Tarciso Gouveia da Silva

Three Essays on Monetary Policy and Financial System

Rio de janeiro, Brazil

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Three Essays on Monetary Policy and Financial System

A thesis submitted to the Universidade Federal do Rio de Janeiro in fulfillment of the requirements for the degree of Doctor of Philosophy in Economics

Universidade Federal do Rio de Janeiro – UFRJ

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This thesis is dedicated to my beloved family:
specially my son, my wife, my mother and to the memory of my father, for their sacrifices and support through my education.

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"But the wisdom that comes from heaven
is first of all pure; then peace-loving,
considerate, submissive, full of mercy
and good fruit, impartial and sincere.
(Holly Bible, James 3, 17)

Abstract

GOUVEIA DA SILVA, Tarciso. Three essays on monetary policy and financial system. Thesis (Ph.D in Economics): Economics Institute of Federal University of Rio de Janeiro, 2018.

The thesis is composed of three essays on the theme of monetary policy and its impacts on the financial system. The first essay presents and discusses the legal theory of finance as a new proposal to analyze the role of monetary policy, especially the central bank as lender of last resort, with the main objective of ensuring stability of the financial system. It concludes that there is an open research agenda that can explore the relationship of this theory in the rule-based versus discretionary monetary policy debate with new elements that involve the discretionary performance of the monetary authority. The second presents an empirical exercise and analysis of the effects of the reports linked to the performance of the Central Bank of Brazil in its sole mandate, to control inflation. With daily data between January 2006 and May 2017, the econometric analysis is based on the estimation of a VAR-GARCH model. The results can be summarized as follows. Negative and positive news did not have a significant impact on volatility of equity prices (Ibovespa) and exchange rate (BRL) before and after the crisis. In addition, the conditional correlation between these variables and negative news increased in absolute value during the global financial crisis. These results, therefore, show that monetary policy rules can be sources of volatility in the financial system by indicating deviation by the monetary authority from its mandate. The third and final essay analyzes the international spillover effects and transmission channels of the Fed's unconventional monetary policy for Brazil in particular. The global VAR method is used to evaluate the impact on stock prices, inflation, exchange rate, yield on 10-year sovereign bonds and international reserves. The results suggest that there is indeed an international spillover effect resulting from these policies, by different transmission channels. Finally, we find evidence that the impact of unconventional policies on Brazil was limited, in the short run, because during these periods unconventional measures were also implemented in Brazil.

Keywords: Monetary Policy. Financial System. Time Series.

Resumo

GOUVEIA DA SILVA, Tarciso. Três ensaios em política monetária e sistema financeiro. Tese (Doutorado em Economia): Instituto de Economia da Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2018.

A tese é composta de três ensaios que possuem como tema a política monetária e seus impactos sobre o sistema financeiro. O primeiro ensaio apresenta e discute a Teoria Legal das Finanças, como uma nova proposta para se analisar o papel da política monetária, sobretudo a atuação do Banco Central como emprestador de última instância cujo objetivo principal é garantir a estabilidade do sistema financeiro. Se conclui que há uma agenda de pesquisa aberta que pode explorar a relação desta teoria no debate regra versus discricionariedade da política monetária com novos elementos que coadunam com a atuação discricionária da Autoridade Monetária. O segundo se refere a um exercício empírico e faz uma análise dos efeitos das notícias vinculadas à atuação do Banco Central do Brasil no seu único mandato, controlar a inflação. Com dados diários entre fevereiro de 2006 e maio de 2017, a análise econométrica é baseada na estimação de um modelo VAR-GARCH bivariado para dois indicadores: taxa de câmbio e índice de ações. Os resultados podem ser resumidos como se seguem. As notícias têm impacto irrelevante sobre o comportamento da média e da variância dos retornos da taxa de câmbio (BRL) e do índice de ações (Ibovespa). Todavia, a correlação condicional entre estas variáveis e as notícias negativas aumentou em valor absoluto durante a crise financeira global. Esses resultados, portanto, trazem a discussão que regras de política monetária podem ser fontes de volatilidade no sistema financeiro ao indicar um desvio da autoridade monetária sobre o seu mandato. Já o terceiro e último ensaio analisa os efeitos transbordamento internacionais e os canais de transmissão das Políticas Monetárias não Convencionais do Fed para o Brasil em particular. A metodologia Global VAR é utilizada para avaliar investigar os impactos sobre os preços das ações, a inflação, a taxa de câmbio, o rendimento dos títulos soberanos de dez anos e as reservas internacionais. Os resultados sugerem que de fato há um efeito transbordamento internacional resultante destas políticas, por diferentes canais de transmissão. Finalmente, encontramos evidências que o impacto das políticas não convencionais sobre o Brasil teve efeito limitado, concentrado no curto prazo, porque durante estes períodos medidas não convencionais também foram implementadas no país.

Palavras-chave: Política Monetária. Sistema Financeiro. Séries Temporais.

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List of abbreviations and acronyms

AIC	Akaike Information Criterion
BCB	Brazilian Central Bank
CB	Central Bank
CDS	Credit Default Swaps
CPI	Consumer Price Index
ECMH	Efficient Capital Market Hypothesis
EMH	Efficient Market Hypothesis
GIRFs	Generalized Impulse-Response Functions
GVAR	Global VAR
ITR	Inflation Targets Regime
LTF	Legal Theory of Finance
LLR	Lender of Last Resort
MA	Monetary Authority
NMC	New Macroeconomic Consensus
OMO	Open Market Operations
PKT	Post-Keynesian Theory
QTM	Quantity Theory of Money
REH	Rational Expectations Hypothesis
TBI	Tax Based Income
TR	Taylor Rule
US	United States
UMP	Unconventional Monetary Policy
VAR	Vector Autoregression
VIX	Volatility Index

Contents

Introduction

This thesis is composed of three independent essays that have a logical sequence and form a cohesive set around a common denomi-nator: the relationship between monetary policy and the financial system. The first essay discusses the Legal Theory of Finance and its pillars, giving a new order to the debate on the performance of the monetary authority, presenting a whimsical theory whose counterpoint challenges the conventional thinking of mainstream economists.

The second essay consists of an empirical investigation using the VAR-GARCH model for daily data between January 2006 and May 2015, in order to evaluate the impact of positive and negative news on the central bank's performance regarding the financial system, represented by stock returns and exchange rates before and after the global financial crisis of 2007-09. The underlying hypothesis is that the rigidity of the inflation targeting regime (ITR) is a driver of volatility in the financial and capital markets. However, during this period the Brazilian government and the Central Bank of Brazil adopted a series of macroprudential measures that may have influenced the volatility and thereby softened its behaviour during the crisis.

The third essay undertakes an empirical analysis of the international spillovers effects and their impacts on the Brazilian financial system stemming from the Fed's unconventional monetary policy (UMP). In general, we find as short term effects the immediate increase of asset prices and decrease of interest rates, which therefore contribute to better global liquidity conditions.

With the spillovers of the global financial crisis of 2007-09, the debate was not only restricted to the escope of financial regulation, which was permissive and inneficient. In addition, there was also substantial breakthrough, both in academia and by policymakers, regarding the role of monetary policy, and of central banks (CBs) in particular.

In this context, in a setting of urgency there was a strong movement to implement a broad set of unconventional policies, resulting in the revision of the new macroeconomic consensus (NMC) by mainstream economists. This set of measures did not mean changes in hypotheses and theoretical models that threatened the essence of the NMC. Although risk management policies and (macroprudential) financial policies were incorporated, both were classified as new monetary policy instruments, but subordinated to the ITR, where inflation is the main objective, with the short-term interest rate as an operational target of the CB. In short, there was no room for a discretionary monetary policy in this conventional view.

The first essay presents and discusses the Legal Theory of Finance (LTF), proposed

by Katharina Pistor in 2013 and seeks to include it in the debate between rules and discretion of monetary policy, identifying points of convergence to this discussion. This new theory strengthens the discussion by bringing in new elements that have escaped the scope of traditional theory and advances a multidisciplinary agenda that unites economics and law.

The motivation for the first essay arises from the recognition of the absence of important elements in the discussion of rule-based versus discretionary monetary policy. In this context, the current in favor of a rule-based monetary policy completely ignores the legal, institutional and power relations that could make it part of the scope of monetary policy. In fact, the UMPs could not be submissive to the ITR, which would give the central bank the role of lender of last resort (LLR), and consequently greater discretion.

The essay concludes that the LTF largely converges to this debate. In a way, the LTF gives new substance to the rule versus discretion debate of monetary policy, incorporating legal elements such that the result is a bias of political economy. Thus, there is acknowledgment that the financial system is unstable and that the state's or CB's performance is fundamental to keep the system healthy.

The second essay performs an empirical analysis of the effects of the news involving monetary policy on the financial market. Through the VAR-GARCH method, with daily data between January 2006 and May 2017, we evaluate the impact of the market's perception of CB performance, notably in relation to the mandate to bring inflation down to the central target (ITR) before and after the global financial crisis, as measured by three financial variables: (i) stock prices; and (ii) exchange rate. To evaluate market perception, we develop a positive and negative news index, based on Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018), with daily data on the CB's performance in the conduction of monetary policy.

Besides contributing to the empirical literature by estimating a bivariate VAR-GARCH (1,1) model to examine the effects of both positive and negative news on assets prices, the motivation of this essay stems from the fact that a CB with a single mandate, as in Brazil, within the RTI may cause market volatility and have important implications, such as a long-term interest rate inertia. In other words, to the extent the CB is unable for some reason to achieve its objective, the market quickly corrects asset prices, forcing monetary policy to react. In other words, the CB (principal) ends up being captured by the market (agent).

This second essay concludes that news do not have relevant impact on the behavior of the market, measured by the return of the two indexes that represent prices of assets in the Brazilian economy. The hypothesis underlying this evidence lies in the foreign exchange market and implementaion of macroprudential policies.

This represents new evidence of the role played by uncertainty (as proxied by conditional volatility) in this context. Of particular note is the finding that the Brazilian market became even more sensitive compared to the pre-crisis period. The links between the news on monetary policy and the financial market clearly became stronger in Brazil in this new financial context, a finding that indicates the need to include other unconventional elements in the CB's mandate, outside the ITR, providing greater discretion to monetary policy.

Finally, the third essay investigates the overflow effect in the global economy of UMPs implemented in the US by the Fed, as a way to mitigate the deleterious effects of the global financial crisis of 2007-09. It also analyzes how these policies affected Brazil's financial market.

In contrast to the previous specialized literature, the third essay focuses only on the developments in asset prices, measured by financial variables. In this sense, instead of using the oil price as a global variable, we propose to use the spread between the yields of ten-year and three-month government bonds.

For this investigation, we used the Global VAR (GVAR) method, developed by Pesaran, Schuermann e Weiner (2004) and Pesaran, Smith e Smith (2005), to evaluate the effects of Fed UMPs on global markets in general and Brazil in Brazil particular. In this sense, we evaluate how and by what transmission channels the negative shocks on the spread of American securities propagate on: (i) inflation; (ii) the country risk; (iii) stock prices; (iv) the exchange rate; (v) international reserves; and (vi) ten-year government bond yields. To understand these effects during the crisis, the sample comprises the period between 2007 and 2014, with monthly data for the variables used in the GVAR model.

We find that the results were disseminated in global markets, but with a wide effect on the variables, which indicates that the unconventional measures affected the variables in these regions, in line with the result found in the literature. In relation to Brazil, the main objective of this analysis, we find that the Fed UMPs affected all variables, as expected, with emphasis on 10-year treasuries, stock prices, inflation and country risk.

Finally, the overall aim of the thesis is to contribute to research in the field of monetary and macrofinance economics, bringing to the center of the debate new theoretical and empirical elements that contribute to rethink the role of monetary policy, whose objectives should prioritize social welfare. Moreover, it is not our pretense to exhaust the theme, but rather to broaden the debate by adding other elements mainly absent in mainstream thinking, such as institutional, legal and power relations, which in turn will give voice to unconventional policies and greater maneuvering room for CBs to act in favor of the common good of society.

1 The Law-Monetary Policy Paradox: the rules versus discretion of monetary policy debate in the legal theory of finance

Introduction

After the outbreak of the global financial crisis of 2008-09, there was a strong advance in the literature on the role of central banks (CB) in the conduction of monetary policy. Since then academics and policymakers have been reassessing the theoretical foundations and operational procedures of economic policy in general, and monetary policy in particular. Special attention has been paid to monetary policy operability in a discretionary manner, such as through the so-called unconventional policies, also known as macroprudential policies.

Regarding macroeconomic policy, the crisis revealed the weaknesses of the conventional theoretical and normative framework regarding the definition of monetary policy objectives and instruments, as well as raising regulatory issues. In this sense, the predominant view before the crisis was that monetary policy had as its main objective the control of inflation in the short term, using rules and the interest rate instrument. Indeed, after almost a half century, there was a broad consensus, notably among scholars, that policymakers' decision should be aligned with pre-established rules Kocherlakota (2016).

This consensus was perhaps strongest in monetary economics, basically due to two seminal works. Kydland e Prescott (1977) defended the implementation monetary policy rules to correct the problem of temporal inconsistency, which according to them is caused by nominal rigidity, with undesirable consequences to welfare. From an empirical perspective, Taylor (1993) targued that Fed decisions guided by monetary rules (given the current state of the observed economy) should be associated with good macroeconomic performance. These two papers:

> (. . .) have had enormous influence in both academic and policy circles. Most academic papers in monetary economics treat policymakers as mere error terms on a pre-specified feedback rule. Most modern central bankstaffs model their policymaker bosses in exactly the sameway. [Kocherlakota (2016, p.1-2)]

Indeed, when the crisis hit the US market, the Fed was forced to act as a lender of last resort (LLR), with no clear evidence of how to act (discretionary), since this subject had been absent from the theoretical discussions of monetary policy in previous years

and the macroeconomic consensus framework prevailed. What remained, therefore, was pragmatism, and the Fed began to improvise with tools and initiatives to contain the spread of the crisis and preserve financial stability, aggressively expanding liquidity in the economy Kocherlakota (2016).

The crisis, therefore, cast doubt on what academics and policymakers believed to be the correct way to conduct monetary policy. In this case, financial regulation was not part of the scope of monetary policy. And, despite being restricted to the academe, it ended up influencing CBs' actions. The crisis widened the restricted terms in which the mainstream thinking had placed the role of the monetary authority (MA) in the debate regarding the objectives to be pursued and the instruments which can and should be used, particularly regarding two main themes: performance of CBs as LLR and the behavior in face of the risk asset deflation.

In this sense, there was a resurgence of the debate between rule-based and discretionary monetary policy. Although this discussion was old, new elements of the concern over CB action to mitigate risks of systemic crisis and aspects of political economy gained credence in the debate, especially with the emergence of new theoretical frameworks, such as the legal theory of finance (LTF), the subject of this essay.

In addition, the global financial crisis and the great recession that ensued required policymakers to implement a range of unconventional economic policies, also known as macroprudential policies, which resulted in revision of the new macroeconomic consensus (NMC) by the mainstream. The proposals have been diverse, ranging from direct monetary policy to financial stability (financial stability is price stability), including relaxation of the inflation targeting regime (leaning against the wind vindicated) or its unrestricted reaffirmation (modified Jackson Hole consensus).

However, the NMC review was in fact a kind of *gattopardo* economics, since the hypotheses and theoretical models preserved the essence of the mainstream thinking Palley (2013). Although the NMC has reflected on and accepted market failures, notably in financial markets, with the inclusion of financial and risk management policies in the scope of monetary policy, the main objective remains long-term inflation targeting.

Given the above, more discussion of the role of the monetary authority with duties beyond maintaining price stability, particularly deterring and dealing with crises, is urgent. In this sense, new theories that seek to provide analytical elements for understanding the dynamics of financial markets and their phenomena need to be examined regarding their contributions and limitations.

There has been a resurgence of the debate between rule-based and discretionary monetary policy. Although this discussion is old, new elements of central banks' actions to mitigate risks of systemic crisis and aspects of political economy have gained credence in

the debate, especially with the emergence of new theoretical frameworks such as the Legal Theory of Finance (LTF).

