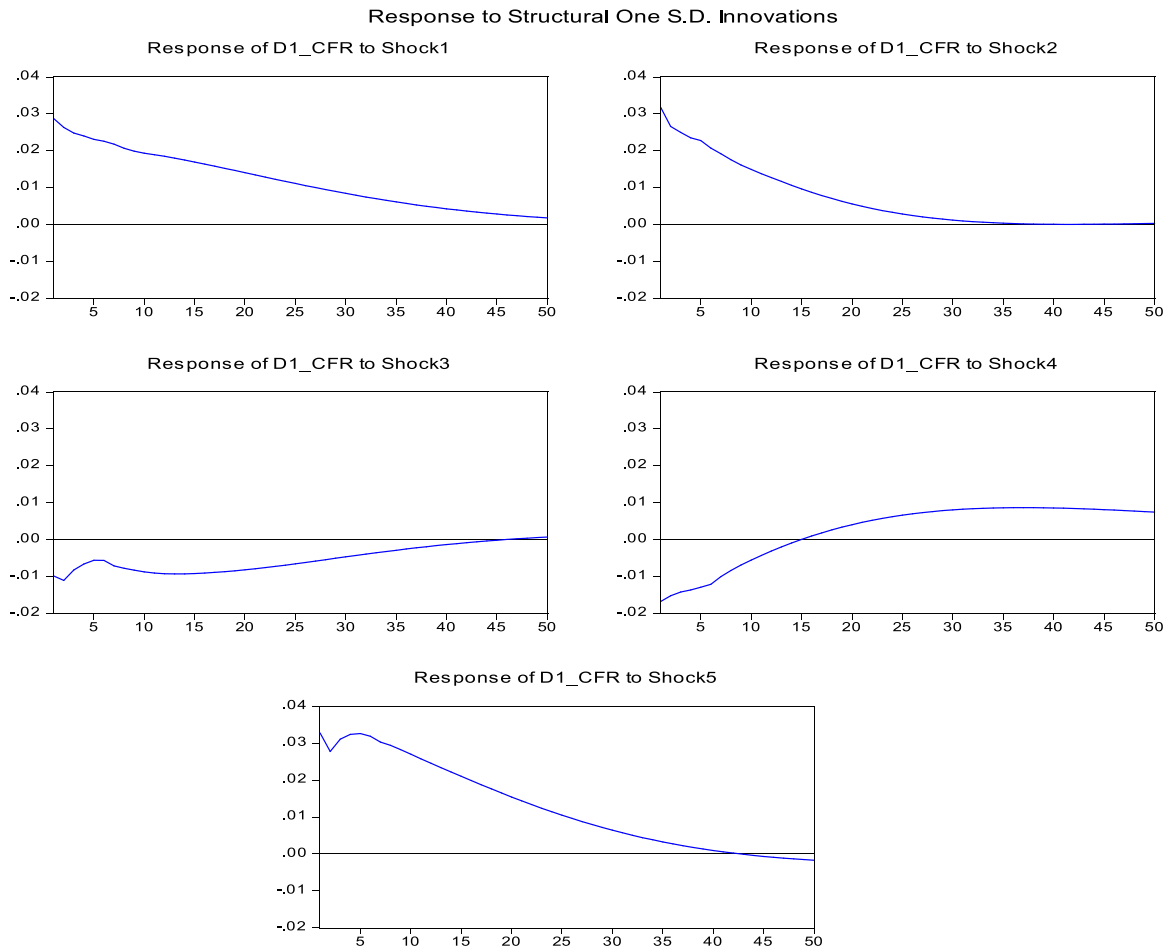


Fig. 1. Impulse response of Specification 1 of SVAR.

Source: Results of *software* EViews 7. Observations: Single impulse (shock) on variables “D1\_CFR, D1\_CT, D1\_INADIM\_E, D1\_M1R, D1\_PRODU” and response in variable “D1\_CFR”. Meanings of “Shock” are: “Shock1 = D1\_CFR”, “Shock2 = D1\_CT”, “Shock3 = D1\_INADIM\_E”, “Shock4 = D1\_M1R”, “Shock5 = D1\_PRODU”.

