

Monetary policy and the automotive retail performance in Brazil

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Abstract

This paper analyses the performance of the automotive retail industry taking into consideration the monetary policy employed by the Brazilian government from 1994 to 2014. Since the research area lacks empirical evidence we decided to use econometric methods that led to estimation models, based on regression and correlation, to check the relation between monetary policy and sector performance. We found out that the performance of the sector, represented by production and export level, was connected to the variables related to the monetary policy. When the performance was measured using exports, the economic variables act as expansion or constrains mechanisms.

1. Introduction

The objective of the Brazilian Government's economic policy is to maintain monetary control and achieve better national development indicators. The government, the Central Bank and the Parliament plan and carry out actions to control the liquidity in the economy that, theoretically, could lead to a better economic situation. Thus, it becomes relevant for government to act in the federal, state and local areas to spread out policies that would result in social and economical development. (Cleto&Dezordi, 2002; Taffarel et al., 2015; Harzer et al., 2016). The adoption of certain economic policies can result in the restriction or expansion of the economic activity. Restrictive policies are used to control price levels, while expansionary policies are used to boost the economy, usually employing measures to increase liquidity in the economic system, for example by reducing the reserve requirements (Barro& Gordon, 1983).

In order to measure the monetary policy and the measures adopted by the government, monetary base, money supply, the Gross Domestic Product (GDP), Net Public Sector Debt (NPSD), the Selic interest rate, Brazilian currency exchange rate, inflation rate, reserve requirements, open market operations and the unemployment rate are analyzed due to the fact that they are measures that evaluate the level of economic activity. One of the vulnerable sectors affected by the monetary policy is the automotive industry, mainly because of their representation in the national and international context. According to Bahia and Domingues (2010) the automotive industry is the most important industry in the Brazilian economic structure since it provides direct and indirect drive to develop other sectors. The authors point out that this sector is a driving agent of the Brazilian technical progress.

Data from the International Organization of Motor Vehicle Manufacturers (OICA) show that between 2012 and 2014, among the countries of South America, Brazil was the most representative country, with a total production of more than 1.5 million vehicles. By in 2014, vehicles

exports reached USD 8.703.121, 00 according to the National Association of Vehicle Manufacturers (Anafae, 2014). Moreover, this sector directly employed a total of 125.977 employees. Based on the presented context, the aim of this study is to analyze the performance of the Brazilian automotive industry in relation to the monetary policy employed by the government from 1994 to 2014. So the research question we want to answer is: **how has the automotive retail performed taking into consideration the monetary policy employed by the Brazilian government over 20 years period?**

We were not able to find in the current literature a study that precisely approached the performance of the automotive sector and the Brazilian monetary policy. Thus, this study contributes for the analysis of economic policies in Brazil in general, and the performance of a strategic sector, the automotive industry.

This paper is structured in four sections besides the introduction: the theoretical and empirical basis on economic policy and the automotive sector; the methodological procedures; key results and data analysis relating the automotive sector performance and economic policy adopted by the government; and finally in the last section we present the conclusions and suggestions for future research.

2. Theoretical Framework

Since the ideas of J. M. Keynes have been accepted by the majority of economic theorists, the government started to act as a regulator of economic activity, mainly through monetary, financial, tax and trading policies. It is no different in Brazil, the liquidity in the economy controlled by the National Monetary Council and Central Bank of Brazil. They use essential instruments of economic policies, such as interest rates, reserve requirements and the buying/selling of securities.

2.1. Economic Policy

The political actions carried out by the State are expressed in the nature of public policies, it is expected that they are carried out independently of social or political interests. However, we see that there are social planning and execution pressures imposed on the way a nation is managed that affects the economic performance. Depending on the level of pressure and the way the government deals with it, the economic policy can become a deliberate attempt to adjust goals based on the political leaders' past experiences (Hall, 1990; Vieira and Veiga, 2009; Leinig et al., 2014;).

To have an impact on the nature of public policy, the State acts as a basis for the executive, legislative and judicial powers, independently of organized social interests or political blocs that might exist (Hall, 1993). Another view is that the public policy is built by interventions and practices from social pressures that orient the actions of an individual that is in office, these actions vary from person to person (Hall, 1993). The aspect that Hall (1993) highlights is the role of learning under uncertainty, mainly because economic policies are outlined and certain positions are taken to deal with critical changes so public management is, in fact, contributing to the development of society.

Because of the uncertainty in the market, the authorities in charge of the economic policy change their policies to manage its mechanisms, so that they can speed up or slow down economic activity, leading the economy to a balance (Hall, 2013). The international financial crisis of 2008 caused the recession in several strategic sectors. In Brazil, the adoption of countercyclical policies emphasized the reduction of the Industrialized Products Tax (IPI) in the automotive sector and contributed significantly to the recovery of industry sales and also to the availability of credit, with considerable effect on their recovery (IPEA, 2010). Thus the state has an important role in the control and intervention of macroeconomic factors in order to mitigate the negative effects of possible imbalances. So if the economic growth rates are small and inflation rate is under control, the state creates certain policies to promote full employment (Hall, 2013).