This chapter presents the LTF, as proposed by Katharina Pistor [Pistor (2013)], and identifies points of convergence with the rules versus discretion debate regarding monetary policy. The LTF brings two substantial elements that favor discretionary action by the monetary authority: fundamental uncertainty and liquidity volatility. These elements are associated with four pillars that support the theoretical foundation of LTF: (i) the legal framework of finance; (ii) the essential hybridity of finance; (iii) the elasticity of law; and (iv) the law-finance paradox. These last two pillars are essential to the convergence of the LTF to the debate between rule-based and discretionary monetary policy.

The LTF is a very recent theory so its literature is still limited. On the other hand, its multidisciplinary character, involving economics, law and political science, makes It accessible to these fields of research, and especially to multidisciplinary works (Reis e Vasconcelos (2016)). In addition, as claimed by Hodgson (2013), the emergence of the LTF has promoted a new institutional agenda, making it a real challenge to conventional economic theory, which fails by not incorporating elements from other social sciences. Deakin et al. (2017) concludes that the LTF represents an advance in the economic literature because of the endogenous nature of the laws on finance and the need to make them flexible, depending on the current state of the economy, as in the case of crises.

This essay aims to contribute to the literature by making connections between the LTF and the rules versus discretion of monetary policy debate and identifying the convergence of the LTF regarding CBs' discretionary actions in favor of stability of the financial system in general. The main conclusions of the chapter are threefold. First, liquidity volatility in conjunction with fundamental uncertainty makes financial markets intrinsically unstable, and the liquidity constraints that occur in times of crisis demand the CBs to act as LLR. Second, the LTF proposes to advance and update the debate between rule-based and discretionary monetary policy by drawing attention to the institutional aspects, power relations and legal concepts that are completely ignored by defenders of pure monetary policy rules. Third, there is room for a literature with multidisciplinary scope, aiming to advance the debate over economic policy, especially the role of monetary policy, incorporating elements of the LTF in the rule versus discretion debate and advancing the research agenda outside the scope of the mainstream, to provide a better understanding of the performance of the MA by prioritizing elements besides price stability.

The chapter is structured in five sections besides this introduction. The first recalls the longstanding debate between rule-based and discretionary monetary policy. The second presents a brief analysis of the theoretical assumptions and implications of economic policy in the post-crisis NMC review. The third presents the LTF proposed by Pistor. The fourth discusses the convergence of the LTF to the rule-based versus discretionary monetary

policy debate. Finally, the fifth presents the main conclusions of this chapter.

1.1 Rescuing the origins of the debate rules versus discretionary monetary policy

Although there is no historical precision, many authors argue that rules versus discretion debate goes back to the Roman Empire, but with stronger presence only since the Middle Ages Bertoldi (2009). Later, with the effects of the Napoleonic wars in Europe, the debate over economic policy, especially monetary policy, based on rules gained considerable space, even among politicians. This period was marked by a series of financial crises in which, after the emergence paper money as means of payment and the suspension of the gold standard by Great Britain in 1797, other monetary factors emerged at the heart of academic discussion. Among these were the nature of paper money, inflation, and the role of the financial system in the economy [Martins et al. (2007)].

In addition, at the end of the eighteenth century and during the nineteenth century, the rapid changes arising from the first and second industrial revolutions gave more momentum to the need for capital allocation. Since then, the banking system has played an even more relevant role in the development of the capitalist economy. At the end of the nineteenth century, two important discussions arose regarding monetary theory, involving its implementation and conduct, which later influenced the development of monetary theory: (i) the bullionist versus anti-bullionist; and (ii) the current school versus banking school [Bertoldi (2009)].

The first debate, also known as the Bullionist Controversies, had as theoretical background the discussion of monetary theory and policy that occurred in the so-called Restriction period (suspension of conversion of paper money into gold by the Bank of England from 1797 to 1821). This debate was between two groups: (i) the bullionists, especially represented by David Ricardo, Henry Thornton and John Wheatley, who defended the assumption that the rise in prices (inflation) was due to the poor performance of the Bank of England, and were therefore opposed to the Restriction; and (ii) the anti-bullionists, notably represented by Robert Torrens and John Stuart Mill, who believed that inflation was the result of conjunctural factors and thus advocated continuation of Restriction [Laidler (2000)].

In theoretical terms, two paradigms were used to describe the monetary effects on the eve of the Restriction, which were the Price-Species-Flow mechanism – widely adopted by the majority of bullionists – and the Real Bills Doctrine, whose foundation was defended by the overwhelming majority of anti-bullionists [Filho (2006)]. Still in a theoretical context, Filho (2006) draws attention to the situation at that time, from the perspective of the interpretation of monetary conditions by the British. For the bullionists, the main point

of the matter involved mercantilism, whereby the trade surplus accumulation was the source of precious metals. In contrast, for the anti-bullionists, it was precisely the opposite, based on the precepts of Adam Smith's Wealth of Nations, rebutting the idea that the accumulation of metals ad infinitum would necessarily lead to growing wealth and welfare.

The debate between the Currency School and Banking School was a continuation of the bullionist controversy. However, before entering this discussion, it is necessary to understand the conjunctural aspect that preceded it. Between 1816 and 1821, harking to the paradox of the previous century, precisely 1797, the deflationary adjustment was considered to be the main factor responsible for financial crises in England, which first broke out in 1825 [Martins et al. (2007) and Bertoldi (2009)]. This event prompted a new debate on monetary theory, also known as the Currency School vs. Banking School controversy. Those hewing to the first school thought that inflation was a problem of mismanagement by the Bank of England, a kind of monetary mismatch, and the result of excessive public spending. The Banking School proponents argued that monetary instability was the result of more complex issues.

According to Schwartz (1989), although there was a consensus among these schools regarding the (re)establishment and functioning of the gold standard, with full convertibility of paper money into gold, there were points of discord that led to this controversy, namely: (i) the matter of parity between banknotes and gold; (ii) discussion of the validity of real bills doctrine; (iii) the problem of overwriting banknotes; (iv) definition of currency; (v) the issue of the occurrence of business cycles; and (vi) operations of the central bank. Therefore, these points of discussion better pin down the debate between rules and discretion.

Indeed, for the Currency School, price stability was a necessary condition for the functioning of the economic system, regardless of whether it operates with a strictly metallic currency or a mixed situation composed of credit, paper money (or bills of exchange) and metallic currency. According to Schwartz (1989), with the flow of gold under a wholly metallic regime, the effects of increases and decreases in the means of payment in circulation would be immediate. In contrast, in a mixed (or mixed currency) regime, the result would be similar only if the gold inflows and outflows were fully offset by an increase or decrease in paper money. In addition, for the mixed regime, the Currency School believed that the change in relative prices and the fall in the gold reserve resulted from excessive issuance of banknotes by the BoE.

To avoid these problems, the Currency School advocated the implementation of effective rules in order to avoid both excess and insufficient banknote issuance. Thus, fluctuations in the value of money that could accentuate the cyclical trends of the economy would be avoided. However, the regulation should be restricted to banknote issues and not be extended to other banking activities (Schwartz (1989)).

Alternatively, Banking School proponents suggested that the effective functioning

of the monetary system would be achieved only by proper bank management, completely rejecting the imposition of rules on the issuance of banknotes by the BoE. That is, this current implicitly urged discretionary action by the monetary authority (Martins et al. (2007) and Schwartz (1989)).

According to Triches (2013), at that time there was strong pressure for maximization of profits by central banks, which were privately owned at the time, from issuing banknotes. In this respect, the BoE, as a private institution, was weakened as a monetary authority by the combination of banking and issuing activity, hampering its ability to control the amount of currency outstanding. In this sense, the activities of the BoE were simultaneously: (i) paper money issuance; (ii) public debt management; (iii) private banking activity; (v) custody of the England's gold reserves; and (vi) last-resort lending. As a result, its discretionary activity was substantially greater, which led to the implementation of a series of monetary policy rules from the second half of the nineteenth century onward.

The first, widely espoused by the Currency School, inspired by the bullionists, assigned to monetary policy the main task of convertibility of the pound into gold. The idea was to protect the economy against external shocks and increased government paper issuance, based on the belief that the central bank was primarily responsible for inflation. Given this monetary endogeneity, the solution supported maintaining the balance of the money supply according to the balance of payments, since the output of precious metals was responsible for reducing the domestic money supply.

The concern was associated with a mismatch of the flow of money in the form of paper and gold, which could culminate in a banking crisis. That is, the issuance of currency should perfectly match the movement of gold in and out of the economy. According to Triches (2013), the Currency School, following bullionist orientation, systematized the analysis of monetary issues with elements of quantitative currency theory. In addition, the school was a precursor in the definition of money stock as a monetary base, which in turn would lead to the implementation of rules (regulation).

For the *Banking School* members, this convertibility rule had proved to be inefficient in preserving price stability, so large issues of banknotes would not prevent bank crises. This was proven by the return of convertibility after the Napoleonic wars and successive banking crises [Triches (2013)].

Next, a monetary policy rule was implemented with the objective of making the monetary base passive to the exchange rate, that is, its regulation was bound by the external flow of the balance of payments. This rule was known as the "Palmer rule", whose operability was governed by a set of measures: (i) a cap on the interest rate and rediscount rate, so in times of crisis, the increase in the interest rate would necessarily imply an increase in the rediscount rate and thus maintain the credibility of the system; (ii) rigid administration of the BoE balance sheet, where one-third of the short-term liabilities

would be backed by currency, gold and silver and two-thirds would be represented by interest-bearing instruments; and (iii) giving a money issuance monopoly to the BoE.

However, the Palmer rule was not effective because of the inability of the BoE to strike a balance between the issuance of currency and the gold reserve. According to Triches (2013), the Currency School believed that the issuance of money was not able to promote long-term growth. A first impression of currency neutrality came from this school, where the intervention of the monetary authority was responsible for triggering economic disturbances rather than mitigating them. Hence, interventions were considered dangerous because in addition to being unable to protect reserves, they lacked credibility with the public.

In 1857, the Overstone rule was implemented. The underlying idea was to ensure convertibility in such a way that bank money and metallic money would be linked to gold reserves. With this, there would be a quantitative limitation on the money supply. The objective was to maintain the balance of payments in equilibrium, boost economic growth and make monetary policy neutral. In other words, monetary policy was restricted only to keeping market expectations stable (anchored).

According to Asso, Kahn e Leeson (2007), the Overstone rule achieved transparency. The belief was that more information to the public would bring peace to the market and increase confidence in economic policy. To this end, a new banking law was enacted to require regular disclosure of banks' reserve position and full backing of the monetary base with gold. In addition, any discretionary movement was closely monitored by Parliament.

Finally, the Bagehot rule – *lend freely at a high rate* –,was proposed by one of the leading scholars of monetary policy at the end of the nineteenth century, Walter Bagehot, who believed that an external drain would necessarily create an internal drain as the public perceived a fall in the gold stock and thereby feared suspension of convertibility, which would culminate in a race for conversion into gold. In this case, when the drainage was noted, the lender of last resort would lend at high interest rates.

The author defended the view that the rules should prioritize financial stability of the economy. In this case, the central bank would act as a LLR, whose function would be to maintain agents' confidence in the financial system and thereby guarantee stability of the banking system, even if it mean lower profits [Asso, Kahn e Leeson (2007) and Triches (2013)].

The Bagehot rule established that the central bank would act to buy assets to provide liquidity, and thus sterilize the impact of the loss of gold on the money supply when there was a sharp withdrawal of gold. The conduct of monetary policy, especially in England, was strongly influenced by Bagehot rule until the beginning of World War I, after which the gold standard lost its strength.

With the advancement of monetary theory in 1920s, the debate over rule versus discretion of monetary policy gained prominence in the development of monetary theory. In this sense, discretion was seen as a panacea against the structural weaknesses of the banking system. Therefore, its implementation was seen as justified by the fact that formulating appropriate policy rules to be followed by the CB would be a complex task. This view was strengthened by the severity of the depression of the 1930s. In this case, a prudential discretionary policy was seen as more appropriate than an automatic rule. This debate took place initially between Simons (1936) and Keynes (1982).

Keynes (1982), was acutely skeptical about the effectiveness of monetary policy with interest rate targets. His argument was that only discretionary macroeconomic policy could keep unemployment rate and the general level of prices stable or stationary. On the other hand, Simons (1936) developed a parity rule sustained by the idea of rigid prices and expectations. In this case, he used the assumption of price rigidity to construct a labor market model that was supported by expectations. This model of insiders and outsiders assumed that unions held power by imposing high costs of firms for worker turnover. Employees (insiders) protect themselves from competition from outsiders by establishing a higher wage cost. Unemployed workers are unable to return to the market due to lack job opportunities.

Until the global financial crisis, the period was marked by advance of the literature on the evolution of macroeconomic policies regarding the forward-looking behavior of the private sector. In other words, the individual decisions made in the present, which form the public consensus, strongly affect the design of future policies chosen ex-ante (at present).

Since economic policy decisions are made by the government and therefore affect the expectations of private agents, the nature of the economic problem is summed up in terms of credibility and reputation. This relationship between the state and the private sector led to the formulation of the hypothesis of rational expectations by the neoclassical school, which introduced this mechanism in optimization models. From then on, the models began to incorporate the impact of private decisions on the policy selected by the central planner.

1.1.1 Rules According to Friedman

The modern version, so to speak, of the debate between rule and discretion re(emerged) with the rise of monetarism in the 1950s, particularly with the works of Friedman (1960), Friedman (1962), Friedman e Schwartz (2008). The first of these with respect to monetary policy rules proposed the extinction of the banking multiplier so that the monetary authority could fully control the issuance of currency and thus ensure the stabilization of the (monetary) system. The hypothesis underlying this argument was that the continued existence of the banking multiplier, implying no control of monetary policy,

would have limited effect because part of the (scriptural) currency would be created by the private (banking) sector.

However, completely abolishing the banking multiplier would bring about an ambiguous situation. On the one hand, this would bring more power to the monetary authority, giving the central bank more discretion to achieve stability, but greater power to the CB could generate both stability and great instability. In this sense, to avoid instability, Friedman (1960) proposed that monetary policy be governed by rules, avoiding discretion, which for him was a source of instability. For this, he proposed a rule for control of the money stock, which became known as a monetarist rule and was one of the pillars of type I monetarism.

Concerned with the excess power that could be bestowed on the monetary authority, Friedman (1962) shifted the focus of monetarist thinking to the defense of economic liberalism, with control of the money supply as one of the main aspects. According to him, the problem lay in the fact that giving the CB more discretion in currency control was in fact assigning extraordinary power to a small group of people. Consequently, the discretionary actions of this small group could lead to abuse of power and therefore harm the individual freedom of society.

Despite suggesting monetary rules again, Friedman (1962) pointed out that having a rule is more important than the rule in itself. In other words, a rule should be the best in light of current scientific knowledge, but can be modified in the future. And at that moment, it seemed to be control of the monetary stock, the main point to be implemented based on the state of knowledge at the time. However, he did not give specific treatment to the risk of losing credibility due to the possibility of flexibility of rules in the future according to the current state of the economy.

Subsequently, the monetary question once again became the focus of the discussion with the contribution of Friedman e Schwartz (2008), but now in the guise of historical contextualization of the USA. This work contrasted with the Keynesian hypothesis of the causes of the Great Depression of the 1930s, which argued that overproduction was the main cause of private sector imbalances that, together with stock market speculation, resulted in the crisis. According to Friedman e Schwartz (2008), the Great Depression was fundamentally caused by the Fed, which dramatically contracted the stock of money in the late 1920s, causing the price and income level to plummet. The text argued that the great oscillations of economic cycles are caused by monetary policy. The authors analyzed the period between 1867 and 1960 and concluded that all crises in the period were linked to large changes in the stock of money, including after the establishment of the Federal Reserve System in 1913[1].

[1] Friedman e Schwartz (2008) point out that before the US had a centralizing monetary authority issuing paper money, currency was a private asset issued by commercial banks. In times of crisis, people ran to

With the creation of the Federal Reserve System and the end of the gold standard with the outbreak of the World War I, the monetary authority came to hold the issuing monopoly, and could ultimately issue money without limitations. Indeed, according to Friedman e Schwartz (2008), the Fed with this high discretionary power and little experience as a money issuer, became much more of a destabilizing rather than stabilizing institution. This conclusion reinforced Friedman's position in defense of monetary policy rules.