Fig. 1 shows the result of the Impulse Response functions of SVAR, that is, how the consumption variable (D1\_RHC) behaves when all model variables receive a shock (individual and single). It should be noted that all these shocks dissipate, returning all the variables to equilibrium, since the variables are stationary - all the variables showed behavior as expected.

A shock on household consumption (Shock1 = D1\_RHC) from consumption itself initially showed a large positive effect, then returning to the equilibrium value. The shock on the number of transactions with credit and debit cards (Shock2 = D1\_CP, proxy for a fall in transaction costs), has a positive net effect on consumption, corroborating with the proposition of the theoretical model, besides the use of card facilitating and expediting the transactions, shortening the time used in transactions, leaving more time for leisure. Analyzing the variable delinquency (Shock3 = D1\_DEL; proxy for an increase in transaction costs), its shock results in a negative effect on consumption, since the individual can be deprived of several methods to speed up consumption and increase leisure time. An important part of transaction costs is that it makes possible to reduce the “shoe leather” cost in order to protect itself from inflation.

On the other hand, the shock coming from the real balance (Shock4 = D1\_M1R) positively affects the consumption of the family, as its detention allows for bargaining and obtaining better deals by allowing cash payment at the time of purchase. The productivity (Shock2 = D1\_PRODU) shows that productivity gain has a positive effect on consumption, making the individual, more productive, able to have more time for leisure, since he can work fewer hours and maintain same salary.