The actions are planned by the government with the right to contribute to the development of the country, so when the government adopts certain economic policies, its performance may result in the decrease of economic effects (anti-inflationary policy) or expansion of the economic activity

(Barbosa, 1996; Meirelles, 2010). Restrictive policies are used when the objective is to control the price level. When it threatens to exceed the targeted inflation level increasing the interest rates is an example of fighting up monetary policy, that entails a reduction in consumption and the economic activity of the country. However, when the government's objective is to boost the economy, it uses monetary policy as a control measure of money supply in the economy, so the government controls the maximum price levels to ensure optimal liquidity, for example, the reduction of reserve requirements (Barbosa, 1996; Meirelles, 2010).

Regarding the level of the Brazilian economy activity, it was observed that between the 1960s and 1970s the economic growth was high and accelerated. Between 1980 and 1990 its growth has become almost nil, justified by the national and international market shocks (Bender Filho et al., 2012). By analyzing the foreign investment behavior between 1980 and 1994, Curado and Cruz (2012) found that especially the 1980s were marked by a deep decline in the production level and increased inflation, which has characterized the stagnation economy and hyperinflation. For this time, Brazilian policy decisions were concentrated in the solution of the external imbalance, so fiscal and monetary policies were restrictive, focusing on the reduction of the money supply, raising interest rates and reducing investments in the private sector (Curado and Cruz 2012; Dalazen et al., 2016; Veiga et al., 2016). The authors also point out that, from then until 1994, Brazil created different plans to stabilize prices and a monetary reform to achieve stability in its currency.

The conditions of the economic policy instruments influence the economy behavior and determine which policy to be adopted according to the economic moment of the country (Bender Filho et al., 2012). Especially after the creation of the "Plano Real", implemented in order to combat inflation, the government started to act more intensely in monetary controls, thus many were the mechanisms used by it to control liquidity, stabilize currency and consequently, the price level. Guided by adequate liquidity in the economic system, monetary policy operates in the balance of the price level and to achieve the goals of macroeconomic policy. Through fiscal policy, the government regulates the tax collection levels and their costs. And for the exchange rate and trading policy, the government has the power to intervene in the commercial drive and in the capital flows entering and leaving the country (Cleto&Dezordi, 2002).

To investigate the growth regime of the Brazilian economy, Araújo and Pala (2013) found a pattern of growth in aggregating demand that responds positively to an increase in the share of wages, even when there is an increase in investments and exports, there is a positive response of aggregated demand, increase in profits and people's income.

Blecker (2010) points out that international competition makes countries vulnerable because exports and imports become price sensitive, mainly because of the impact on macroeconomic variables such as real GDP growth, the profit rate, accumulation of capital and percentage of wages in income.

2.2. Monetary Policy

Monetary policy is a means used by the government to reduce inflation and stabilize prices through measures that control market liquidity available to the country's economic agents (Shikida, Araújo& Smith, 2011). Among the measures adopted by the government we can mention currency and credit management, interest rates structure and the influence of these elements on employment, production and international operation prices (BancoCentral do Brasil2014).

The adjustment of the economic system liquidity is considered one of the most important functions of the monetary authorities to maintain its balance and to instigate economic growth. The monetary control is carried out by the Central Bank through instruments such as interest rates, reserve requirements, operations of loans to commercial banks, discount calls, and the purchase and securities sales on the market, called Open Market (BancoCentral do Brasil 2015).

The variables that measure the monetary policy in the Brazilian context are the monetary base, GDP, DLSP, the Selic interest rate, the real exchange rate, inflation rate, reserve requirements, open market operations, unemployment rate that can help us measure the level of economic activity, among others. The details of these elements can be seen in Table 1.

Elements	Investigations
Monetary Base	Total volume of money created by the central bank, considering the compulsory deposits and government securities (Banco Central do Brasil, 2015).
GNP	Economic activity level (Central Bank of Brazil, 2015). Relations between the monetary base and GDP were investigated as drivers of economic growth municipalities (Kohler and Souza, 2004).
NPSD	It refers to the balance between the debts and credits of the nonfinancial public sector and the Central Bank (Central Bank of Brazil, 2015). When the interest rate and the holders of NPSD increase, immediately become richer and receive greater flow of interest payments stimulating demand (Nakano, 2005).
Interest rate (SELIC)	The adjusted mean refers to the daily financing in the Special System of Clearance and Custody (SELIC) (Banco Central do Brasil, 1999). The rate hike causes a reduction in the levels of investment and consumption, controlling rising prices and contributing to the achievement of the inflation target (Fonseca & Kirienco, 2010).
Exchange rate	Is characterized by the amount paid to a foreign currency with a view to their equivalence in relation to national currency, among the major currencies, highlights the US dollar (Banco Central do Brasil, 2014d). Changes in the exchange rate affect the auto industry in exports and imports of products and raw materials.
Inflation	It refers to the devaluation of the currency, with consequent increase in the price level (Banco Central do Brasil, 2015).
Reserve requirements	Influence the amount of money in the economy and represents a percentage of commercial bank deposits that must be kept by the Central Bank. It is an instrument to control inflation Banco Central do Brasil (2015). The increase in reserve requirements contributed to the reduction in credit volume and consumption of goods and service (Silva & Longuinhos (2013).
Open market operations	Refers to operations with government securities used to balance the money supply and the interest rate (Central Bank, 2005).
Unemployment rate	It refers to the percentage that indicates the amount of hand work idle obtained with the help of the Brazilian Institute of Geography and Statistics (IBGE). A high unemployment rate affects negatively the auto industry, which may cause bottlenecks in the production process due to the lack of qualified personnel to manage operations.