Given the above, in his seminal work Friedman (1968) highlighted what monetary policy can and cannot do. He tried to establish what the effective role of the monetary authority in the economy is. Here, Friedman defended the creation of monetary rules as a practical proposition of economic policy that endorsed monetarist ideas. In particular, the proposed rule was that monetary expansion must equal to the GDP growth rate. The hypothesis underlying this strategy is that price stability can only be achieved if the money supply evolves pari passu with real GDP.

The starting point of monetarism is the hypothesis of the natural rate of unemployment. According to the Friedman, the natural rate of unemployment excludes the Keynesian hypothesis of involuntary unemployment. That is, unemployment can either be voluntary, which occurs when a person decides not to work because of perceived insufficiency of the real wage, or frictional, which happens when a worker is temporarily unemployed, in transition from one job to another.

The natural idea put forward by Friedman (1968) was in the wicksellian[2] sense, to distinguish the causes of the structural and institutional nature of other factors - notably monetary policy - in determining the level of employment. He therefore rescued the idea of full use of factors of production, one of the fundamental axioms of classical economics, by defining:;

> (...) the "natural rate of unemployment," in other words, is the level that would be ground out by the Walrasian system of general equilibrium

the banks and tried to exchange their dollars for gold. It turns out that not every coin was gold-bearing; for this reason, banks made convertibility difficult, because if they allowed it freely they would become insolvent. For this reason, the bankers themselves proposed the creation of a central bank that would guarantee the liquidity of the system in moments of crisis, amid the gold standard.

[2] "Thanks to Wicksell, we are all acquainted with the concept of a "natural"rate of interest and the possibility of a discrepancy between the "natural" and the "market" rate. The preceding analysis of interest rates can be translated fairly directly into Wicksellian terms. The monetary authority can make the market rate less than the natural rate only by inflation. It can make the market rate higher than the natural rate only by deflation. (...) This analysis has its close counterpart in the employment market. At any moment of time, there is some level of unemployment which has the property that it is consistent with equilibrium in the structure of real wage rates. At that level of unemployment, real wage rates are tending on the average to rise at a "normal" secular rate, i.e., at a rate that can be indefinitely maintained so long as capital formation, technological improvements, etc., remain on their long-run trends. A lower level of unemployment is an indication that there is an excess demand for labor that will produce upward pressure on real wage rates. A higher level of unemployment is an indication that there is an excess supply of labor that will produce downward pressure on real wage rates. (...) I use the term "natural" for the same reason Wicksell did-to try to separate the real forces from monetary forces" [Friedman (1968, p.7-8)].

> equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity market, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on [Friedman (1968, p.8-9)].

In summary, the natural rate of unemployment is the one that balances the labor market, given its structural and institutional characteristics and the preferences of economic agents. In other words, it represents the level of unemployment that is compatible with the rational utility-maximizing behavior of economic agents: at this level of unemployment, all agents are optimizing their utility functions Modenesi (2005) .[3]

Another fundamental aspect of the monetarist approach is the assumption that economic agents form adaptive expectations. Friedman (1968) used this hypothesis to construct his version of the Phillips curve, which became known as the accelerationist Phillips curve or Friedman-Phelps Phillips curve, for the tradeoff between inflation and unemployment. For Friedman (1968), Phelps (1967) and Phelps (1968), the fact that agents anticipate or form expectations about the variation of the general price level required adding a new variable in the original Phillips curve. The expectation of inflation, therefore, was to compose what was known in the economic literature as the accelerationist Phillips curve.

The Friedman (1968)' proposal includes the idea that agents form expectations with information collected from the past. In other words, the expectation of inflation in period t depends only on the rate of change of prices in t-1. In this case, if there is no error in relation to expectations, the current level of unemployment will be equal to the natural rate. In summary, in the absence of monetary illusion, the level of unemployment equals the natural rate. However, if inflation exceeds expectations, the level of unemployment falls below its natural rate. If inflation falls below expectations, the level of unemployment rises above the natural rate. In other words, unemployment fluctuates around the natural rate of unemployment; economic fluctuations result in expectational errors resulting from the creation of unanticipated inflation by CB.

The model of adaptive expectations considers that the money supply is exogenous and determined by the CB. In addition, it also considers that workers do not have information about current inflation, instead calculating the value of wages based on expected inflation. Thus, if the CB expands the monetary base at time t so that inflation exceeds expectations - given that these were formed based on inflation in t-1 - in line with QMT (Quantitative Monetary Theory), this increase raises the general price level. The expansion of monetary stock raises aggregate demand.

[3] In simple terms, since the level of unemployment is equal to the natural rate, those workers who are changing jobs (frictional) or those who believe that the goods acquired with the current salary provide a lower level of utility than the hours of leisure, thus characterizing involuntary unemployment.

If the price of commodities adjusts more rapidly than the price of production factors, firms realize there has been a reduction in real wages and are therefore willing to accept a nominal wage increase in favor of keeping the real wage and the level of employment constant. However, information about price changes typically lags for employees. In this way, they will underestimate the effects of inflation and misinterpret the rise in their nominal wages as a real wage gain. The fact that workers do not realize that the increase in nominal wages only compensates for the increase in inflation, increases the labor supply. This inability to distinguish between variations in the general level of prices and relative price changes is called the monetary illusion. [4]

Furthermore, Friedman (1968) wanted to conclude that monetary policy can only affect real variables in the short term and thereby consolidate the traditional idea that currency is neutral in the long run. In the long run, monetary policy affects only the nominal variables (exchange rate, inflation and money stock). So, if a rule were needed, it would have to be about one of those variables:

> (. . .) to state the general conclusion still differently, the monetary authority controls nominal quantities-directly, the quantity of its own liabilities. In principle, it can use this control to peg a nominal quantity-an exchange rate: the price level, the nominal level of national income, the quantity of money by one or another definition-or to peg the rate of change in a nominal quantity-the rate of inflation or deflation, the rate of growth or decline in nominal national income, the rate of growth of the quantity of money. It cannot use its control over nominal quantities to peg a real quantity-the real rate of interest, the rate of unemployment, the level of real national income, the real quantity of money. the rate of growth of

[4] This mechanism is explained by the accelerationist version of the Phillips curve, "Let us assume that the monetary authority tries to peg the "market" rate of unemployment at a level below the "natural" rate. (. . .) Accordingly, the authority increases the rate of monetary growth. This will be expansionary. By making nominal cash balances higher than people desire, it will tend initially to lower interest rates and in this and other ways to stimulate spending. Income and spending will start to rise. To begin with, much or most of the rise in income will take the form of an increase in output and employment rather than in prices. People have been expecting prices to be stable, and prices and wages have been set for some time in the future on that basis. It takes time for people to adjust to a new state of demand. Producers will tend to react to the initial expansion in aggregate demand by increasing output, employees by working longer hours, and the unemployed, by taking jobs now offered at former nominal wages. This much is pretty standard doctrine. But it describes only the initial effects. Because selling prices of products typically respond to an unanticipated rise in nominal demand faster than prices of factors of production, real wages received have gone down-though real wages anticipated by employees went up, since employees implicitly evaluated the wages offered at the earlier price level. Indeed, the simultaneous fall ex post in real wages to employers and rise ex ante in real wages to employees is what enabled employment to increase. But the decline ex post in real wages will soon come to affect anticipations. Employees will start to reckon on rising prices of the things they buy and to demand higher nominal wages for the future. "Market" unemployment is below the "natural" level. There is an excess demand for labor so real wages will tend to rise toward their initial level. Even though the higher rate of monetary growth continues, the rise in real wages will reverse the decline in unemployment, and then lead to a rise, which will tend to return unemployment to its former level. In order to keep unemployment at its target level (. . .), the monetary a1thority would have to raise monetary growth still more. As in the interest rate case, the "market" rate can be kept below the "natural" rate only by inflation. And, as in the interest rate case, too, only by accelerating inflation" [Friedman (1968, p.9-10)].

> real national income, or the rate of growth of the real quantity of money [Friedman (1968, p.11)].

The rule should therefore apply to one of these nominal variables. In fact, he only confirmed what he had already said in Friedman (1962): at the stage of knowledge of those times, the best possible rule would be monetarist - control of the money stock - because of the three variables cited, the currency is one over which CB has greatest influence. [5]

In short, the accelerationist hypothesis is an argument against discretionary monetary policy, in that it suggests that any systematic attempt to reduce the level of unemployment below the natural rate ultimately results in higher inflation. This is an undesirable situation in view of the effects on contract duration and the ability of the price system to efficiently coordinate economic activity (Friedman, 1988). In addition, Modenesi (2005) highlighted two other reasons that counterpoise monetary discretion: (i) the reduction of the level of utility of agents under the monetary illusion; and (ii) the low level of knowledge regarding the true causes of economic cycles and the existence of lags in the conduction of monetary policy.

Regarding monetary illusion, this is a necessary condition to support the hypothesis of non-neutrality of money. In this case, economic agents suffering from monetary illusion, in Walrasian terms, do not maximize their utility functions, thus generating a loss of social well-being (dead weight loss), so this non-optimizing behavior deflects the economy from efficient (Pareto optimal) equilibrium.

About the lag in the conduction of monetary policy[6] , for Friedman its existence was a more than sufficient argument to defend the monetary (target) rule. According to Friedman (1948), this situation, coupled with the low stage of development of economic theory, implies that discretionary monetary policy can aggravate rather than stabilize economic fluctuations.

Therefore, Friedman (1968) was emphatic about the undesirable consequences of the use of discretionary monetary policy. In this sense, he stressed that the reason for the existence of a propensity to react exaggeratedly does not generate doubts; instead it reflects the failure of the monetary authorities to consider, for example, the lag in their actions

[5] Friedman (1968) argues that a rule on the exchange rate would generate difficulties in adapting to market players and apparently does not make sense when the objective is to control inflation. For this same reason it might seem more than natural for the author to propose a rule on price level, such as inflation targets, but he emphasized that monetary policy takes some time to take effect. In the author's view, this lag would be less when manipulating the currency than when trying to affect prices directly. Thus, even if the ideal were to control inflation directly the monetary policy lag would not allow such an attitude. This justification was based on the fact that the greater the should be the forecasts. How to make long-term predictions was rather complicated a rule that would allow a shorter forecast period seemed more feasible. For this reason, Friedman (1968) defends a rule about the currency.

[6] According to Modenesi (2003), the lags can be: (i) internal - the time period between the occurrence of a crash and the taking of measures by the authorities; and (ii) external - time interval between the adoption of the measure and the appearance of its effects.

and their after effects on the economy. These lags tend to determine actions according to the current state of the economy. In this way, the authorities will be encouraged to reduce (increase) the pace, depending on the situation, which is a difficult decision.[7]

To sum up, for the reasons given above, Friedman defended the idea that monetary policy can avoid being a major source of instability and provide a stable structure for the economy. The link between monetary policy actions and the price level is indirectly worse than with any other monetary aggregate. Thus, monetary policy action takes a longer time to affect monetary aggregates, and both the lag and magnitude of the effect varies with the various economic circumstances. Since it is not possible to adequately predict the effect of a monetary action, by attempting to directly control inflation the monetary policy generates instability in the economic system because of the authority's own errors, prompting attempts to correct them.

1.1.2 The Kydland and Prescott Model

The use of rules by CBs is associated with the concept of credibility, which can therefore be interpreted from the agents' point of view regarding the degree of confidence in the monetary authority regarding the fulfillment of a certain announced policy. Thus, the lower the probability of occurrence of time inconsistency, the greater the ability of monetary policy will be to convey credibility to agents. In this sense, in a seminal work, Kydland e Prescott (1977) dealt with the question of the credibility of monetary policy with respect to temporal inconsistency. For the authors, monetary policymakers can assess that immediate and passive output-level outcomes obtained in the short term through an expansionary monetary policy are more important than can be achieved by the monetary authority through compliance with monetary policy rules.

However, by deviating from compliance with the pre-established rule, and by using an expansionary monetary policy, reducing the level of unemployment becomes unlikely. In this case:

> (...) current decisions of economic agents depend in part upon their expectations of future policy actions. Only if these expectations were invariant to the future policy plan selected would optimal control theory be appropriate. In situations in which the structure is well understood, agents will surely surmise the way policy will be selected in the future. Changes in the social objective function reflected in, say, a change of administration do have an immediate effect upon agents' expectations of future policies and affect their current decisions [Kydland e Prescott (1977, p.474)].

The contribution of Kydland e Prescott (1977) added to the debate in favor of a rule-driven monetary policy under the assumption that discretionary monetary policy will

[7] According to Friedman (1968), the actions affect the economy between six and nine months later.

compromise credibility and reveal intertemporal inconsistency. This analysis suggests that the growth of the monetary aggregate is the main cause of inflation. This contribution emerged in the wake of the formulation of the hypothesis of rational expectations by the neoclassical school, with the introduction of this mechanism of expectations in the optimization models. In this sense, the models began to incorporate the effect of the decisions of private economic agents on the policies managed by a central planner (government). However, the introduction of this hypothesis of expectation formation into optimal control models has generated the problem of temporal inconsistency of policies. Consequently, the optimal policy, announced and implemented by the central planner in the planning horizon, does not remain optimal over time. According to the authors, temporally inconsistent policies tend to weaken the credibility of the policies to be announced and implemented later.

According to the authors, temporal inconsistency can be considered a problem of optimal control technique, associated with a context in which rational expectations prevail. This problem arises whenever decisions are taken sequentially, and agents are unable to anticipate the future of the variables that affect their decisions in the present. In this sense, according to Kydland e Prescott (1977), the dynamic optimization methods can provide two possible results: a policy consistent in time and a policy inconsistent in time.

The time-consistent policy corresponds to a situation in which the central planner decides from the initial period the system path to the next period. When that period arrives, the planner defines the trajectory for the subsequent moment, and so on. In this case, one can conclude that the solution of the sequential problem calculated from the initial state of the economy is consistent, since it will always be confirmed and maintained subsequently.

On the other hand, the consistent solution is sub-optimal because it offers the second-best result in terms of well-being, since it is dominated by the optimal policy solution. However, the temporal inconsistency is the change from consistent policy to optimal policy. This change occurs because considering a system that operates under rational expectations, dynamic optimization considers past events to be invariant over time.

1.1.3 The Barro-Gordon Model

The debate was later reestablished with the contribution of Barro e Gordon (1983). In this paper, the authors rescued the analysis of Kydland e Prescott (1977), emphasizing the importance of the credibility of monetary policy. In this new version of the debate, the authors introduced temporal inconsistency as a criticism of Friedman, showing that the shift from a rule-based monetary policy to discretionary action makes it inconsistent over time. If the government signals that it will change the way monetary policy is conducted

in a discretionary manner, with no apparent institutional reason, the result will be the occurrence of surprise inflation. In fact, agents with rational expectations keep abreast with this movement and, consequently, the economy is in a sub-optimal equilibrium (discretionary monetary policy equilibrium), which is inefficient in terms of welfare by generating higher inflation than a rule-based policy would. As the authors argued:

> (..) in a discretionary regime the monetary authority can print more money and create more inflation than people expect. The benefits from this surprise inflation may include expansions of economic activity and reductions in the real value of the government's nominal liabilities. However, because people understand the policymaker's incentives, these types of surprises—and their resulting benefits- -cannot arise systematically in equilibrium [Barro e Gordon (1983, p.1)].

The analysis by Barro e Gordon (1983) focused on the hypothesis that the persistence of inflation is a result of the loss of credibility of the government, due to noncompliance with the rules previously agreed upon with agents. From then on, the inflationary bias became common in the subsequent studies, that is, the existence of incentives for the CB to inflate the system.

For the authors, there are two reasons that encourage the government to inflate the system. The first is explained by the inflationary financing of public spending, whether through issuing money or securities. The second relates to the employment problem and is based on three questions. The first is that the economy is subject to deviations from employment relative to its natural level, and these fluctuations are directly (positively) associated with inflation. The second is the idea that government tends to stimulate employment at the expense of lower inflation. Finally, the third, assumes that the government chooses the rate of inflation that maximizes its welfare, taking as given the inflationary expectations of the period. In other words, the optimal inflation rate is one that minimizes the joint costs of the tradeoff between inflation and unemployment. As the marginal costs of the two variables are increasing, the minimum rate of inflation is positive.

In the model of Barro e Gordon (1983), the information is complete. In this case, the agents know the behavior of the government, which guarantees them the prerogative of anticipating inflation, and therefore avoiding reducing real wages. At first, employment is kept around its natural level. However, when the government tries to reduce unemployment below the natural rate but is unsuccessful, the result is equilibrium with higher inflation.