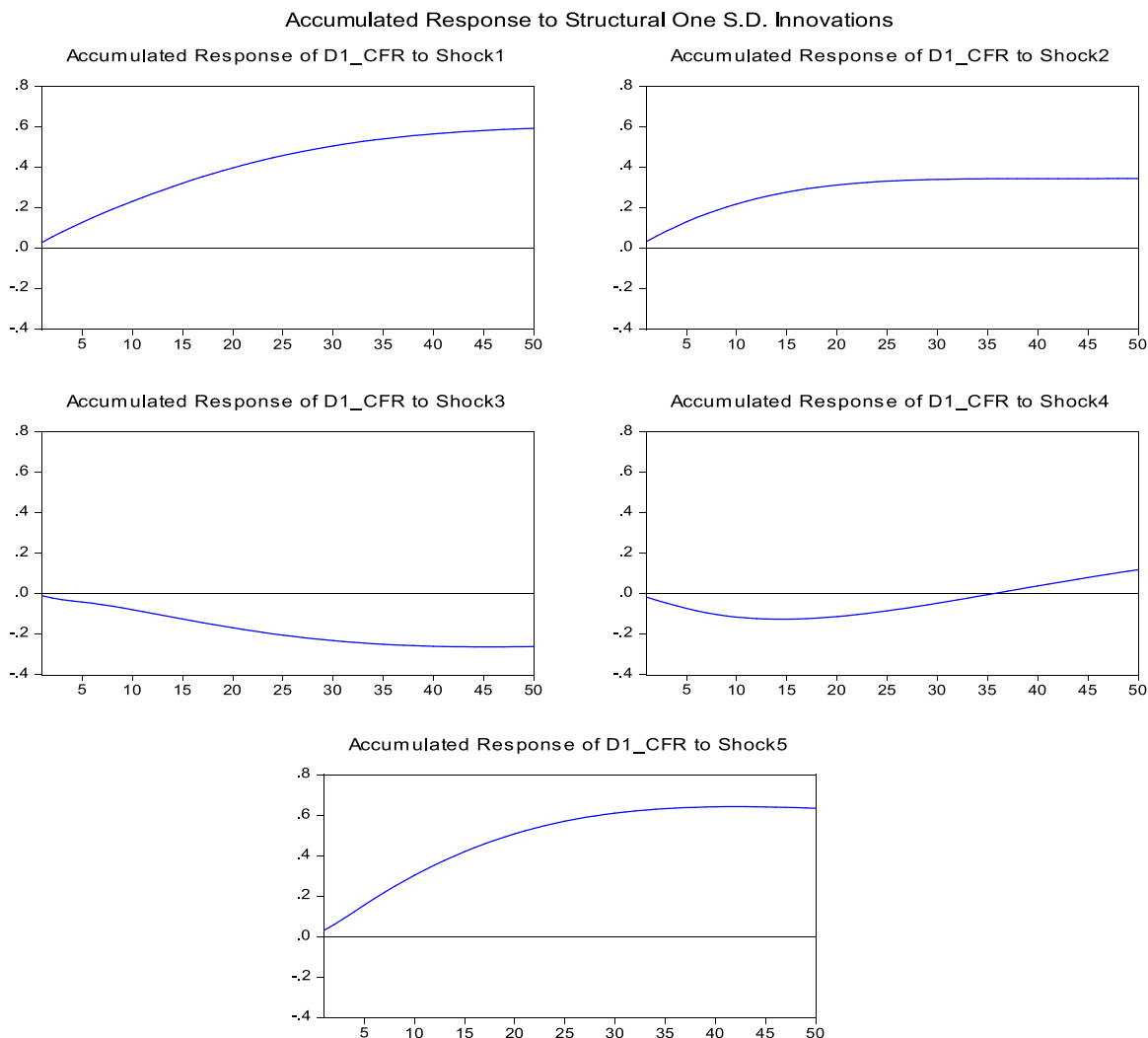


Fig. 2. Cumulative impulse response of Specification 1 of SVAR.

Source: Results of *software* EViews 7. Observations: Cumulative impulse (shock) on variables “D1\_CFR, D1\_CT, D1\_INADIM.E, D1\_M1R, D1\_PRODU” and response in variable “D1\_CFR”. Meanings of “Shock” are: “Shock1 = D1\_CFR”, “Shock2 = D1\_CT”, “Shock3 = D1\_INADIM.E”, “Shock4 = D1\_M1R” and “Shock5 = D1\_PRODU”.

The results obtained in the impulse response functions, Fig. 2, show the empirical validity of the theoretical model of Dias (2002), that is, all the accumulated shocks impact the consumption as expected and demonstrated in the theoretical model, are: consumption on itself, the use of cards, currency and productivity positively impact consumption; in turn, delinquency negatively impact consumption. In this case, the shock accumulated in consumption (Shock1 = D1\_RHC), its response is that it positively influences consumption.

In relation to the number of transactions with credit and debit cards (Shock2 = D1\_CP, proxy for a drop in transaction costs), shock has a positive effect on consumption, corroborating with the idea of the theoretical model, besides the use of cards facilitating and expediting transactions, shortening the time used in transactions, leaving more time for leisure; in turn, delinquency (Shock3 = D1\_DEL) has a negative effect on consumption, since the individual considered in default is deprived of some tools that can speed up consumption – such as cards – that is, these tools have the purpose of reducing costs of transactions, leaving more time for leisure, other activities. The reduction in transaction costs is important because the individual saves the cost “shoe leather” to protect himself from inflation.

Fig. 2 shows the non-neutrality of the currency (Shock4 = D1\_M1R), since the deviation of currency has a positive effect on consumption because it can bargain more at the time of purchases, with cash-in-advance. However, initially