Table 1. Details of monetary policy elements in the Brazilian context
Source: Research data

The main element of monetary policy is the interest rate and operations carried out by financial organisms that act with currency outside banks and make cash deposits in commercial banks (Pohlmann & Triches, 2008). In this sense, Shikida, Araújo and Smith (2011) argue that the government's intention is to create a stable environment and eliminate the inconsistency between supply and expected growth rate for the conditional currency demand.

2.3. Brazilian automotive sector

The global auto industry is one of the most important sectors in the economy of the leading countries in the world. Table 2 presents data from the International Organization of Motor Vehicle Manufacturers (OICA) and reveals information's as the sales statistics of motor vehicles in the world and the percentage compared to the total number of years, according to the regions, between 2012 and 2014.

Table 2 data show an increase in vehicle production in most countries of the world, with an average of 3.4% production increase between 2012 and 2014. The Americas had the highest production of vehicles in the period, exceeding 11 million in the first half of 2012 and 12 million in 2013 and 2014. The United States had the highest production volume in the Americas; more than 7 million in the first two years and after greater than 8 million. Among the countries in Central and South America, Brazilian vehicle production was more than 1 million and a half in the three periods.

One of the possible reasons for this growth is the restructuring of the sector with the creation of the Plano Real in 1994, designed to boost national productivity in response to a past environment of low productivity and efficiency (Laplane & Sarti, 1997). From the stabilization of inflation in 1994, the Brazilian government encouraged foreign investment and promoted the development of the country (Arbix, 2000). This action was related to a policy created in the mid 90's for Brazil's entry into the world market in order to promote the import and export in the country. This policy was called Foreign Direct Investment (FDI) (Arbix, 2000). The deployment of the automotive regime aimed to balance the interests of the government and automakers to promote investment (Laplane&Sarti, 1997). Most Brazilian automotive manufactures are in the Southeastern and Southern regions of the country, in the states of São Paulo, Rio Grande do Sul and Paraná. Brazil is the sixth largest automobile maker in the world, but it is the only BRIC member that does not to have national companies in the industry, only foreign companies participate in the market (ANFAVEA, 2016). Brazil is also the largest producer of automobiles in the continent, there are over 40 plants in the country. Companies like Fiat, Ford, General Motors and Volkswagen have nearly 70 percent of current sales (ITA, 2016).

The government's objective, as highlighted Arbix (2000), was the restructuring of the economy facing the globalized market relations through offering support for a monetary policy that could attract investments in sectors considered sensitive in the Brazilian economy. Foreign direct investment (FDI) were encouraged with the opening of the Brazilian economy, deregulation and the creation of government privatization programs (Arbix, 2000). Brazil's participation in the BRIC group (Brazil, Russia, India and China) was a driver for economic growth and internationalization. Among the BRIC countries, Brazil is the most internationalized; Foreign Direct Investment (FDI) represents 18% of the GDP. This participation has attracted foreign investment in various sectors, including the automotive sector (IPEA, 2010).

These government strategies boosted the entry of automakers in Brazil and strengthen the automotive sector, and currently, this sector receives more investment from other sectors related to Brazilian industry (Arbix, 2000). Bahia and Domingues (2010) point out that the automotive industry is the most important sector within the Brazilian economic structure because it provides direct and indirect drive in the development of other sectors. This sector is also a booster agent of the Brazilian technical progress (Bahia & Domingues, 2010).

Regions/Countries	2012 S1	2013 S1	2014 S1	% Change
Europe	9.893.574	9.200.506	9.448.752	2,7%
EU 25 countries + EFTA	7.851.882	7.323.155	7.800.311	6,5%
EU 15 countries + EFTA	7.353.773	6.861.227	7.259.978	5,8%
América	11.633.356	12.430.755	12.486.009	0,4%
Nafta	8.786.861	9.387.383	9.752.949	3,9%
Canadá	885.868	902.008	926.950	2,8%
México	478.511	519.758	515.088	-0,9%
Estados Unidos da América	7.422.482	7.965.617	8.310.911	4,3%
Central and South América	2.846.495	3.043.372	2.733.060	-10,2%
Argentina	397.875	497.132	378.594	-23,8%
Bahamas	1.700	1.700	1.700	0,0%
Belize	200	200	200	0,0%
Bolivia	1.281.175	10.400	9.200	-11,5%
Brasil	1.716.916	1.799.064	1.662.920	-7,6%
Chile	169.478	192.329	173.242	-9,9%
Colombia	140.800	139.200	144.500	3,8%
Costa Rica	17.800	17.500	19.500	11,4%
Cuba	2.200	2.200	2.200	0,0%
República Dominicana	10.400	10.300	12.300	19,4%
Equador	64.007	56.235	56.177	-0,1%
El Salvador	5.500	5.500	5.700	3,6%
Guadeloupe	6.877	6.513	6.324	-2,9%
Guatemala	11.900	11.900	13.200	10,9%
Guiana	2.714	2.461	2.540	3,2%
Honduras	4.500	4.700	4.700	0,0%
Jamaica	2.200	2.300	2.500	8,7%
Martinique	5.840	5.352	5.418	1,2%
Nicarágua	4.000	4.100	4.100	0,0%
Panamá	23.800	23.500	25.000	6,4%
Paraguai	14.800	14.800	18.500	25,0%
Peru	91.391	102.986	92.845	-9,8%
Porto Rico	48.000	48.500	49.500	2,1%
Trinidad	7.200	7.300	8.000	9,6%
Uruguai	27.200	27.200	27.200	0,0%
Venezuela	58.797	50.000	7.000	-86,0%
Asia/Oceania/ Middle East	19.267.063	20.201.507	21.347.806	5,7%
África	742.884	809.256	790.695	-2,3%
All countries	41.536.877	42.642.024	44.073.262	3,4%