1.1.4 The Inflation Targeting Regime and the Taylor Rule

The regime of inflationary targets derives from the work that permeated the debate on rule-based versus discretionary monetary policy in the 1970s and 1980s, with the contributions of Kydland e Prescott (1977) and Barro e Gordon (1983), as well as the

emergence of rational expectations with and Sargent e Wallace (1975). Later, in addition to the operability of monetary policy, Taylor (1993) joined this debate, giving support pillars of the so-called new monetary policy consensus.

The idea is to use the microeconomic fundamentals within a macroeconomic models of general equilibrium, while still considering a range of hypotheses of rigidities in the adjustment process, but incorporating rational expectations to explain the effects of monetary policy in particular on the real variables of the economy, so that its effects are only transitory (long-term neutrality of the currency). This unified the neoclassical and new Keynesian theories. In this sense, Woodford (2011) added that although monetary policy is not considered irrelevant to explain fluctuations, its most important sources are real. Thus, monetary policy is important to contain inflation, whose dynamics have monetary roots. Therefore, following Friedman's monetarist idea, monetary policy should be used exclusively to control the price level, since it has no lasting effect on the real economy.

The proponents of the inflation targeting regime rescued the quantity theory of money (QTM) regarding monetary control of inflation by the monetary authorities (exogenous currency) to defend the hypothesis of monetary policy neutrality. From there, more appropriate prescriptions can be extracted, which are the use of rules and / or practices of commitment of governments to monetary policy [Cukierman (1994); Walsh (1995); Mishkin (2000)], avoiding the own bias of inflation Kydland e Prescott (1977).

Despite its origin in the QTM, the rule the inflation targeting operates through the interest rate and not through control of the monetary aggregate, as advocated by monetarist theory. This is a result of discrediting the hypothesis that the velocity of money circulation is constant. According to the new consensus, it is the exact opposite. That is, the velocity of the currency is unstable, which makes it difficult for CB intervention regarding the currency, and consequently involving inflation.

Over time, Friedman's monetarism, which prescribed price control by intervening in monetary aggregates, was gradually abandoned. In this sense, in a more modern version, monetary policy focused on the intervention of the interest rate as an instrument to control inflation. Although this change was considered a Keynesian victory over the monetarists, the theoretical and institutional framework is far from being a Keynesian theory. According to Arestis e Sawyer (2004), in the long run the inflation rate is the only macroeconomic variable that monetary policy can affect. Thus, in the long run monetary policy cannot affect economic activity, economic output, employment and so on.

The inflation targeting regime (ITR) is therefore based on the premises of the new macroeconomic consensus. According to Arestis e Sawyer (2004), the principles of ITR refer

1. Separation between real and nominal factors: the assumption is that the effects of monetary policy would be restricted to the monetary sphere, having no lasting impact on the real side of the economy. Therefore, regardless of the transitory effects due to a monetary illusion or some unanticipated movement by the monetary authorities, the currency plays a secondary role in determining the level of output.

2. Inflation is a predominantly demand phenomenon: there are no diagnoses that inflationary pressures can originate from other factors that are not directly related to the demand side of the economy. Indeed, inflation may be due to excess demand and / or supply shocks.

3. Natural rate of interest: the concept of natural interest rate is inherited from the Wicksellian rule. In this sense, Taylor used the same concept and the difference between this and the current rate as one of the factors for monetary policy orientation.

Taylor (1993) presented a proposition as part of the effort to obtain an interest rate rule, and a rule for monetary policy to replace monetary rules. He explained that monetary policies based on rules of interest rates related to inflation variations and product variations are more stable, achieving better control than other types of policy that may be adopted. In other words, he argued that well-enforced rules are compatible with changes in interest rates in response to changes in prices or economic activity, without compromising the expectations of other agents.

From US macroeconomic factors, Taylor (1993) argued that US interest rate behavior could be represented by a linear relationship with the inflation rate, the inflation target, and the output gap. In summary, this implies a rise (reduction) of the interest rate when inflation is above (below) the target, and likewise indicates that in case of increase (decrease) of the output gap, there must therefore be an increase (decrease) in the interest rate, to contain the growth of aggregate demand and avoid inflationary pressures.

1.1.5 The Post-Keynesian approach

In Keynes's sense, the debate gained scope with de contribution of post-Keynesian authors. According to TPK, the monetary system is not able to avoid, by its own methods, the inflationary process. On the other hand, it becomes mandatory to identify the causes and origins of inflation and then work on them. Therefore, in the Keynesian world, acting on the origins of this process allows monetary issues to validate the causes of inflation instead of suppressing them.

Unlike the conventional theory, under monetarist auspices, "money is, neither in the short run nor the long run, neutral. Consequently, Keynes's general theory analysis suggests that any monetary policy that effects the quantity of money in the system or the rate

of interest (and therefore the market value of liquid financial assets) will impact directly on real economic outcomes" Davidson (2006). The assumption behind this argument is supported by one of the main pillars of the construction the Keynesian theory: uncertainty. In Keynes's view, agents' decisions are made in an environment where the future does not have perfect predictability (nonergodicity), so it goes without saying that money is never neutral.

Additionally, according to Davidson (2006), in the real world, one of the main functions of the central bank is the provision of liquidity, instead of determining the rate of inflation. In opposition to classical theory, in Keynes's view the banking system has an important role of assuring liquidity continues to oil the gears of the productive sector, through credit. As a result, "this first function of any central bank, as controller of the banking system, is to encourage bankers to make credit (liquidity) available as cheaply as possible while the economy has significant idle resources" (Ibid., pp. 691-2). Furthermore, this function, necessarily implies other one, namely to assure stability in the financial market.

First, it is necessary to understand the inflation process in a Keynesian world. According to Davidson (1978) and Davidson (2006), the causes of the inflationary process have origins in the productive process, involving commodity inventories, productivity and the market structure. Consequently, the types of inflation can be classified as: (i) wage inflation; (ii) profit inflation; (iii) decreasing returns inflation; and (iv) shock inflation.

Regarding the wage, profit and decreasing returns types of inflation, their origin is linked to wage increases, monopoly status and labor productivity, respectively. Briefly, regardless of the size of the employment gap, increases in wages unaccompanied by increased productivity cause inflation. The solution of this problem was developed by Weintraub (1977), through an anti-inflation policy called TIP (tax-based income). The proposal was to penalize firms that increase wages and profits beyond the national productivity growth rate[8].

The main cause of inflation shocks (spot or commodity inflation) is "a sudden and unforeseen change in demand or available supply for immediate delivery" Davidson (2006). This type of inflation "can easily be avoided if there is some institution that is not motivated by self-interest but instead maintains a 'buffer stock' to prevent unforeseen changes in spot demand and supply from inducing spot price movements" (Ibid., p. 695). The proposal was to protect society from changes in demand and supply that would induce significant spot price movements. The maintenance of the buffer stock consists of a public policy where the government buys the excess output from the market in good years to ensure supplies during hard times.

[8] For more details, see Weintraub (1977) and Davidson (1978) and Davidson (2006).

According to Davidson (2006), in the conventional theory, the central bank has a role to control income inflation through the monetary policy tools, to ensure that all workers and firms against losing income and sales. The hope is that this fear policy will reduce the pressure on wages and prices. To ensure this fear is credible, "a central bank doing inflationary targeting must institute a restrictive monetary policy so that all firms and workers feel threatened" (Ibid, p. 701). The effectiveness of this fear policy is linked to the domestic natural rate of unemployment and the size of the population of economies where workers are willing to accept lower wages than they are in developed countries.

In an empirical study, Angeriz e Arestis (2006) applied a structural time-series model technique in the case of ten countries with inflation targeting policy since the 1990s. Although the inflation targeting regime starting in 1990 in New Zealand, the quarterly data covered the period from 1980 to 2004. The dependent variable (inflation) was a vector of cross-sectional variables corresponding to each inflation targeting country against a stochastic trend, a variable that captures short-term cyclical movements and an intervention variable. The results suggested that the ITR had not been efficient in decreasing inflation significantly, and in most cases, "inflation had already entered a downward trend well before inflation targeting was introducing" (Ibid., p. 566).

Through a simplified macroeconomic model, Atesoglu e Smithin (2006) examined the impact of inflation targeting. Under the assumption of non-neutrality of monetary policy, the authors concluded that, in terms of income distribution, "a lower inflation target will tend to reduce real wages and profits and increase real interest rates, that is, the return to rentiers" (Ibid, p. 685). This conclusion is in line with one of the inflationary diagnoses presented by Davidson (2006), in which he questioned whether the target is achieved mechanically by the simple monetary policy rule, since a more audacious goal may increase inflation and impact productivity negatively. Indeed, to avoid productivity growth from lagging behind wage increases, the economy should work with lower real interest rates, rather than the higher ones that are traditionally associated with anti-inflationary policy according to the Taylor rule (Ibid., p. 686). Finally, the authors argued that even if the inflation target is low, the real interest rate will always be positive for two reasons. First, a low but positive interest rate would protect the economy from inflationary instability by having to maintain a negative real rate for an extended period. Second, in terms of distributional conflict among rentiers, entrepreneurs and workers, positive real interest rates preserve the values of financial assets. As a result, the income policy is maintained, but only for the rentiers and not for entrepreneurs and workers.

In a recent work, Lima, Setterfield e Silveira (2014), starting from the empirical literature that suggests persistent and time-varying heterogeneity in inflation expectations, embedded two types of inflation forecasting heuristics: one based on the current effective inflation and the other anchored to the official inflation target. Through the dynamic

macroeconomic model, they showed (p.23) "that, in general, convergence towards an equilibrium consistent with the level of output and the inflation target by policy makers is achieved regardless of whether or not the satisficing evolutionary dynamics that guide the choices agents make between inflation forecasting strategies are subject to noise". Furthermore, although the agents, in a heuristic way, model their forecasts based on the inflation target, the credibility of the monetary authority's capacity does not guarantee the goal (target) will be achieved. The result suggests that the inflation expectations adjust endogenously over time, and hence decision making under uncertainty by private agents may facilitate rather than hinder policy decisions by the monetary authority.

In view of the above, the post-Keynesian critique brings together elements regarding the causes of inflation and the costs to society associated with maintaining a monetary policy rule. Moreover, the theoretical elements that mark the inflation targeting regime, in addition to being incompatible with explaining the functioning of a monetary production economy, call into question the credibility of the monetary authority regarding its ability to conduct monetary policy under established rules.

In sum, the proponents claim that the credibility gain, compromise, easy reporting provided by the rules, the existence of discrepancies in monetary policy decisions and the loss of reputation resulting from the adoption of inefficient discretionary policies are the main arguments leading the monetary authority to choose rules for the conduction of monetary policy. On the other hand, defenders of discretion emphasize the flexibility acquired by the monetary authority, the diversity of shocks in the economic environment, and the capacity for better interaction between monetary policy and other economic policies as the main attributes encouraging policymakers to opt for discretion.

1.2 Lessons from the crisis and the revision of the New Consensus

The global financial crisis of 2008-09 led to a combination of unconventional (macro-prudential) policy measures that in turn resulted in a revision of dominant thinking. Since then, a large volume of work by mainstream economists has emerged with proposals to revise the main pillars supporting the New Macroeconomic Consensus (NMC). The proposals range from significant changes in the MP, with a focus on financial stability, through relaxation of the ITR, according to the so-called Modified Jackson Hole Consensus [Paula, Saraiva e Modenesi (2018)].

As discussed by Paula, Saraiva e Modenesi (2018), the main elements of the NCM, which had wide convergence and acceptance, were maintained in the post-crisis revision. These elements can be summarized, according to Mishkin (2011), as: (i) inflation is always a monetary phenomenon; (ii) the existence of the short-term tradeoff, the absence of the long-term tradeoff, the natural rate of unemployment and the rational expectations

hypothesis (REH) remain valid; (iii) the theses of temporal inconsistency, inflationary bias of discretionary monetary policy and the central bank independence also hold; (iv) the Taylor Rule (TR) is valid; and (v) inflation targeting should be used as the nominal anchor.[9]. Regarding the proposals for economic policy changes, the following should be highlighted: (i) the monetary authority should incorporate risk management into its MP, besides administering macro-prudential regulation; (ii) capital control and exchange management should be established on a temporary basis by emerging economies; and (iii) fiscal policy is an automatic stabilization instrument.

It is not the scope of this paper to review all of the above[10]. However, we give special treatment to the issues related to the debate about the rule-based versus discretionary nature of monetary policy.

In this sense, the analysis can be restricted under the aspect of temporal inconsistency, the inflationary bias of discretionary MP and the CB's independence. In relation to the temporal inconsistency thesis, its supporters still follow the NMC assumptions and therefore the validity of the other hand, although the NMC supports the hypothesis that uniqueness equilibrium properties are underestimated, under the assumption that the agents form their expectations in a rational way. On the other hand, these elements are insufficient to support the superiority of rule-based MPs to the detriment of discretionary policies [Paula, Saraiva e Modenesi (2018)]. Furthermore, although the NMC supports this hypothesis, macroeconomic and microeconomic evidence as suggestive but not conclusive against the natural rate assumptions. Policymakers "should keep the natural rate hypothesis as their null hypothesis, but also keep an open mind and put some weight on the alternatives" Blanchard (2018).

In addition, the temporal inconsistency thesis, one of the pillars of the NMC, is an essential element for the effectiveness of the ITR, which has not been abandoned by the mainstream. This permanence is complementary with the proposition of an independent CB, and consequently with the tripod of reputation, credibility and delegation. In this context, the MP will only be effective in the short term with the reduction of unemployment, but with an increase in inflation in both the short and long run, reversing the gain of well-being obtained in the short term.

However, with systemic elements, the global financial crisis of 2008-09 challenged the efficient markets hypothesis, since MP's action on asset deflation goes beyond the supposed costs necessary to avoid it, or at least reduce the impacts. In order to guarantee

[9] According to Bernanke e Gertler (2000), the inflation target acts as a nominal anchor in order to coordinate inflationary expectations. In addition, the authors emphasize the disbelief of the use of a discretionary monetary policy in an efficient way, reinforcing the conventional hypothesis that the functioning of the economic system in an efficient way is dependent on the monetary stability.

[10] For a more detailed approach, see Paula, Saraiva e Modenesi (2018), Mishkin (2011), Mishkin et al. (2012), Blanchard, Dell'Ariccia e Mauro (2010), Blanchard, Dell'Ariccia e Mauro (2013), Blanchard (2018) and Wren-Lewis (2018)

the maintenance of the ITR, there were a series of recommendations and revisions of other economic policies, especially regarding financial policies. On the other hand, the incorporation of risk management as one of the MP's objectives was not consensual. While acknowledging the need for revision of the pillars of the NMC, the MP modus operandi has been largely maintained. As Taylor (2010, p.20) argues:

> Along with rational expectations came reasons for predictable, rule-like policies: time inconsistency, credibility, and the Lucas critique, or simply the practical need to evaluate macro policy as a rule. Along with the sticky prices came specific monetary rules which dealt with the dynamics implied by those rigidities as fit to actual macro data. These models did not fail in their recommendations for rules-based monetary and fiscal policies.

However, Bernanke et al. (2009), Mishkin (2011), Mishkin et al. (2012) and Woodford (2011) broadly advocate a revision of the MP with the inclusion of other mandates. Woodford (2011) goes further, proposing the incorporation of financial risk, through a social loss reaction function, as a way of guaranteeing CB independence, since both MP and financial risk management will be under its management.

The inclusion of risk management, as the final objective of MP, with the same relevance attributed to inflation and output, as proposed by Bernanke et al. (2009), may constitute a paradox. In fact, the inclusion of this new objective threatens the affirmation of the ITR, especially the thesis of an independent CB, since the macroprudential (unconventional) policy has to be coordinated with the inflation target (rule). This situation is further complicated when proposing to include risk management, which requires two objectives (inflation target and financial stability) for the same instrument (interest rate).

Although it may be considered a breakthrough in rethinking macroeconomics, with a supposed mea culpa from conventional theory, for other authors the manifestation of NMC is nothing more than more of the same. For Palley (2013), the revision of the NMC is a Gattopardo economics, to the extent that the change serves to leave everything as before.