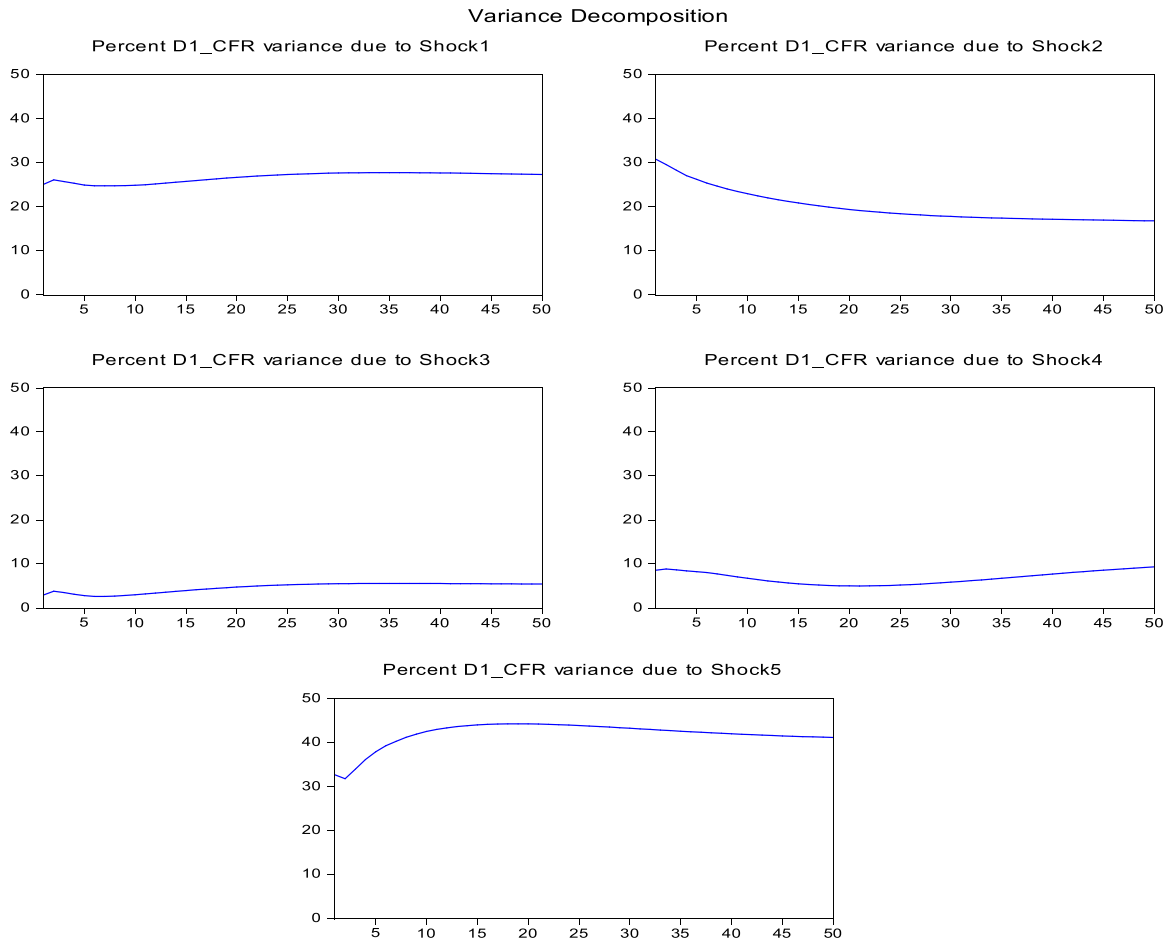


Fig. 3. Decomposition of the SVAR Specification 1 variance for variable D1\_CFR.

Source: Results of software EViews 7. Observation: The meanings of “Shock” are: “Shock1 = D1\_CFR”, “Shock2 = D1\_CT”, “Shock3 = D1\_INADIM.E”, “Shock4 = D1\_M1R” and “Shock5 = D1\_PRODU”.

we noticed a decrease in consumption, this is probably due to the adjustment of expectations that agents will make. Immediately after this adjustment, it can be seen that the currency positively affects consumption. The productivity (Shock5 = D1\_PRODU), as discussed above, affects consumption in a positive way, making the individual, who is more productive, able to have more time for leisure, since he can work fewer hours and maintain the salary. Note that in cases of accumulated shocks, the variables do not need to equilibrium.

### 3.1.3. Prediction error variance decomposition

Fig. 3 presents the results of prediction error variance decomposition of the SVAR model for the variable “D1\_RHC”, considering 50 periods. Initially the analysis of the consumption variance decomposition showed that the proxies for the transaction costs determine the greater variance of consumption, having its effect diminished later.

After proxies for transaction costs, the determinants of consumption variance are productivity, consumption itself, followed by real balance. When we consider the end of the analyzed period, it is possible to perceive that productivity is what matters most in the variance of consumption, followed by consumption itself, the proxies, with the currency increasing its share to almost 10%. As already mentioned, its ownership allows for greater bargaining – confirming the long run non-neutrality of the currency in the United States economy – as the general model of Dias (2002) demonstrates. The role of transaction costs, which are fundamental for the individual to use the “saved” time in transactions in other leisure activities, is also perceived.