Table 2. Vehicle production by country in the first half 2012-2014
Source: International Organization of Motor Vehicle Manufactures (OICA).

3. Materials and Methods

This study analyzes the performance of the automotive sector in relation to the monetary policy employed by the government over 20 years, therefore, this is a quantitative study. Describing the features and events of the automotive sector, as well as monetary policy, this study is classified as descriptive as it analyzes the characteristics, facts and events related to them.

We used a longitudinal analysis in a 20 year period (1994-2014), mainly because it was when there were political and economic events that changed the configuration of Brazilian politics and economy, for example: the Plano Real, the change of national currency and the first reduction initiatives of high inflation. Thus, as the data collection procedures, ranked ex-post, involved the use of secondary data and econometric methods.

Data were collected by the Institute of Applied Economic Research (IPEA), National Association of Motor Vehicle Manufacturers - Anfavea and Central Bank of Brazil in the period 1994-2014, with a total of 241 observations of monthly data series. We collected information on the variables (Table 3): money supply, GDP, NPSD, Selic, Unemployment rate, real exchange rate against the US dollar, inflation rate, reserve requirements, open market operations and the automotive sector, Tax on Industrialized Products (IPI), exports and production. The performance of the automotive sector was represented by the variable production and export.

The relationship between the government's economic decisions and the performance of a strategic sector like this for the economy lacks empirical evidence and so the emphasis of this work on this discussion, seeking to understand if such decisions could have an impact on current performance of the Brazilian automotive sector, facing current difficulties.

Based on empirical studies we have prepared three assumptions that guide this research, described below. The first hypothesis was drawn up based on the study and Costa Filho and Rocha (2010) investigating the relation between the Central Bank and the futures interest market. The authors stressed the importance of having an alignment between the behavior of asset prices and the objectives of the monetary authorities, as this consistency helps bring an efficiency of the instruments adopted by the government. The relevance of cohesion between the instruments of monetary policy, over the years, implies that the elements follow the same direction, which does not disagree with each other and enables government intervention more effective means. Thus, the first (H1a and H1b) hypothesis is described as follows:

H_{1a}: There is cohesion between the monetary policy instruments over time.

H_{1b}: There is no cohesion between the monetary policy instruments over time.

The second hypothesis uses as a basis the study of Tomazzia and Meurer (2009). The authors investigated the impact of monetary policy in the industrial sectors from 1999 to 2008 and concluded that the production is directly influenced by monetary policy employed and its effect on productive activity is perceived in the long run, from less than two years after its implementation and that a restrictive monetary policy tends to reduce demand for goods. The following assumptions can be described as:

H_{2a}: A tight monetary policy reduces the performance of the automotive sector.

H_{2b}: An expansionary monetary policy contributes to the performance of the automotive sector.

The third hypothesis has been prepared based on studies of Nakabashi, Cruz and Scatolin (2008) and Nunes, Costa Júnior and Meurer (2005) that investigated variations in the performance of sectors in relation to monetary policy employed by the government. Nakabashi, Cruz and Scatolin (2008) analyzed, from 1996 to 2008, the export performance of Brazilian industries in relation to exchange rates, interest rates and global growth.