According to Minsky (1986), when the economy is in the process of expansion, the financial system is always in a fragile situation, where agents make investment decisions based on future income expectations and assume contractual commitments (debt) to execute their projects[11] . This is due to a basic characteristic of the financial system,

[11] Minsky divides financial agents into three different groups: (i) hedge, which is both liquid and solvent in the short and long runs, because for each period, the earnings from cash flows are sufficient to pay obligations (ii) speculative is one in which the expected cash flow is less than amortization payments (principal plus interest) in a given period, but is sufficient to pay interest. Companies in this situation have to resort to periodic refinancing to honor their commitments; and (iii) Ponzi is one in which the expected short-term cash flow is lower than contractual charges, and is insufficient even to pay interest.

especially of the banks that are balance sheet administrators. That is, institutions raise funds through demand and time deposits, as well as other sources of funding (liabilities), which will be passed on to the public in the form of loans (assets). In this case, banks assume contractual obligations in the form of liabilities, whose payment is associated with the expectation of return of the asset portfolio composed of the debt contracted. However, if there is a frustration of expectations, the chances of default increase, so the financial system may suffer a systemic crisis.

For both Keynes (1982) and Minsky (1986), financial fragility has pro-cyclical performance, so in times of economic expansion, the euphoria of agents automatically reduces the perception of risk, increasing the degree of leverage of agents (households and firms), thus aggravating the systemic risk. In this sense, three conditions lead to financial fragility: (i) financial deregulation, by providing institutions with greater freedom to manage balance sheets as a way of extracting some competitive advantage; (ii) financial innovations that go far beyond the regulator's ability to change the institutional design to contain any advance of systemic risk; and (iii) financial globalization, which leads to risk transfer between countries.

Given the above, Minsky (1986) argued in favor of a Big Government and Big Bank to ensure economic stability. The focus of the CB is therefore on the need to regulate financial institutions in order to deter them from assuming more fragile positions, that is, to prevent them from migrating from their hedging status to Ponzi status. In addition, the CB needs to act as a lender of last resort at the first signs of default, thus avoiding escalation of bankruptcies in the financial system, which would generate a systemic crisis with adverse effects on the real economy. Thus, according to Minsky, the monetary authority should direct its monetary policy to prioritize stability of the financial system, so that in times of high uncertainty, unemployment increases, income stagnates, companies go bankrupt, dragging the economy into recession.

Furthermore and from the perspective of endogenous risk, the dominant conventional theory holds that managers of macroeconomic policy in general, and of monetary policy in particular under the aegis of the ITR, lack proper instruments, or are not skillful enough, to stabilize the economic cycle. In fact, there is a need to introduce new macroeconomic policy instruments that, together with conventional ones, can help to contain volatility and therefore keep the real economy on the path guided by productive investment.

The recent economic crisis gave a prominent role to CBs, since through unconventional (macro-prudential) policies, they acted to stabilize credit and provide liquidity in the respective markets. In this sense, there has been a substantial increase in the powers of these institutions to intervene in the financial system Duran (2012). Furthermore, in an attempt to stabilize the financial system during the global financial crisis, CBs took market risks, which could jeopardize their status as "independent" institutions. According

to Goodhart (2009), CBs changed their focus and started to act on the liquidity of assets in detriment of the liquidity of financing linked to treasury bonds.

The global crisis, in the context of financial globalization, has restructured the dynamics of the monetary authorities, where the action to guarantee price stability has been supplemented with action in favor of financial stability, including new interventionist instruments. Consequently, globalization has led to a reduction in the market power of economic agents in several sectors, which until then had been ignored in the formulation of monetary policy by CBs Duran (2012). Indeed, this context has a deflationary nature and therefore ignores the anchoring of long-term inflation expectations formulated by the monetary authority, but adds complexity to the management of monetary policy [Aglietta e Rigot (2009); Aglietta, Berrebi e Cohen (2003); Borio (2011); Duran (2012)]. In this sense, new forms of intervention are needed, extending the powers of monetary policy. However, new powers require new instruments, and CBs innovated substantially in this regard, notably during the crisis [Duran (2012)].

Undoubtedly, the crisis reinforced the argument of those who advocated the discretionary performance of monetary authorities. In this context, economic crises become real theoretical challenges that go beyond the boundaries of conventional theory, where mainstream thinking has proved incapable of providing a conceptual and analytical treatment [Duran (2012)]. Moreover, as Borio (2011) argues:

> central banks face a threefold challenge: economic, intellectual and institutional. First, they will operate in a hostile economic environment. The Great Moderation has ushered in the Great Recession. Mature economies will carry the long-lasting scars of the crisis, while emerging economies may well continue to boom and face problems not dissimilar to those that heralded the crisis elsewhere. Second, central banks will take decisions in full knowledge that their benchmark macroeconomic paradigms have failed them.

Monetary policy, therefore, must also consider the objective of financial stability. One of the ways of exercising this mandate is through prudential regulation, although it is considered by CBs as an instrument of capital provision to avoid systemic risk. This refers to a form of credit leverage containment between banks and other non-bank financial institutions [Aglietta e Rigot (2009)].

According to Goodhart (2009), in addition to guaranteeing price stability, the CB must include in its mandate the provision of liquidity and the guarantee of stability of the financial system. Indeed, during a crisis, instruments other than the conventional set gain prominence, in such a way that:

> (...) liquidity management takes on a life of its own, potentially independent of official interest rates. This is patently obvious once nominal interest rates hit the zero lower bound, so that subsequent unconventional

> measures, whether quantitative easing, credit easing or the ECB's suite of market measures, all involve OMOs[12] and manipulation of the central bank's balance sheet (Ibid, p. 9).

Although arguments in favor of CB discretion have gained ground, based on the absence or weakness of conventional arguments in favor of the rule-based approach in topics involving the institutional framework and power relations, the legal aspects of the accountability of monetary policy have been largely ignored. Thus, the central point of this essay is to describe a legal context for the debate over rule-based versus discretionary monetary policy

As will be seen later, the LTF converges in favor of the group that advocates the discretionary view. In this sense, situations that indicate some difficulty of CBs to conduct their policies cause volatility in the prices of financial assets, affecting bondholders. The central point, and the main contribution of this work, is that in the rule-based versus discretionary monetary policy debate, those who advocate rules so far have not considered the legal, institutional and power relation aspects. In this sense, the LTF emerges to fill this gap. Although it is a pro-operating theory of the financial system and not monetary policy, we believe that its insights are applicable to the rule-based versus discretionary monetary policy discussion, and that in turn brings dimensions hitherto mainly absent from the debate.

This argument is also present in the LTF and sheds light on the flexibility of the rules, which fits in with a conclusion in favor of discretionary monetary policy, as suggested by Keynesian theory in particular. Thus, one can find elements of convergence between the LTF and post-Keynesian thought (PKT) regarding the role of monetary policy, especially in what Pistor (2013) called the "law-finance paradox", suggesting the "elasticity of law". Before connecting the LTF to the rule-based versus discretionary monetary policy debate, we present it briefly below.

1.3 The Legal Theory of Finance (LTF)

Developed by Pistor (2013)in her seminal work "A Legal Theory of Finance", the LTF presents a modern and intuitive version of the functioning of the financial and capital markets, whose arrangements are backed by contracts in a legal environment that guarantees their performance. In this sense, since financial instruments depend on performance of contracts, they will automatically depend on legal interpretations by the courts and the regulatory system [Reis e Vasconcelos (2016) and Goldmann (2017)]. In short, finance and law are intrinsically involved in a dynamic process in such a way that:

[12] Open Market Operations

> The ability to design instruments that are not obviously in conflict with existing rules in different jurisdictions even as they seek to mitigate their costs on the issuers or holders renders a comparative advantage. In short, law and finance are locked into a dynamic process in which the rules that establish the game are continuously challenged by new contractual devices, which in turn seek legal vindication Pistor (2013, p.1).

In short, financial markets are complex and innovative. In this sense, both legal arrangements and regulations always lag behind financial innovations, given the interconnections between the parties, which makes the enforcement process challenging. According to Pistor (2013), the LTF is a rereading of the functioning of the financial market, but from a strictly legal perspective. It should be noted that the LTF is not restricted to a single market or type of instrument; it deals with all classes of assets, namely shares, derivatives, private debt, government bonds, foreign exchange market, and so on.

The LTF works under two basic premises: fundamental uncertainty and liquidity volatility. Similarly, in Keynesian theory, the two go together: indeed, uncertainty and liquidity are reciprocally related. Thus, "if the future were known we could take precaution to deal with future liquidity scarcity", (Ibid, p. 2). Furthermore, if liquidity were ways available on demand, the uncertainties about the future would be softened and there would be no reason for major concerns, given the possibility of endless refinancing of obligations.

Regarding fundamental uncertainty, his analysis follows the Knightian approach. According to Knight (1921), in a future without perfect predictability, risk (or any event) cannot be quantified, even classified as probable. Hence, there is a belief that ergodicity is present in the decisions of economic agents, that is, their positions are based on non-probabilistic expectations[13] . Therefore, investment strategy planned today will have to be adjusted if the future deviates from the premises that are assumed beforehand. So, fundamental uncertainty introduces a crucial element into decision making. These assumptions help explain the frequency of financial crises in financial markets [Kindleberger e O'Keefe (2001)]. In addition, according to Reinhart e Rogoff (2009), there is historical evidence, consisting of 800 years of data and events, that financial crises occur much more frequently than people believe. There is, therefore, no consensus even among the followers of the efficient capital market hypothesis (ECMH) that at least some aspects of finance are beset by inherent instability.

Regarding *volatility of liquidity*, it is related to the (in)ability of the any agent to form a portfolio, either by selling assets or exchanging them for other ones. In times of high uncertainty, liquidity becomes scarce and makes it difficult to reallocate the portfolio without drastic loss of value. As evidence, in the global financial crisis of 2008-09m liquidity conditions changed sharply over a short time. Furthermore, in the Minsky sense,

[13] These cases call for judgment, not calculus. Keynes developed a similar concept in his Treatise on Probability, also published in 1921[Keynes (1921)].

the combination of fundamental uncertainty with volatility of liquidity creates inherently unstable financial markets. Therefore, it is essential to have a legal arrangement for the contracts and commitments to remain negotiable in order to avoid deepening the crisis and even collapse of the entire economic system.

According to Pistor (2013), the LTF assumes that the functioning of the asset market depends on legal parameters. In other words, an asset is nothing more than a contract with party and counterparty having individual interests. It is through laws, both domestic and international, that capital and liquidity of the system are ensured [Reis e Vasconcelos (2016)]. Therefore, given individual interests, which may be conflicting and lead to contract enforcement, fundamental uncertainty and liquidity volatility can lead to results that are opposite to those agreed in the obligations. In the words of Pistor (2013, p.318):

> (...) while perfectly rational from the perspective of individual contractors, predetermined, non-negotiable obligations designed to mitigate the effect of future contingencies on individual parties, such as collateral calls, margin calls, etc., can increase the financial system's vulnerability to crisis.

In this sense, the preference for liquidity is low, i.e., without liquidity constraints, assets, configured as contracts, whether public or private, can be considered to be near substitutes for money. This, in turn, facilitates portfolio reshuffling by agents in the financial market. However, as Mehrling (2012) notes, when most part of the market goes in the same direction at the same time, seeking to change their portfolios, it can be too late for some assets meet the liquidity conditions previously reached. In this case, the market will give priority to currency or a class of assets that can be perceived as near-perfect substitutes for currency, such as sovereign bonds. Thus, it is easy to argue that the financial system is not flat, but hierarchical.

Furthermore, Reis e Vasconcelos (2016) conclude that the only agent capable of serving as a lender and/or trader of last resort is an agent with an infinite money supply: states (or their central banks). However, will be seen, the LTF says that central banks should work in a discretionary way, and credibility is mandatory. Thus, *political and social accountability* is considered to be an indicator of credibility to support the state and central bank, as explored in the next session of this chapter.

The LTF is supported by four pillars: (i) the legal construction of finance; (ii) the essential hybridity of finance; (iii) the law-finance paradox; and (iv) the elasticity of law. The latter two are the key elements that make the LTF part of the debate between rule and discretion of monetary policy, the subject of this chapter.

1. *The legal construction of finance.* The main concept is that no exist financial market

outside rules. Therefore, financial assets work as contracts and are designed to be legally accepted by the public. As Pistor (2013, p.321) argues,

> The more a financial system moves from relational finance to entities and ultimately markets, the more it depends on a formal legal system with the capacity to authoritatively vindicate the rights and obligations of contractual parties or to lend its coercive powers to the enforcement of such claims.

Thus, the credibility and fungible value of financial contracts depend on such legal support. In this sense, again, we draw attention to the conditions of the policy capacity in the legal and institutional arrangement. Regulation, therefore, has a relevant role in this context. Indeed, there can be no financial markets without regulation, so one cannot assume there are markets in an environment of deregulation. Instead, some markets are self-regulated, as evidenced in the years since the global financial crisis of 2008-09 [Hodgson (2013) and Reis e Vasconcelos (2016)].

According to Harvey (2013), the condition of self-regulation is associated with a form of implicit delegation to private agents who are "forced" to fulfill a set of rules which are fully protected by the institutional legal apparatus. In summary, this pillar shows the importance of a legal system for the operation and development of a modern financial and capital market. Furthermore, an analysis that does not account for such a crucial aspect is incomplete, so it will likely not provide the correct explanations for the phenomena observed in financial markets [Reis e Vasconcelos (2016)].

2. *The essential hybridity of finance.* Modern financial markets are necessarily hybrids, i.e., there is no public or private exclusivity, while also there are no free or statist markets. This hybridity is also reflected in the structure of foreign exchange and sovereign debt markets, for example: both are private markets for financial claims underwritten by public actors. Fundamentally, considering that an asset is a type of contract, the parties involved often depend on the state, and its legal system in particular, to provide enforcement mechanisms and other laws necessary to support the development of ostensibly private markets.

3. *Power as the differential relation to law – The elasticity of law.* The elasticity of law can be defined as the probability that ex ante legal commitments will be relaxed or suspended in the future. In other words, the elasticity of law can be interpreted here as a discretionary power. As Pistor (2013) indicates, a sovereign country with its own currency is at the top of the power range, as it theoretically has access to infinite resources, given its ability to issue currency.

4. *The law-finance paradox.* There is a paradoxical relationship between law and finance. The legal underpinning secures finance, but strong enforcement of law can break it. Although necessary to provide reliability and predictability to the financial market,

laws can lead to a collapse of the system if full compliance with contracts is required [Reis e Vasconcelos (2016)] What is at stake here is the credibility of the system. In fact, if laws (rules) are relaxed to save the system, this may directly affect agents' expectations. That is, knowing that the rules might change according to the current state of the economy, agents will have no incentive to follow them. According to Pistor (2013), this creates a paradox in the sense that it is hard to enforce a law when agents know that it can be relaxed when necessary.

The last two pillars, the elasticity of law and the law-finance paradox, show adherence to the rules controversy in the economic policy aspect, and consequently insert the LTF in the debate regarding rules versus discretion of the monetary policy. First, like the financial market, the implementation of rules (laws) in the scope of monetary policy is akin to entering a land of promises that will inevitably not be kept in case of the collapse of the system. Here lies the role of the elasticity of law. In this sense, in situations of complexity of the economic cycle, that is, in moments of crisis where the confidence of economic agents is substantially shaken, the rules (laws) need to be relaxed to mitigate, or even avoid, economic depression and the risk of systemic crisis in the financial and capital market.

Regarding the law-finance paradox, as Pistor (2013) argues, it follows that law and finance stand in an uneasy, paradoxical relationship to one another. In other words, legal support secures finance, but stringent enforcement of law can break it [Reis e Vasconcelos (2016)]. The credibility of the legal and institutional system is under judgment. According to Pistor (2013), laws provide credibility to financial instruments in the market by casting the benevolent glow of coercive enforceability over them. Thus, the problem is if the laws or rules are relaxed or suspended to save the real economy as a last resort, the system's credibility is at stake. Here again, one of the main elements supporting the mainstream argument for a rule-based monetary policy is credibility.

However, even if the monetary authority has a discretionary role, credibility is mandatory. In other words, credibility is not a condition for monetary policy only for the defenders of monetary rules; the raison d'être of the MA is to provide credibility to the public. Indeed, the public should be aware that if it believes that a monetary policy is subject to course changes, that policy also may not succeed in its objective, even if compatible with the public interest. Thus, the more transparent the government's indications are, the faster and calmer the movement should be in that direction (Carvalho, 1999).