Therefore, analyzing the two empirical specifications, it can be seen that all followed the same pattern of response, that is, they presented the expected signs of the coefficients for the SVAR in the long run and, it can be seen that the currency is not neutral in the North American economy, containing the inertia of consumption, with transaction costs and productivity as important determinants of consumption, since they expedite consumption, allow easier exchanges, and allow more time for leisure. In this way, research can help policymakers measure the long run consequences of their decisions.

#### 4. Final considerations

The present study applies the theoretical model of [Dias \(2002\)](#) to the North American economy. In general, monetary policy can affect indicators of production, employment and consumption in the short run through shocks. The proposal is the empirical application of a theoretical model that includes nominal rigidities arising from transaction costs and real rigidities arising from firms' competition structure, based on cash-in-advance, shoe-leather costs theories and imperfect competition.

In particular, this research contributes to the academic debate about the ability of macroeconomic policy to affect the real sector of the economy in the short and long run. In addition, it proposes empirical advances regarding the application of this model to the North American economy, identifying a greater capacity of the economic policy to affect the aggregates in the long run.

Thus, the proposal was to investigate the effects of monetary policy shocks on agent consumption in the long run for the United States economy from 1988 to 2014 (monthly data), with the objective of help policymakers measure the long run consequences of their decisions.

To reach the objectives, two empirical specifications were estimated using the time series methodology of Structural Vector Autoregressive (SVAR) models. For the long run relationships of the variables, the SVAR models are appropriate, allowing the analysis of simulated shocks through impulse response functions.

In the two empirical specifications estimated – taking into account the long term – it was possible to perceive a significant long run relationship between the variables. The results also indicated the inertia of household consumption in the long run. It is evident that the money is not neutral in the North American economy, since the individual who has money can bargain during the transactions and, consequently, can buy goods/services at lower prices, that is, the possession of currency positively influences consumption, leaving more time for leisure.

Moreover, in relation to the use of cards (proxy for a decrease in transaction costs), it was noticed that they alter the consumption relation of the families in a positive way since they tend to speed up at the moment of the exchanges, facilitating them, besides not being necessary for the individual to move to a physical store, being able to make purchases through virtual stores, without leaving home, and to use this “time saving” in other activities, that is, the time savings were due to the decrease of the time spent in transactions making the individual have more free time for leisure, since the time spent during transactions is discounted from leisure time. It should be noted that this facility helps the individual to protect himself from the cost of “shoe leather”, since he can search, for example, through the internet, to buy goods and services at lower prices, that is, to protect himself against the costs of inflation.

Productivity has a positive influence on consumption, since the family that has more money available increases its purchasing power and possibly its quality of life, since it may have more leisure time or more money available for other activities.

Delinquency (proxy for the increase in transaction costs) negatively affects the consumption of families because they need to “regularize” their past due debts, that is, they need to separate part of the budget to pay off past due debts and, therefore, income available for consumption decreases. Once debts are regularized, families will be able to get credit again so that they can return to their “normal” consumption patterns in the future – without going into debt again. The individual considered in default is deprived of some tools that can expedite the consumption – such as cards, for example – that is, these tools have the purpose of reducing transaction costs, leaving more time for leisure, since the individual in default incurs “shoe leather” costs to also protect himself from inflation - since it erodes purchasing power, and families tend to anticipate consumption in order to mitigate the loss of purchasing power.

In light of the above, it is evident that the empirical model confirmed the theoretical results of the model of [Dias \(2002\)](#) for the United States economy – where cumulative shocks have impacted consumption as demonstrated in theory – and therefore, research can help policymakers measure the long run consequences of their decisions. Additionally, it can be seen that the ideas developed here dialogue with the main theories about consumption because, at the same

time that they discuss these theories, they claim the need to consider transaction costs and money in determining consumption.

For future work, it is suggested to apply the other relevant variables of the theoretical model to the economic analysis of other economies.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.econ.2020.02.001>.

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