Variables	Characteristic	Operationalization of variables	Source
Monetary Base	Independent	When the volume of the monetary base of the composition increases, banks and people have higher currency reserves, this fact offers conditions for banks to invest in the auto sector and people show a greater willingness to spend	Measured by the Central Bank (2014 b)
GPD	Independent	The higher the GDP, the greater the wealth in this economy and more significant becomes the performance of this sector	Brazilian Institute of Geography and Statistics (IBGE)
NPSD	Independent	Consider the balance between debts and credit the public sector (non-financial) and the Central Bank. For the automotive sector, the higher the balance of the accounts, may be the best performance of the industries in the sector	Measured by the Central Bank (2014c) e Simonassi (2007)
Interest Rate (SELIC)	Independent	A reduced interest rate allows credit enhancement, increased consumption and increased investment by businesses	Measured by the Central Bank (2014a)
Unemployment rate	Independent	The unemployment rate is an important indicator of how is the level of economic activity in the country and that restrictive policies usually lead to higher unemployment	Brazilian Institute of Geography and Statistics (IBGE)
Exchange rate	Independent	Changes in the exchange rate affects the exports and industrial imports, and the liquidity of the economy when encourages or discourages the entry / exit of foreign currency	Measured by the Central Bank (2014d)
Inflation	Independent	High inflation makes it difficult to create new investments by companies as the market remains in an uncertain environment and risk	General Price Index (IGP) - Getulio Vargas Foundation
Reserve Requirements	Independent	The higher reserve requirements, the lower the availability of credit in the economy and the lower the reserve requirements, increased credit availability	Measured by the Central Bank (2014a)
Tax on Industrialized Products (IPI)	Dependent	The reduction of such a rate warms the industry as it induces the increased consumption	Federal Revenue (2014d)
Automobile Production	Dependent	The sector's production is usually related to the level of demand. It is understood that this production level is positively related to industry performance.	Institute of Applied Economic Research (IPEA)
Automobile exports	Dependent	It depends on variables such as exchange rates, government incentives and external demand. This variable is linked to the performance of the sector.	Institute of Applied Economic Research (IPEA)

Table 3. Operationalizing the research variables

They concluded that segments based on work, have not profited from the macroeconomic policies adopted, not even by the growth of the rest of the world. The export segment based on science has not had problems with exchange rate and not with interest rates increases, helping to explain its good performance in the period. Nunes, Costa Júnior and Meurer (2005) studied the relationship between macroeconomic variables and the returns of the Ibovespa index of companies listed on the São Paulo Stock Exchange after the implementation of the Real Plan. The results showed a positive relationship between inflation and economic activity and that inflation rate impacts the real interest rate.

H_{3a}: there are variations in the performance of the automotive sector related to monetary policy employed over 20 years.

H_{3b}: there are not variations in the performance of the automotive sector related to monetary policy employed over 20 years.

Data from this study are characterized as temporary, thus, the method used was the econometric to the analysis of time series with the help of the statistical software Give-Win version

2.20. When data is configured as series of temporal nature, these consist of a set of observations regarding a variable weight at different time points, which can be daily, weekly, monthly, bimonthly, quarterly, biannually, annual, between others (Gujarati, 2004). Through these observations over time, inferences about the future behavior of these variables can be inferred, based on their past behavior.

The data analysis was performed through descriptive statistics, plotting the graphs to verify if the series had a trend, the Dickey-Fuller Expanded test (ADF) and the AIC to examine the stationarity of variables. It estimated the long-term regression as dependent variables the production and export, the ADF and AIC test was performed to examine the stationarity of the residuals of the regression and, finally, the degree of association between the variables of monetary policy and the automotive sector, through the correlation coefficient.

4. Discussion and Data Analysis

Initially we generated descriptive statistics of the variables related to monetary policy and the automotive sector. For that, we considered the year, the month, the interest rate SELIC, the Reserve Requirements in cash or term, the Monetary Base, GDP, Unemployment Rate, the Real Exchange Rate against the US dollar, the inflation rate, the NPSD, and the automotive sector Production, Exportation and the Tax on Industrialized Products (IPI). Table 4 shows the results of 241 observations.

Some variables were dispersed in its minimum and maximum values, while others kept a degree of stability. The unemployment rate had its lower rate of 6.9 and its maximum value was 13.6. Thus, there were times when the policies employed by the Brazilian government can have helped reduced this index, however, at other times it contributed to its increase. Cruz, Angels and Sáfiadi (2014) point out that the unemployment rate may be coupled with social and economic phenomena by which a country faces and the policies adopted by the government.

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
Year	241	2.004041	5.823.653	1994	2014
Month	241	6.502.075	3.452.203	1	12
Interest rate (SELIC)	241	1.485.394	0.8790743	0,49	6.87
Reserve Requirements - in cash	241	0.546888	0.1648707	0,42	1
Reserve Requirements - term	241	0.1614523	0.0665642	0	0.30
Monetary Base	241	114.773	0.8743515	9,22	12,73
GDP	241	1.196.515	0.6384983	10,62	12,99
Unemployment Rate	241	1.023.942	1.484.048	6,90	13,60
Exchange	241	9.060.257	2.061.402	65,56	147,44
Inflation	241	0.7623237	2.155.945	-0,52	32,45
NPSD	241	1.300.838	0.8338092	11,08	13,95
Production (automobile)	241	1.186.332	0.361146	10,80	12,46
Exportation (automobile)	241	9.830.788	0.8097771	7,01	10,90
Tax on Industrialized Products IPI (automobile)	241	2.569.378	1.702.582	20,43	751,95

Table 4. Descriptive statistics of the variables of monetary policy and the automotive sector
Source: Research data.

Variable exchange rates fluctuated between 65.56 and 147.44 and indicate the times when the exchange proved devalued while the Brazilian currency valued. These variations occurred mainly in situations where the United States went through a time of recession.

In 20 years of government policies, the inflation rate was negative (-0.52), mainly concentrated in 1998, and positive (32, 45). Government policies in 1998, favored the economic development of Brazil while other times when inflation was high, the country presented a smaller

development. The volatility of inflation was studied by Vieira (2013) considering the periods from 1939 to 2013. The author found that there is a positive correlation between inflation rate volatility of the and the money velocity and that implementation of the *Plano Real* in 1994 reduced inflation, however, between 2003 and 2007 inflation rate presented greater volatility (Vieira, 2013).