Regardless of the approach of the LTF with Keynesian theory regarding fundamental uncertainty, Pistor (2013) does not give proper treatment to one of the main premises of his theory, volatility of liquidity, treating it as an exogenous event. The key point of the

LTF is that liquidity is "the ability to sell any asset or cash at will (Ibid., p. 316).

The fundamental uncertainty addressed by Pistor (2013) does not seem compatible with the hypothesis of exogeneity of liquidity. In this sense, it is feasible to assume, as in Keynes (1982), that from the standpoint of the LTF, decisions are made in an environment of fundamental uncertainty, based on agents' expectations about the future without perfect predictability. In fact, in times of high uncertainty there is a natural search for more liquid assets, which has consequences in determining the market interest rate.

Thus, the interest rate requires special attention, forcing the MA, through monetary policy, to act on the short end of the yield curve in order to influence long-term interest rates. Moreover, as the LTF advocates, the function of the MA is not restricted solely to ensuring the stability of the currency, but also to ensuring the stability of the financial system, which in times of crisis, "implies that in the last instance the only true lender or dealer of last resort is an agent with unlimited supplies of high-powered money. Only few actors can assume this role: Sovereigns (or their central banks) that control their own currency and who issue most of their debt in that currency" [Pistor (2013, p.319)].

In view of the foregoing, in order to perform its functions in full, the MA needs a certain degree of discretion. In fact, in situations of high uncertainty, coupled with the need to adapt to economic policy in specific situations, policymakers must act deftly in adapting monetary policy, which is not possible when this is based on hard and fast rules, as suggested by the framework of the ITR.

In addition, the MA's attributions in the LTF show convergence with the PKT regarding transparency of monetary policy performance. In other words, the degree of discretion is not synonymous with lack of transparency. Rather, both for Keynes (1982) and the post-Keynesians, the MA should signal clearly that the objectives and the direction that monetary policy will take, so as to avoid ineffectiveness of the policy. It could, on the contrary, increase its effectiveness [Libanio et al. (2004)]. Furthermore, fundamental importance is attached to the credibility that the MA possesses, given that the success of monetary policy depends substantially on the public's belief in its feasibility. Thus, the effectiveness of monetary policy depends on the credibility of actions on the one hand, and on reputation and competence on the other [Bibow (2002)].

In short, the freedom and power that the MA has to act in a discretionary manner are of public interest, so that its performance should not benefit private interests Palley (2006). Therefore, the legitimacy of monetary policy implementation is sustained in time by the legal mechanisms of accountability. They tend to ensure public support for the exercise of CBs' mandate [Duran (2012)]. Therefore, this is one more factor that approximates the PKT's LTF in defense of the discretionary establishment of monetary policy, with emphasis on the cruciality of the legal system and institutions in understanding modern financial systems.

Combining the two pillars, the elasticity of law and the law-finance paradox, one can rescue the idea that wise state intervention can correct market failures and mitigate the effects that would otherwise lead the economy to recession. In general, the argument here has the underlying assumption that the aggregate state intervention supports the collective interests of society, and opposes the liberal argument (not the Anglo-Saxon one, but the traditional one). In other words, state intervention in economic policy in general, and monetary policy in particular, ultimately frustrates the self-interest of a particular class regarding the maximization of power (public choice). In this sense, monetary rules in the scope of economic policy bring with them an increase in the power of the monetary authority that can be diverted to serve other classes of interest in detriment of the collective (political economy).

Within the framework of a capitalist economy, monetary rules bring with them volatility of financial assets and elevate the power of renaissance. Normally, in economies that do not have a precise diagnosis of economic problems, such as inflation in Brazil[14]., economic policy rules overload the manager (central bank, for example) when it demonstrates for some reason inability to reach the goal defined officially (law).

However, as in Keynes, Pistor (2013) implies that although the role of the state in the modern capitalist and business economy is fundamental, economic policy activism must be restricted in situations of generalized crisis, such as the global financial crisis of 2008- 09. In this sense, the action takes place as a countercyclical strategy, given the inability of the market to self-regulate. Thus, under conditions of instability, it is necessary to consider a more active role of the state in coping with complex situations and in reversing distrust of economic agents. This is the connection with the pillars in favor of discretionary policy. If agents know implicitly that in crisis situations laws can be relaxed, and that the rules are aligned with the current state of the economy, then why no longer act in a discretionary way (the elasticity of law)? And if state intervention via coordinated countercyclical policies soothes the market's concerns and reclaims credibility, does it make sense to keep economic policy restricted to rules (the law-finance paradox)?

It is precisely these two hypotheses that we explore and try to answer below as the central objective of this essay, and try to show that the LTF converges to the debate about rule-based versus discretionary monetary policy. The main argument implicit in the LTF is that in economies where economic problems do not have accurate diagnoses, monetary policies based on (strict) rules, notably in inflation targeting regimes, the monetary authority may be submissive to private market interests and thereby make the financial market more volatile. This brings consequences such as difficulty of capital market development and inertia over the long-term interest rate, which can slow real growth and economic development.

[14] See Sicsú (2002), Sicsú (2003), MODENESI (2011) and Modenesi e Modenesi (2012)

The proposals presented and discussed below are not intended to exhaust the debate on the subject. In addition to contributing to the debate over rule-based versus discretionary monetary policy, this paper also provides important insights for further research, especially about the interdisciplinary interaction between law and economics. A key contribution of this essay is to add to the debate an institutional conception, embedded in power relations, from a legal point of view that is absent from the argument in favor of monetary policy managed by rules. This may be useful not only to understand the functioning of the financial system, but also of economic policy in general. Thus, in addition to the relationship with monetary policy, as shall be seen below, its consequences can be applied to other areas of macroeconomics.

1.4 Introducing the LTF in the Rule versus Discretion of Monetary Policy Debate

The starting point to introduce the LTF in the debate, following the Minskyan sense, is correlated with the uncertainty of markets and liquidity constraints that make financial markets inherently instable. Law contributes to that instability, since debts are nothing but enforceable legal obligations [Goldmann (2017)]. Indeed, in extreme situations, such as the global financial crisis of 2008-09, creditors will desperately try to enforce their contracts simultaneously, in the worst case leading to collapse of the financial system. In other words, "obligations at the apex of the hierarchy of finance might not be honored to ensure the system's survival, while borrowers in the lower echelons of the financial system without systemic significance will have to pay" (Ibid., 20).

Moving from the debate of economic theory to economic policy involves other factors that need to be considered. Direct equivalence of problems in a particular context or situation does not have to exist to propose means of intervention (rule breaking). This passage demands great caution when one is studying this topic because there is an important mediation between the analysis of problems and the diagnosis of the means of intervention, which has much to do with two things and are exogenous in the technical sense..

One is pure and simple preference. Here the preference is marked by exogenous factors, such as human nature with deviations of ethics that make politics devoid of credibility. The second is political preferences. Thus, it is reasonable to say there are tradeoffs in economics. That is, the economy moves by choices, so there are inevitably preferences.

In view of the above, the LTF brings elements that converge to the debate about rules and discretion of monetary policy, especially regarding aspects of the credibility and reputation of the monetary authority in its discretionary action. This is connected with

the law-finance paradox pillar:

> (...) it follows that law and finance stand in an uneasy, paradoxical relation to one another. Law lends credibility to financial instruments by casting the benevolent glow of coercive enforceability over them. But the actual enforcement of all legal commitments made in the past irrespective of changes in circumstances would inevitably bring down the financial system. If, however, the full force of law is relaxed or suspended to take account of such change, the credibility law lends to finance in the first place is undermined [Pistor (2013, p.323)].

Monetary rules bring with them volatility of financial assets and raise the power of renaissance. Normally in economics, there is no precise diagnosis about problems, such as inflation in Brazil. Economic policy rules overload the manager (CB for example) when it for some reason is unable reach the goal defined officially (law).

In this sense, in crisis situations, countercyclical policies are implemented. This action is per se an intervention that breaks the economic policy rule. That is, the monetary authority uses discretionary policies. There is, however, a paradox here: if, in situations of economic depression, the monetary authority acts discretionally, why use rules? In addition, agents know that in extreme situations there will be intervention, so credibility should not be at stake.

However, although it is not directly mentioned Pistor (2013), the the monetary authority is protected institutionally under the aegis of the government. Therefore, if it has time operational freedom in the use of monetary policy instruments to achieve its objectives, even by acting in a discretionary manner, the CB must present clarity and transparency in its actions, in search of credibility and good reputation.

In this sense, the allocation of power to the monetary authority is not only to stabilize the value of money and to control inflation. Converging to the LTF, a degree of arbitration is mandatory in its performance in a situation of high uncertainty. In fact, uncertainty about the future coupled with the need to adapt economic policy to specific situations requires that economic policy managers have some capacity for change and adaptation, which is not feasible when CB acts through specific rules, as suggested by the framework of the inflation targeting regime. Moreover, no credibility would be given to a policy formulated under one state of the economic cycle that is maintained when the situation is different. It would therefore be desirable to maintain a certain degree of discretion in order to deal with new or unforeseen situations.

Finally, regarding the elasticity of the law, the underlying question points to the beneficiaries, that is, why and for whom the law would be more elastic. The modern financial system thus has a true "hierarchy" [Mehrling (2012)]. Pistor (2013) recognizes these characteristics of the modern financial system, but goes further with the LTF. She

notes that despite being inherent in agents' position in the system, the hierarchy is not natural. Rather, the hierarchy results from the power exerted by other agents.

The absence in the discussion between rules and monetary policy discretion of elements such as institutional aspects, power and legal relations, in relation to the MA's performance, is in line with the LTF framework and necessarily supports the idea that there is a convention favoring conservatism of monetary policy. This rhetoric is more active in developing economies, especially those working with RTIs, where the theoretical assumptions in the NMC require more conservative action by CBs. In other words, high interest rates do not pose a problem of an exclusively macroeconomic nature. They result from an influential coalition of interests formed around the maintenance of interest at high levels, for example, and the resulting appreciation of the local currency.

In this case, one observes non-neutrality of the economic policy itself. What is perceived is the building of a broad and powerful coalition of interests that is not only beneficial to the holders of financial assets, but also to the MA itself, which benefits from its reputation for conservative performance or extreme adversity to inflation. Thus, it is not just a typical situation in which the agent, the CB, is captured by the principal, the rentiers. In the words of Erber (2011, p.43):

> There, as a large and powerful constellation of interests structured over time around the combinatorial high-valued exchange interest, which established a convention that these elements are essential for the development of the country. [...]. This coalition of interests has powerful instruments to consolidate and disseminate its development convention. The most explicit is in the hands of the financial system [...]. But there are others [...] such as the financing of political campaigns, relations with members of Congress, "bureaucratic-business rings" [...] and relations with the media. The Central Bank is a necessary member of this coalition [...]. For the establishment of the coalition and the convention that serves as a social representation, it is enough that the Central Bank and private members derive joint benefits from the same policy - in this case, the prestige of meeting the goals and profits derived from high interest and exchange rates valued.

According to Modenesi (2014), there is a logical difficulty on the part of the mainstream to assimilate the correct meaning of this thesis - probably because it transcends economic theory, given its eminently sociological character. Moreover, it is not possible to give formal treatment to this thesis, due to the fact that historical time and social and political relations are irrelevant.

The hypothesis of fundamental Knightian uncertainty, as presented by Pistor (2013), is another element of convergence to the rule versus discretion of monetary policy debate, whose concept allows establishing a connection between the formation of expectations and conventional behavior. As presented by Reis e Vasconcelos (2016), the LTF also has elements that are in line with Keynes's idea of uncertainty. In this sense, for both cases

the expectations are exogenous, that is, they are not determined mechanically by objective factors, allowing the behavior of consumers and investors to be reduced to mechanical models, in which iron laws of motion or of gravitation are imposed on the agents, regardless of what they want to do [Carvalho (2014)].

The idea of convention is relatively simple and straightforward: it comes down to a belief shared by a number of individuals. In this case, the convention works as a reducer of uncertainty, by making predictable the behavior of those who are assumed to share the same belief. However, their relevance will necessarily depend on how many individuals share a particular belief. Hence the term conventional behavior emerges, in the sense that a dominant belief at a given moment is one capable of explaining not only the behavior of an individual, but rather that of the economy as a whole.

According to Erber (2011), conventions form a broader concept and include not only common assumptions regarding economic policy but also a common hierarchy of ends. This concept approaches the theoretical conception of the LTF by adding that it is not restricted to a common understanding of how a market economy works, but also involves a hierarchy that defines the solution of possible tradeoffs that require some external intervention.

In this sense, Pistor (2013) assumes that financial operations are planned and executed within a legal system. Therefore, financial assets are necessarily contracts, with amounts depending on their legal validation. Thus, contracts and assumed obligations, with the purpose of protecting against losses and ensuring the health of the financial system, can under fundamental uncertainty and liquidity volatility lead to opposite results.

According to Reis e Vasconcelos (2016), contracts and obligations are assumed by public and private entities and are considered to be quasi-perfect substitutes for the currency, and can thus be traded with a certain ease. However, changes in the scenario with increased uncertainty may unleash a sudden search for other assets. If multiple agents do this at the same time, market liquidity conditions will suffer. In this case, as described by Mehrling (2012), the assets considered as insurance, currencies and sovereign bonds, become even more attractive, which makes the financial system uneven and hierarchical.

Here lies a real dilemma between the development convention and the stability convention, in line with the hierarchy and power interests seen in the LTF. More precisely, these two conventions are not confined to hypotheses about the fundamental mechanisms of operation of an economic system as regards the contrast between them, but also to the preference, in the first, for the promotion of development even if this undermines stability, or stability while sacrificing development.

In the light of the above, it is invariable to include in the discussion the analysis of the forms of intervention by economic policy in the operation of the economy and in

the pursuit of the ends proposed by each convention. Therefore, a convention would also include a specification of the most efficient intervention instruments [Carvalho (2014)].

Here lies the essential role of the CB as the only agent with the capacity to intervene in order to make the financial system level. In other words, although it is not clear from the LTF, other mandates should be included, leaving not only the responsibility for guaranteeing price stability (RTI). In this sense, it is the only institution, representative of the state, qualified to serve as LLR, being an agent with infinite power to provide liquidity in the market.

Therefore, as seen the LTF presents elements of convergence with the rule versus discretion of monetary policy debate. First, there is an absence of essential elements in the debate that is brought by Pistor, such as institutional, legal and power relations aspects. These elements are totally neglected by most defenders of monetary policy rules.

However, the act of providing liquidity of last resort extends the CB's room for maneuver to conduct monetary policy in a discretionary manner. According to Pistor (2013), the importance of having a CB with capacity to provide unlimited liquidity is of paramount importance to ensure the health of the financial system. In addition, although it is not fully explicit in the LTF, the rules when threatened (for example, when the CB demonstrates that it will not be able to reach the inflation target) cause high market volatility. In effect, the liquidity volatility, a la Pistor, makes it impossible to reconfigure the portfolio at any time.

Finally, the LTF is a highly promising theory. It incorporates several elements in favor of discretionary monetary policy intervention, enriching the debate. Thus, the prescriptions in terms of economic policy to ensure the proper functioning of the financial system and reduce the risks of tacit tradeoff between the market and the MA, in the form of a convention, converge in an essential point, also present in the current post-Keynesianism: the state - generally through the CB – is a provider of liquidity of last resort in an economic system in which decisions are made in relation to the future without perfect predictability (fundamental uncertainty).

1.5 Conclusion

The present chapter discussed the relationship of the LTF, proposed by Katharina Pistor, and the debate about rules and discretionary monetary policy. The rise of the LTF came in the wake of the global financial crisis of 2008-09, to provide a theoretical alternative to the conventional thinking dominated by mainstream economic analysis.

The recent crisis and its unfolding led to a revision of the mainstream, notably the NMC, regarding the conventional paradigm of a monetary policy based on rules, also

serving as a guide for other economic policies. Kocherlakota (2016) notes there is evidence that discretionary action by the Fed, for example, would have better results. Theoretically, "discretion allows central banks to take advantage of information about the macro-economy that is hard to write into rules" (Ibid, p.32). In short, the distancing from the Taylor rule would allow the MA to pursue a more rapid recovery from crises.