The variable export the automotive sector reveals that there was an increase from 7.01 to 10.9. This may be related to government policies to expand the Brazilian market and economic development. The IPI had a minimum range of 20.43 and a maximum of 751.95.

When working with time series is necessary to make the trend test to see if the series over time, present trends. Thus, graphs were plotted for each variable. Figure 1 shows the results.

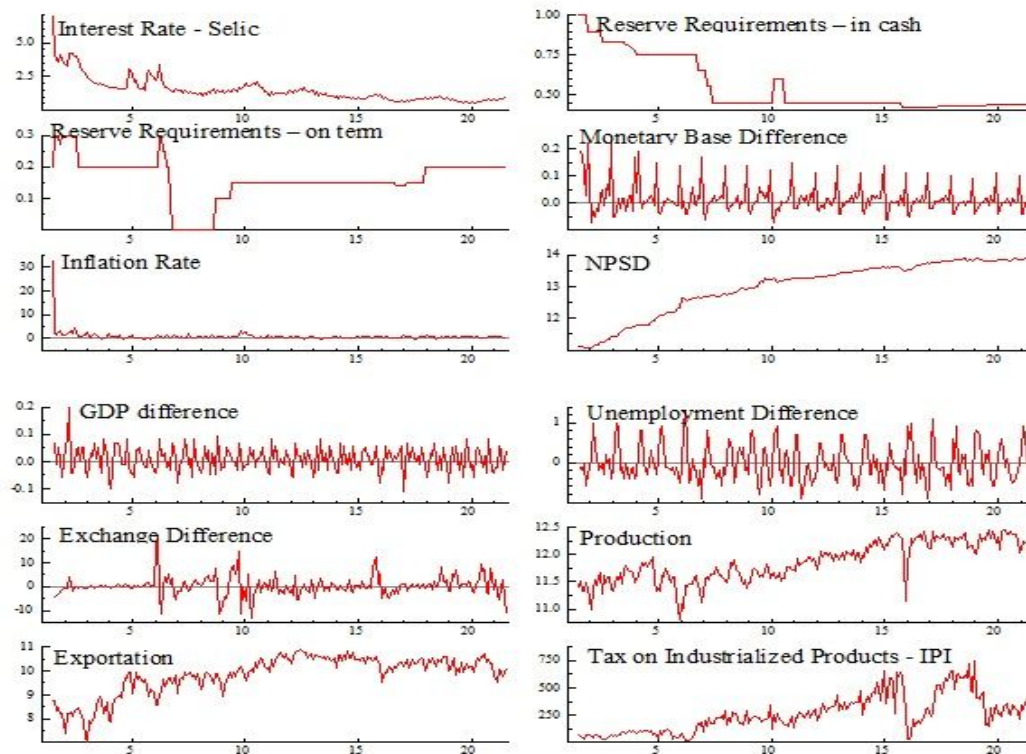


Figure 1. Trend of research variables
Source: Research data

Initially it was verified the stationary condition of the time series, which need to be stationary, and it was found that the variables Monetary Base, GDP, Unemployment Rate and Exchange Rate showed non-stationary behavior. Thus, the variables were transformed by applying the logarithm of the difference. After performing this test, all variables became stationary and then confirmed by the completion of the Dickey-Fuller test Expanded (ADF) or unit root test and the value of the AIC, it was found that all series are stationary. The ADF results are shown in Table 5.

Variables	ADF test	Variables	ADF test	Variables	ADF test
Interest Rate - SELIC	-3.059*	GDP	-1.206*	NPSD	-4.083*
Reserve Requirements - in cash	-3.141*	Unemployment	-2.413*	Production	-3.476*
Reserve Requirements - on term	-2.469*	Exchange	-0.9883*	Exportation	-3.057*
Monetary Base	-2.025*	Inflation	-7.588*	IPI	-3.967*

Table 5. Expanded Dickey-Fuller test (ADF)
Source: Research data.

Considering that the estimated t-ADF values (1% = 3.46) and critical t-ADF (5% = 2.87) were significant at 1% and 5% can be said that the series is stationary. In order to verify the degree of association between the variables of monetary policy and the automotive sector were calculated the correlation coefficient. Table 6 shows the results:

Variables	SELIC	Requirem In cash	Requirem On term	Monet. Base	GDP	Unempl.	Exchang e	Inflation	NPSD
SELIC	1,000								
Requirem in cash	,835	1,000							
Requirem on term	,392	,475	1,000						
Monetary Base	-,703	-,704	,084	1,000					
GDP	-,690	-,684	,103	,993	1,000				
Unemploy	,095	,045	-,335	-,555	-,547	1,000			
Exchange	-,319	-,454	-,230	,372	,383	,117	1,000		
Inflation	,535	,297	,124	-,164	-,167	-,098	-,024	1,000	
NPSD	-,759	-,820	-,030	,965	,956	-,397	,388	-,195	1,000

Table 6. Correlation coefficient of the variables
Source: Research data.