In fact, the crisis in the diagnostic view of mainstream economists have as key elements to fail in the financial markets and the absence of a financial policy in favor of the soundness of the financial system in general, hitherto ignored in the EMH. Hence divergences emerged within the NMC, the results of which, although early, suggest the inclusion of risk management as an intermediate objective of MP and the incorporation of macroprudential policies as a new MP instrument.

However, since the NMC's progress is limited, it can be considered a kind of mea culpa, especially regarding the efficient markets hypothesis, bringing to the center of the discussion the inclusion of financial stability in the focus of monetary policy [Palley (2013)]. The inflection of the mainstream was not sufficient for a complete revision of the conventional paradigm. In this sense, the theoretical foundations of the ITR were not completely abandoned, with maintenance of the diagnosis of inflation as a monetary phenomenon, the hypothesis of rational expectations, the natural rate of unemployment, the rigidity of prices in the short term, and the maintenance of models of temporal inconsistency in favor of an independent CB. Thus, financial policy remains subordinated to the monetary targets, being coordinated by the CB, consequently, eliminating any discretionary action in competition with the ITR.

Is has thus been shown that the LTF provides a new conceptual framework for the analysis of financial and capital markets, where the MA plays a key role in expanding its mandate for financial stability by acting as LLR. In this sense, according to the hypothesis of fundamental uncertainty and liquidity volatility exposed in the LTF, by emphasizing that financial interdependences are legally constituted, the theory suggests that this condition may increase the liquidity constraint when past investments are corrected in light of new facts. Thus, according to Reis e Vasconcelos (2016), this situation enables the LTF to define the dual character of the law: "while law is necessary for the functioning of the system, the law may also be responsible for the destruction of the system if the law is not sufficiently elastic" (Ibid. p. 224).

The elasticity of the law and the paradox of the relationship between law and finance provide a new theoretical and conceptual framework for analyzing the role of monetary policy. As discussed by Pistor (2013), the recent crisis led to an abrupt change in pursuit of more liquid assets, necessarily government bonds and money instruments. In fact, one can conclude that the financial system is not level, but rather hierarchical [Mehrling (2012)]

As has been seen, the only agent with the ability to perform the LLR function is an agent with infinite power to issue money. In the modern capitalist economy, only the state or its central bank has such capacity to issue debt in its own currency. This framework leads us to the *law-monetary policy paradox*, the title of this chapter.

Undoubtedly, the CB here faces a real dilemma. The paradoxical relationship between finance and the laws that regulate it, the rules of monetary policy in the conventional view, although it can be consensual, have the function of providing reliability and predictability to the financial market. The existence of previously agreed rules (laws) may lead to the collapse of the system when full compliance is required. On the other hand, if the rules are relaxed or suspended in order to save the system from collapse, the MA may lose its credibility.

As has been seen, credibility is also present in MA discretion. That is, the greater its accountability, the greater the monetary policy room for maneuver is, especially in times of high uncertainty. However, the heart of the matter is over who benefits from a rigid rules-based monetary policy. The discussion deepens in the relations of power and is directed towards the political economy.

The convention in favor of conservatism in monetary policy explains the maintenance of policy rules. In this case, in developing countries, especially those that adopt inflation targeting, monetary authorities tend to be more conservative, thus favoring rentiers. In this case, the conduct of monetary policy in the framework of rules is not only a macroeconomic problem, but is also linked to a range of interests involving the principal-agent problem, in which the central bank (agent) is captured by the rentiers (principals).

This pact is beneficial to both. Rentiers benefit from the profits provided by the high yields of their financial investments while the CB enjoys the prestige of reputation in the international arena due to its high degree of conservatism. In fact, the CB is a necessary member of this coalition - it is the institution that designs and executes monetary policy - not necessarily implying “capture” in the sense of “public choice”. For the establishment of the coalition, it is enough that the CB and private members derive joint benefits from the same policy - in this case, the prestige of meeting the targets and the profits derived from high interest rates and the appreciated exchange rate.

The conservative profile of the CB and the fruits harvested by the coalition with rentiers translate into keeping the interest rate at very high levels, which not consistent with an economy that seeks growth and welfare improvement for society as a whole. Also, the rigidity of monetary policy is so complex that the five theses presented here are not capable of explaining this phenomenon in isolation. However, there are some measures that can be taken to clear the transmission channels of monetary policy.

Finally, based on the conservatism convention in the conduct of politics, the LTF

converges to the debate between rule-based and discretionary monetary policy. Therefore, it is necessary to redesign the current monetary policy strategy, since the control of inflation through interest rates causes harmful side effects to the growth and development of the economy, i.e., it is necessary to discuss the importance of discretionary action to the detriment of a policy based on rules.

Hence, there is room in the literature advance the discussion between rule and discretion of monetary policy, investigating how the characteristics present in Keynesianism (or PKT) can dialogue with the points presented by the LTF that are not present in the debate, especially in the field of defense of rules, such as the emphasis on power relations, institutional and legal aspects. The LTF is strengthened and evolves as a theory developed outside the structure of analysis of the mainstream that provides an improved understanding of CBs' performance in favor of collective welfare of the whole society.

2 Effects of monetary policy news on the behavior of financial assets: evidence from Brazil before and after the global crisis (2006-17)

Introduction

The development of studies investigating the behavior of prices and returns on financial assets is longstanding, and the demand for appropriate models has increased substantially with the rising complexity of financial products, the closer connection between markets, technical progress, and more recently, the occurrence of economic crises. Among the variables studied in the financial and capital markets, volatility stands out.

Although it may seem simple, the concept of volatility does not have a single definition. It is generally associated with the concept of risk in relation to the return of a financial asset class. Thus, the literature and the market in general define it as the standard deviation of the returns of a financial asset, in each period, conditional on the information existing at the beginning of the period.

Faced with the subjectivity of the concept of volatility, the literature has advanced on finding different ways of estimating and analyzing this important unobservable variable. In this sense, the choice of the estimation method and its analysis depend on the purpose of the estimation. In this essay, following the macrofinance literature, we consider the models in which volatility depends on past asset values.

In this class of models, volatility characteristics are known, with their variation in time (heteroscedasticity) and a tendency to group in certain periods, so that small variations tend to be succeeded by small variations and large ones tend to be succeeded by large variations. This is the concept behind the first model of this class, developed by Engle (1982): ARCH (Autoregressive Conditional Heteroskedastic).

The literature advanced further with the seminal contribution of Bollerslev (1986), with extension to the GARCH (Generalized ARCH). In addition, researchers recognized the need to expand the multivariate GARCH case, leading to the Multivariate GARCH (GARCHM) model, initially proposed by Bollerslev, Engle e Wooldridge (1988), through the VEC model. The main motivation of the multivariate models is to estimate the relationship between the volatility and co-volatility of various assets and markets.

The macrofinance literature has paid relevant attention to assessing the impacts of economic news on financial assets. The recent global financial crisis of 2007-09 whetted the interest of analysts and researchers to investigate the effect of macroeconomic events on market volatility. Indeed, after the outbreak of the crisis, the mindset of actors, in particular investors, became more sensitive in this highly uncertain environment, a situation that still exists.

Unlike the efficient markets hypothesis (EMH), whose theoretical fragility was revealed by the crisis, the underlying premise here lies in the concept of Knightian uncertainty. Knight (1921)'s approach to uncertainty is one of the most widely studied in the literature. Its importance derives from the conceptual difference between risk, whose probability of occurrence is measurable, and uncertainty, whose probability is unobservable and therefore impossible to quantify.

For Keynes (1982), agents' psychology, which he called "animal spirits", does not consider factors with a high degree of uncertainty. Although in certain situations highly uncertain facts may become decisive, a reasonable guide to current decisions is to consider events considered to be highly likely. Thus, the formation of long-term expectations suffers to some extent from the influence of the current state of the economy, unless the opinion on the current situation is well justified. The usual practice of agents is to look at the current situation and then project it into the future, modifying it only when they have clear reasons to expect change

Several empirical investigations have been developed to analyze the effects of the agents' feelings, especially of the investors, on the financial and capital market. However, in the context of monetary policy, these works are mostly applied to analyze the effects of their (forward-looking) behavior, the information on which is collected in communiqués and policy committee minutes, or by investigating the impacts of policies on financial assets.

For daily and higher frequency data, an extensive literature examines finance in several dimensions. In this range of empirical research, news of various macroeconomic natures, such as economic activity, inflation, interest rate expectations, trade and capital flows are considered. This type of analysis focuses on evaluating the impacts of macroeconomic factors as inputs for portfolio allocation strategies. However, the focus of this essay goes further. The idea here is to bring to the discussion the impact of events associated with monetary policy on the behavior of financial assets in the Brazilian market. Precisely, we analyze how the news about the conduction of monetary policy affects the market volatility, represented by variance of the return of assets used as proxies in the model.

Although the international literature is extensive, we did not find any work applied to Brazil with daily data and high frequency to capture the effects of macroeconomic news on the behavior of financial assets. Specifically, there are no academic studies for

the Brazilian economy that have examined how the market reacts to news related to the conduction of monetary policy.

If a monetary policy based on rules is subject to monitoring by the market (forward looking), it is expected that news will reveal the central bank's mandate deviation quickly affecting asset prices (causing volatility). In this context, asymmetry is expected in the interpretation of the market. In other words, negative news is expected to have a greater impact than positive news. However, it is also possible that news about the conduction of monetary policy will have little impact on the perception of the market. This stems from the fact that Brazil has also intensively used unconventional (macroprudential) measures, both in monetary and exchange rate policies.

To fill this gap and contribute to the literature, the present essay performs an empirical analysis of the effects of the news involving monetary policy and its spillovers on the financial market. Through the VAR-GARCH methodology, with daily data between January 2006 and May 2017, we evaluate the impact of the market perception of the CB's performance, notably in relation to its mandate to bring inflation down to the central target (ITR) before and after the global financial crisis, on two financial variables: (i) stock prices and (ii) exchange rates. To evaluate market perception, we develop a positive and negative news index, based on the proposal of Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018), with daily data on the Brazilian Central Bank's (BCB) monetary policy performance.

Besides contributing to the empirical literature by estimating a bivariate VAR-GARCH (1,1) model to examine the effects of both negative and positive news on assets prices, the motivation of this essay stems from the fact that a CB with a single mandate, as in Brazil, within the ITR may cause market volatility and have important implications, such as long-term interest rate inertia. In other words, to the extent the CB is unable for some reason to achieve its objective, the market quickly corrects asset prices, forcing monetary policy to react. That is, the CB (principal) ends up being captured by the market (agent). However, as mentioned, during the global financial crisis the Brazilian government and BCB adopted a series of macroprudential measures. Indeed, it is no surprise that news about monetary policy had little effect on average returns, and volatility in particular, during the period studied.

From the foregoing, the motivation of this study is twofold. First, there have been no studies examining the bi-directional relationships between monetary policy news and asset prices in Brazil in a bivariate VAR-GARCH framework. Second, this is the first study to contemporaneously examine the impact of negative (positive) monetary policy news on the mean and variance of the Brazilian equity and currency markets.

This essay makes a threefold contribution. First, it focuses on the relationship between monetary policy news and asset prices before and after the 2008 crisis in Brazil,

for which limited evidence is available. Second, it considers the linkages between the second moments of the variables of interest, so that the conditional volatility can be seen as a proxy for uncertainty, whose role we are therefore able to assess in this context. Third, this essay also contributes by providing a time series approach, which is better suited to capturing time variation in the high-frequency (daily) series and considers a considerably longer sample time frame.

We find little evidence of the impact of news on the behavior of the Brazilian financial market, represented here by the exchange rate and the stock index. In relation to the former, we find little influence, both on the average of returns and their volatility, of negative (positive) news about the ability of monetary policy to guide inflation to the central target. The stock index was sensitive to negative news before and after the crisis. Additionally, for both variables, there is evidence that the specialized media was influenced by market closure.

In addition to this introduction, this chapter consists of five more sections. In the second we review the literature on macroeconomic news and surprises and their impacts on the financial market. In the third section we present the models used to conduct the tests. In the fourth, we present the data econometric method. In the fifth we discuss the empirical results. The sixth section concludes.

2.1 Expected Effect of News and the Related Literature

There is an extensive literature that associates economic fundamentals and asset prices. The effects of macroeconomic news on assets prices have been analyzed extensively in the more recent financial literature. The theoretical motivation comes from asset pricing models according to which factors driving macro series such as consumption and investment should also affect asset prices Merton (1973). Asset prices are expected to react to information, especially surprises, regarding the behavior of macroeconomic variables which in turn, systematically affect agents' expectations about the future of the economy. In effect, there is a direct impact on cash flows, due to the change in the discount factor (which is a function of the interest rate and the risk premium) and, consequently, the assets price in general.

Although the crisis aroused interest in studying of the impact of news, both good and bad, on macroeconomic policy, interest in this subject is not recent. An example of this is the contribution of Pearce e Roley (1984). The authors examined the daily response of stock prices to announcements about some macroeconomic variables for the US market, covering the period between September 1977 and October 1982: (i) money supply; (ii) inflation; (iii) real economic activity; and (iv) discount rate. For macroeconomic surprises, they compared the effect on the expectations of agents, as measured by a survey among

market participants and economists, of the announcements of each indicator on their respective dates. Through an OLS model with lagged variables, the authors found evidence that new information on monetary policy had a significant effect on the S&P500 (stock index). In addition, inflation and surprises about economic activity also had implications for the behavior of the US stock market, as seen by the S&P 500's daily returns.

As for the exchange rate, with daily data from January 1999 to December 2000, Galati e Ho (2003) investigated the influence of macroeconomic news on the daily exchange rates of the euro against the dollar in the first two years of the Economic and Monetary Union (EMU). The authors collected data on macroeconomic indicators of the US and central countries of the Euro Zone. Following Balduzzi, Elton e Green (2001) and Andersen et al. (2003), they created a news index (macroeconomic surprise) based on the difference between the announcement of the variable and the market expectation of the standard deviation of the sample.

Galati e Ho (2003) found evidence that the exchange rate between the euro and dollar is influenced by macroeconomic news. The impact was greater when news changed from positive to negative. In addition, the authors also found that the relationship between macroeconomic news and the euro/dollar rate exhibits considerable time variation. Finally, they found some evidence that the market is more inclined to react to bad news, while generally ignoring positive news about macroeconomic indicators.

One of the pioneering works on the impact of macroeconomic news on financial asset behavior was the article by Balduzzi, Elton e Green (2001). The authors investigated how macroeconomic surprises (the difference between market expectations and the actual outcome of each variable) affected the behavior of the US government bond market. With intraday data, with a difference between five minutes before the announcement and thirty minutes after the announcement, they found evidence that the news has a strong impact on daily prices of three-month, two-year 10-year and 30-year T-bills. In addition, they also found important implications for yield curve models and interest rate dynamics in the US market.

Balduzzi, Elton e Green (2001) showed that the differential impact of news on instruments with different maturities is consistent with the existence of least two uncertainty factors that affect the term structure. Moreover, the almost instantaneous adjustment of prices to public news suggests that jumps are a needed component of realistic time-series models of interest rates. Finally, the authors found that surprises explain a substantial portion of price volatility and that bid-ask spreads tend to revert quickly to their normal levels, suggesting that public information is rapidly absorbed in prices.

Flannery e Protopapadakis (2002) also found evidence that stock market returns are significantly correlated with inflation and monetary expansion. They estimated a GARCH model with daily stock index returns for the US economy, where realized returns

and their conditional volatility depended on 17 macro series announcements. This study is an extension of the Pearce e Roley (1984) with a daily (close-to-close) on return to the value-weighted NYSE-AMEX-NASDAQ market index obtained from the Center for Research in Security Prices (CRSP), from the beginning of January 1980 through year-end 1996. They use the same survey used by Pearce e Roley (1984)but with the most extensive dataset ever employed to study the impact of macro conditions on equity returns. Of these, the inflation measures affected only the returns' conditional volatility, while the monetary aggregate affected both returns and conditional volatility.

Another seminal paper that served as the starting point for a range of contributions to the literature on volatility, was that of Andersen et al. (2003). In this study, the authors, using daily high frequency data (every five minutes), between January 3, 1992 and December 30, 1998, investigated the effects between market expectations and official announcements for 41 macroeconomic indicators on the market in view of the US exchange rate. They empirically analyzed how the exchange market (dollar against the German mark, British pound, Japanese yen, Swiss franc and euro) reacted during the day to macroeconomic surprises.