The variables with the highest correlation coefficient were the monetary base to GDP (0.993) and the NPSD (0.965), the GDP with the NPSD (0.956), the interest rate (SELIC) and the Reserve requirements in cash (0.835) and inflation (0.535). This result indicates that those variables are directed in the same way, or that there is a direct correlation. The net public sector debt is correlated with other variables because of the fact that it is directly related to the tax revenues of municipalities, states and the federation.

The opposite can also be observed, as other variables showed negative correlation coefficients indicating occasions when these relations were indirect therefore did not follow in the same direction. These associations are mainly represented by the variables: SELIC with Monetary Base (-0.703), with GDP (-0.690) and the NPSD (-0.759). The Reserve requirements in cash to be associated with the NPSD (-0.820), with the monetary base (-0.704) and GDP (-0.684).

Regarding the monetary variables employed by the government, it was found that there is little cohesion between the instruments adopted by it, accepting the hypothesis 2 because, variables such as requirements, the view was associated negatively with the Monetary Base, indicating indirect correlation between them.

Long-term regression was estimate for the dependent variables Production and Export, related to the automotive sector. Table 7 shows the results for production as independent variable.

The regression results indicate that the performance of the automotive sector, represented by the variable production is influenced proportionally by the Reserve Requirements variables and the GDP difference. This result suggests that when these variables are growing or have positive values, the production of automobile sector also increases. On the other hand, some variables affect

the production of this sector in reverse order, they are: the interest rate (SELIC), the Reserve Requirements in cash and the difference of the Monetary Base.

Variables	Coefficient	Standard deviation	T-Value	T-Prob	R ²
Constant	12.9379	0.7941	16.3	0.000	0.5369
Interest rate - Selic	-0.262785	0.03276	-8.02	0.000	0.2193
Reserve Req - in cash	-0.727423	0.2563	-2.84	0.005	0.0340
Reserve Req - on term	2.24418	0.2562	8.76	0.000	0.2510
Inflation	0.0198412	0.02125	0.93	0.351	0.0038
NPSD	-0.0632513	0.05299	-1.19	0.234	0.0062
Monetary base difference	-0.576464	0.2650	-2.18	0.031	0.0203
GDP Difference	1.61195	0.2824	5.71	0.000	0.1246
Unemployment Difference	-0.0312495	0.02971	-1.05	0.294	0.0048
Exchange Difference	-0.00374357	0.002930	-1.28	0.203	0.0071
Tax on Industrialized Products - IPI	0.000582514	0.0001021	5.71	0.000	0.1245

Table 7. Regression coefficient with the dependent variable Production
Source: Research data

The model R2 coefficient indicates that 76.36% of the variation in production of the automotive industry is explained by monetary variables that showed significant. Thus, the regression equation can be described as follows:

$$\text{Change Production} = 12,938 (\text{Constant}) - 0,2628 (\text{Selic}) - 0,7274 (\text{Reserve Req in cash}) + 2,244 (\text{Reserve Req on term}) - 0,5764 (\text{MonetBaseDif}) + 1,6119 (\text{GDP Dif}) + 0,000582(\text{tax - IPI})$$

The regression was also estimated variable for the export and the results are shown in Table 8. The export performance of the automotive sector has a positive relation with the interest rate (SELIC), NPSD, GDP and IPI difference. When these monetary variables have increase in its rates there is also increase in the export performance of the sector. On the other hand, the Reserve Requirements in cash, Inflation and Unemployment Rate difference, showed an inverse relationship with exports. This result indicates that, with regard to reserve, lower requirements lead to greater availability of money and more likely exports to occur. As for inflation, the relationship is explained by the increase in imports and direct impact on the exchange rate. The unemployment rate, in turn, has an inverse relation that is explained as higher exports creates more jobs, or lower rates of unemployment.

Variables	Coefficient	Standard deviation	T-Value	T-Prob	R ²
Constant	1.00904	1.617	0.624	0.533	0.0017
Interest rate - Selic	0.284825	0.06670	4.27	0.000	0.0738
Reserve Req - in cash	-1.16035	0.5217	-2.22	0.027	0.0211
Reserve Req - on term	-0.725153	0.5216	-1.39	0.166	0.0084
Inflation	-0.252165	0.04326	-5.83	0.000	0.1292
NPSD	0.705547	0.1079	6.54	0.000	0.1574
Monetary base difference	0.118450	0.5394	0.22	0.826	0.0002
GDP Difference	1.74467	0.5749	3.03	0.003	0.0387
Unemployment Difference	-0.111657	0.06049	-1.85	0.066	0.0147
Exchange Difference	-0.00824112	0.005964	-1.38	0.168	0.0083
Tax on Industrialized Products - IPI	0.000454438	0.0002078	2.19	0.030	0.0205

Table 8. Regression coefficient with the dependent variable Export
Source: Research data.

These results reject the hypothesis 1a and confirm the hypothesis 1b that there is no cohesion between the monetary policy instruments over time. Some variables with expansionist characteristics caused reductions in the sector's performance, on the other hand, there were also moments that the policy of the Brazilian government caused an increase in the export performance, while reductionist policies that restricted the number of outstanding money supply impacting negatively on their performance.

The model R2 coefficient indicates that 80.51% of the variation in exports of the automotive industry is explained by the significant variables. Thus, the regression equation explains the model is:

$$\text{Change Exportation} = 1,001(\text{Constant}) + 0,2848 (\text{Selic}) - 1,1603 (\text{Reserve Req in cash}) + 1,7446 (\text{GDPDif}) - 0,2521 (\text{Inflation}) + 0,7055 (\text{NPSD}) + 0,00045 (\text{tax} - \text{IPI})$$

The results obtained by the estimates of the regressions both for production and for export, offer evidence to confirm the hypotheses 2a and 2b, implying that a tight monetary policy reduces the growth performance and exporter of the automotive sector and, on the other hand, a expansionist monetary policy increases the performance of the automotive sector. In addition, this result provides evidence to confirm the hypothesis 3a that there are variations in the performance of the automotive sector across the employed monetary policy over the years, therefore, it was rejected H3b that there is no variations in sector performance automotive relative to monetary used over 20 years.

After estimated regression was carried out the test or ADF unit root test to verify the stationarity of the waste and the results indicated that there is integration between sets since the residuals were stationary, confirming the model used in this study.

The Table 9 shows a summary of the findings of this study, with the accepted and rejected hypotheses.

Hypothesis	Results	Coefficient
<i>H_{2a}: There is cohesion between the monetary policy instruments over time</i>	Rejected	Correlation Coefficient negative with Monetary Base (-0.704) and GDP (-0,684)
<i>H_{2b}: There is no cohesion between the monetary policy instruments over time</i>	Confirmed	
<i>H_{2c}: A tight monetary policy reduces the performance of the automotive sector</i>	Confirmed	Regression coefficient with production: Selic: 0,2628; Reserve Req on term: 2,244; MonetBaseDif: - 0,5764; tax -IPI: 0,000582 Regression coefficient with export: Selic: 0,2848; Reserve Req in cash: 1,1603; Inflation: -0,2521; NPSD: 0,7055; tax - IPI: 0,00045
<i>H_{2d}: An expansionary monetary policy contributes to the performance of the automotive sector</i>	Confirmed	Regression coefficient with production GDPDif:: 1,6119; Reserve Req in cash: - 0,7274; GDPDif (export): 1,7446
<i>H_{3a}: there are variations in the performance of the automotive sector related to monetary policy employed over 20 years</i>	Confirmed	Change Production = 12,938 (Constant) - 0,2628 (Selic) - 0,7274 (Reserve Req in cash) + 2,244 (Reserve Req on term) - 0,5764 (MonetBaseDif) + 1,6119 (GDPDif) + 0,000582(tax -IPI)
<i>H_{3b}: there are not variations in the performance of the automotive sector related to monetary policy employed over 20 years</i>	Rejected	Change Exportation = 1,001(Constant) + 0,2848 (Selic) - 1,1603 (Reserve Req in cash) + 1,7446 (GDPDif) - 0,2521 (Inflation) + 0,7055 (NPSD) + 0,00045 (tax - IPI)

Table 9. Summary of accepted and rejected hypotheses and regression coefficients

5. Final Considerations

This study aimed to analyze the performance of the automotive sector across the monetary policy employed by the government over 20 years, between 1994 and 2014. The results suggest that over the years the performance of the automotive sector was configured, at times, as inconsistent with the essence of its monetary policy instruments, so in some situations these variables should act as expansionary or restrictive but its effect caused otherwise. On the other hand, there were times when it acted consistently, to contribute to the industry's best performance. In general it was found that production in the automotive sector is positively influenced by monetary policy decisions, especially those related to the reserve requirement. The Tax on Industrialized Products - IPI, while economic policy, was also considered significant, since this tax reduction boosted the automotive sector. About the relationship found between GDP and production, we can say that expansionary policies increase the performance of the sectors, especially the automotive sector. On the other hand,

the variables that showed greater impact on exports were the interest rate (SELIC), GDP, NPSD and the Tax on Industrialized Products - IPI. Increases in the interest rate (SELIC), could negatively affect the automotive sector, reducing consumption and investments. Other indicators were also significant for production and exports in the automotive sector.

We conclude that in the period analyzed some monetary policy instruments adopted showed no cohesion, however, some monetary variables were linked to the economic variables and the industry. This may be linked to the Brazilian system of democracy, characterized by being ruled by politicians of different parties, which due to certain interests can prioritize different types of instruments in its management. For this reason the automobile industry receives direct impact of the actions taken by the government, mainly demonstrated by variations in terms of performance.

This study is relevant because there are not other studies that analyze the performance of the automotive sector combined with the variables that make up the monetary policy employed by the Brazilian government, as well as economic and industry indicators. Thus, the theoretical contribution is based on the behavior of monetary, economic and industry variables. Yet, as research contribution, it was found clues about how a more restrictive or more expansionary policy can impact the performance of the automotive sector.

This study is limited because it examines the monetary policy from a set of variables that impact on the Brazilian automotive industry. We chose not to include other monetary variables that could also influence the performance of the sector. For future research, we suggest the analysis of the automotive sector's performance related to other types of economic policies adopted by the Brazilian government, such as tax and exchange rate policy. Moreover, studies may consider the performance of other sectors allied to government policies

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