Andersen et al. (2003) used a multivariate GARCH (1,1) model and the results indicated that macroeconomic surprises (difference between macroeconomic expectations and macroeconomic realizations) produced conditional mean jumps, and the high frequency exchange rate dynamics were linked to fundamentals. Furthermore, they found evidence that the market reacts to news asymmetrically, i.e., bad news has greater impact than good news on the spot currency market.

Some studies have also evaluated the reaction of the financial and capital markets to the news about a particular macroeconomic variable. An example is the contribution of Boyd, Hu e Jagannathan (2005), who analyzed the market reaction to news about the labor market, specifically unemployment data. The authors used monthly data on unemployment covering the period from February 1957 to December 2000. The news was classified according to the macroeconomic surprise framework, i.e., they measured the anticipated and unanticipated (news) component of the unemployment figures announced every month. The authors' proposal was to evaluate the US stock market reaction to unemployment news.

The main conclusion by Boyd, Hu e Jagannathan (2005) was that on average stock prices rise when there is bad unemployment news during expansions, and fall during contractions. Furthermore, they found two factors that affect the price of stocks but do not affect the price of risk-free government bonds: the equity risk premium and the expected future growth of dividends. The first reacted positively to unemployment news during expansions, but not during contractions. They also found that dividend growth expectations responded negatively to unemployment during both expansions and contractions, and had

a larger response during contractions.

Andersen et al. (2007) investigated the real-time interactions among US, German and British stock, bond and foreign exchange markets in the periods surrounding US macroeconomic news. As an econometric method, the authors estimated a multivariate GARCH model to identify the cross-relationships between these markets in light of the news about the US macroeconomics. In other words, they explored the movements of asset prices in these three markets under the influence of the US market.

Their results were especially intriguing regarding stock market responses to news, which displayed distinct state dependence. In particular, the found that bad macroeconomic news has the traditionally expected negative equity market impact during contractions, but a positive impact during expansions. This explains the small stock market news reaction effect when averaged across expansions and contractions, as reported in the previous literature. The asymmetric responses manifest themselves in very different stock–bond return correlations across the business cycle. Andersen et al. (2007) verified that these distinct correlation patterns are not limited to the period around announcements; rather, they apply generally for trading day returns in expansions and contractions. They conjectured that such real-time correlation measures would be useful for more refined classification of the phase of the business cycle.

Following the global financial crisis of 2008-09, there strong interest in the empirical literature to study the effects of economic news on asset behavior. With the use of a Poisson-Gauss-GARCH process with time-varying jump intensity, which allows responding to such information, Rangel (2011) examined the effect of macroeconomic news releases on stock market volatility. The day of the announcement, per se, was found to have little impact on jump intensities. Employment releases were an exception. However, when macroeconomic surprises were considered, inflation shocks showed the persistent effect while monetary policy and emplyment shocks had only short-lived effects. Also, the jump intensity responded asymmetrically to macroeconomic shocks. Their results provided evidence of macroeconomic variables' relevance in explaining jump dynamics and improving volatility forecasts on event days.

Birz e Jr (2011) proposed a different route to examine the effects of macroeconomic news on stock price behavior in the US market. They used time series of closing daily returns of the S&P 500 from January 1991 to June 2004. They then picked out returns for the release days from the economic data series. They proposed a different way to find the effects of macroeconomic news on stock price behavior in the US market. To do this, they developed a complex set of information about the real economy as announced in the media to serve as a proxy for macroeconomic news.

For Birz e Jr (2011), besides reporting statistical facts, newspaper stories also indicate whether the news media perceive something as important and may also reveal

how the economy performed in relation to expectations. In addition, newspaper stories can reveal the meaning of the statistical data on different economic conditions and therefore can indicate the actual news associated with the release. To conduct statistical analysis, they classified the newspaper articles for conversion into a quantitative measure.

To test their hypothesis, the authors regressed stock returns on their newspaper variable, along with various control variables including economic surprises and the state of the business cycle. They found strong and statistically significant relationships between stock returns and newspaper headlines about unemployment and GDP. This was true even though stock returns were not significantly correlated with economic surprises in the time period. Although GDP growth is one of the most common measures of economic activity, the authors stated they were the first to find an effect of US GDP news announcements on the US stock market.

To measure the contagion effect of the global crisis on emergin Asian countries, Kim, Kim e Lee (2015), using a multivariate GARCH models, proposed a novel approach that simultaneously estimates the conditional correlation coefficient and the effect of its determining factors over time, which can be used to identify the channels of spillovers. They found some evidence of financial contagion around the collapse of Lehman Brothers in September 2008. They further found a dominant role of foreign investment for the conditional correlations in international equity markets. The dollar Libor-OIS spread, the sovereign CDS premium, and foreign investment were found to be significant factors affecting foreign investment were found to be significant factors affecting foreign exchange market.

Similarly, Bekiros (2014) analyzes the contagion of the crisis on the BRICS countries. To examine the dynamic linear and nonlinear causal linkages, a stepwise filtering method was introduced, for which vector autoregressions and various multivariate GARCH representations were adopted. The sample covered the after-Euro period and included the financial crisis and the Eurozone debt crisis. The empirical results showed that the BRICS became more internationally integrated after the US financial crisis and further substantiated the contagion effects. Furthermore, some nonlinear causal links persisted after filtering during the examined period. According the author, this indicates that nonlinear causality can, to a large extent, be explained by simple volatility effects, although tail dependency and higher moments may be significant factors of the remaining interdependencies.

Caporale, Spagnolo e Spagnolo (2016) analyzed the effects of macroeconomic news on the returns of eight Eurozone countries (Belgium, France, Germany, Greece, Ireland, Italy, Portugal and Spain) with the application of the VAR-GACH model. To do so, they created a daily positive (negative) news index based on GDP, unemployment, retail sales and durable goods output for the period from January 1994 to December 2013. In addition, they controlled for monetary policy and stock market globalization using domestic interest

rates (90-day Treasury bill rates) and a proxy for the global stock market index (US stock market index).

Specifically, Caporale, Spagnolo e Spagnolo (2016) investigated whether macroeconomic news affected the stock markets of these countries differently before and after the global financial crisis. They concluded that positive (negative) news had significant positive (negative) effects on stock returns in all cases (especially in Ireland and Portugal) Furthermore, the markets responded more to negative news, and the reaction to both types of news appeared to have increased during the financial crisis. News volatility had a significant impact on both stock returns and their volatility, the effects being again more pronounced in the case of negative news and bigger in the recent crisis period, especially in peripheral countries of the euro area. Specifically, the authors found an increase in news volatility always to be associated with a decrease in stock returns. The exogenous factors considered, namely the US 90-day Treasury bill rate and US stock returns, had the expected negative and positive effects respectively on stock returns. Finally, the conditional correlations between stock returns and positive (negative) news were significant and positive (negative), and their increase in absolute value in the case of negative news during the financial crisis indicated higher sensitivity of financial markets to negative releases.

More recently, Caporale, Spagnolo e Spagnolo (2018) analyzed the effects of macro news on the spread between the yield on the 10-year German Bund and sovereign bonds for the same euro area countries that they studied in Caporale, Spagnolo e Spagnolo (2016). Through a bivariate VAR-GARCH model, they concluded that negative news has a significant positive impact on yield spreads for all countries except Italy for the pre-crisis period (before September 2008). In addition, they found that markets respond more intensely to negative news.

In relation to the news volatility, Caporale, Spagnolo e Spagnolo (2018) found that it has a significant impact on yield spread volatility, the effects being more pronounced in the case of negative news and bigger in the most recent crisis period, especially in the peripheral countries of the euro area.

Following Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018), we chose the VAR-GARCH-in-mean model, as detailed below, motivated by its properties: this type of specification enables the researcher to test for causality in variance, causality in mean and GARCH in mean effects (along with the conditional correlations) within the same framework. Given the relatively high number of model parameters (in particular, considering the fact that in our case the inclusion of dummy variables to anlalyze the effects of the global crisis doubled the number of cross parameters to be estimated), the chosen specification appears to be the most appropriate to model the time-varying dynamic linkages with the variables of interest. Furthermore, we apply the same method of those authors to the Brazilian market. However, we replicate the news

index only regarding monetary policy in Brazil to assess its impact on the foreign exchange market and stock market.

Although there is a vast international literature on the subject, we found no studies on how macroeconomic news, especially about monetary policy, affects the Brazilian market. In this sense, the present work, in addition to contributing to the literature on econometrics applied to finance by estimating the bivariate model VAR-GARCH (1,1), also seeks to advance research on market behavior, considering other institutional aspects, such as macroprudential regulation and policy and their effects on market dynamics.

2.2 Models for Time Series Volatility

Since it is an unobservable variable, there is great interest both by researchers and market professionals estimate volatility, because of its utility in problems related to the dynamics of the financial and capital markets. In this sense, in a seminal work, Engle (1982) developed the ARCH model which was later extended by Bollerslev (1986) with the construction of the GARCH model. with the construction of the GARCH model. Both models were pioneers and have been widely used in the literature as starting points for a range of more modern and complex models in econometrics applied to financial macroeconomics.

With regard to volatility, there are two forms of calculation methods for an asset's profitability. The first, let P_t be a series of prices at time t, where the return R_t in period [t-1, t] is given by the relative price variation in this period:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{\Delta P_t}{P_{t-1}} \tag{2.1}$$

Another way to calculate profitability is through the continuous compound return, also known as a log-return of an asset:

$$r_t = log\frac{P_t}{P_{t-1}} = log(1 - R_t) = p_t - p_{t-1} \tag{2.2}$$

where $p_t = logP_t$ and, for small R_t, $log(1 + R_t) \approx R_t$. In this essay, this definition will be used.

In the case of financial series, one usually works with large datasets, emphasizing the importance of the frequency used: per minute, per hour, daily, monthly and etc. In addition, the financial series are also characterized by presenting some stylized facts. According to Francq e Zakoian (2011), the main stylized facts to include can be described by:

1. stationarity of the series of returns, as opposed to series of prices that are non-stationary;

2. absence or low autocorrelation in the return series: the return series present small autocorrelations, making them close and to white noise;

3. presence of autocorrelation in the squares of the returns;

4. conglomerates of volatility: small variations tend to be succeeded by small variations, and large variations tend to be succeeded by large variations, generating a trend for values of small returns of returns to be grouped, with the same effect occurring with large variations of returns;

5. fat-tailed distribution compared to normal distribution;

6. leverage effects: these refer to the asymmetry of impacts on volatility caused by positive and negative returns, where in general, negative returns impact volatility more than positive returns; and

7. seasonality: high-frequency data may have an effect at the time of day on volatility (e.g. hour immediately after market opening or near closure).The daily data, as used in this chapter, may have day-week effect.

Given these stylized facts, we developed a series of volatility adjustment models with the aim of trying to reproduce these events. Here we present those that were used in our empirical estimation. The first one refers to the heteroscedasticity model conditional on the past values of the series: the ARCH model and its generalization to the so-called GARCH. Next, we present the GARCH model in two multivariate versions: VEC and BEKK. It is not our intent to undertake a comprehensive review of volatility models; a more complete list can be found in Bollerslev et al. (2008).

2.2.1 ARCH

Engle (1982)introduced the autoregressive model of heteroscedastic conditional variance (ARCH) model in an attempt to estimate and extract information about volatility more reliably and closer to reality. It satisfies the following return r_t process:

$$r_t = \mu_t + \delta_t \eta_t, \qquad t \in Z \tag{2.3}$$

where μ is the mean conditional on past information which, by simplification, can be considered zero, and η_t is a sequence of independent random variables (called innovations), with mean zero and variance equal to one. Also according to the model η_t is independent and σ_{t-j} and r_{t-1-j}, for $j = 0,1, ...$ The most usual distributions in the

literature that are assumed for the innovations are: the normal distribution [Engle (1982)], t- Student asymmetric [Bollerslev (1987)] and generalized error distribution of error or GED [Nelson (1991)]. In addition, let $\mathcal{F}_{\sqcup}$ be the information set up to time period t. Then the conditional distribution of returns, i.e., $r_t|\mathcal{F}_{\sqcup-\infty}$, has mean zero and variance σ_t^2. The variable rt follows an ARCH (q) process if σ_t^2 is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i r_{t-i}^2 \tag{2.4}$$

where $\omega > 0$, $\alpha_i \geq 0$, the conditions being sufficient for σ_t^2 . The stationarity condition is $\sum_q^{i=1} \alpha_i < 1$.

2.2.2 GARCH

Subsequently, an extension of the ARCH model was developed by Bollerslev (1986), the generalized ARCH model (GARCH). In the GARCH process (p, q), the sigma conditional variance is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i r_{t-1}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \tag{2.5}$$

where $p \geq 0$, $q > 0$, and sufficient conditions for σ_t^2 to be positive are $\omega > 0$, $\alpha_i \geq 0$, $i = 1, ..., q$, $\beta_j \geq 0$, $j = 1, ..., p$. The condition to achieve strict stationarity in the GARCH model is based on the concept of the Lyapunov exponent, by defining a sequence of random matrices $(A_t, t \in Z)$ of dimension $(p + q)$ X $(p + q)$ of the form:

$$A_t = \begin{bmatrix} \alpha_1\eta_t^2 & & \cdots & \alpha_q\eta_t^2 & \beta 1\eta_t^2 & & \cdots & & \beta p, t\eta_t^2 \\ 1 & 0 & \cdots & 0 & 0 & & \cdots & & 0 \\ 0 & 1 & \cdots & 0 & 0 & & \cdots & & 0 \\ \vdots & \ddots & \ddots & \vdots & \vdots & \ddots & \ddots & & \vdots \\ 0 & & \cdots 1 & 0 & 0 & & \cdots & 0 & 0 \\ \alpha_1 & & \cdots & \alpha_q & \beta_1 & & \cdots & & \beta_p \\ 0 & & \cdots & 0 & 1 & 0 & \cdots & & 0 \\ 0 & & \cdots & 0 & 0 & 1 & \cdots & & 0 \\ \vdots & \ddots & \ddots & \vdots & \vdots & \ddots & \ddots & & \vdots \\ 0 & & \cdots 0 & 0 & 0 & & \cdots & 1 & 0 \end{bmatrix} \tag{2.6}$$

According to Francq e Zakoian (2011), to ensure the existence of stationarity, the necessary and sufficient constraint in the GARCH model implies that the Lyanupov

coefficient is less than zero, that is, $\gamma < 0$, such that:

$$\gamma = inf \frac{1}{t} E(log||A_t A_{t-1} \cdots A_1||) \tag{2.7}$$

The strict stationarity condition is complicated, and the second order stationarity conditions are generally used in the applications, as in the general GARCH model (p, q) and (sum) for w> 0. The sum of alpha and beta is known as model persistence. According to those authors, due to the complexity of the strict stationary condition, are usually applied to the second order conditions, which in the GARCH model are $\sum_q^{i=1} \alpha_i + \sum_p^{j=1} \beta_j < 1$. The sum between α_i and β_j is known as persisntence of the model. Thus, satisfying the condition of second order stationarity, the unconditional variance is:

$$\sigma^2 = \frac{\omega}{1 - \sum_{i=1}^{q} \alpha_i - \sum_{j=1}^{p} \beta_j} \tag{2.8}$$

Finally, for simplicity, it is common to find the use of GARCH(p, q) as:

$$\sigma_t^2 = \omega + \alpha r_{t-1}^2 + \beta \sigma_{t-1}^2 \tag{2.9}$$

where $\alpha + \beta < 1$ is the restriction to reach second order stationarity.

2.2.3 Multivariate Models - Direct Generalizations of Univariate Cases

The literature on econometrics applied to finance has advanced in studies of co-volatilities. According to Bauwens, Laurent e Rombouts (2006), the main motivation is the possibility of analyzing the dependence of assets or markets on each other and how they affect volatility, in addition to the meaning and magnitude of these relationships, among other factors. In addition, it is possible to construct models closer to reality, either to help inform decisions about the allocation of financial assets by the market, or to analyze the risks embedded in a well (or poorly) applied economic policy. the point of view of policy makers and academia.

Before proceeding with the presentation of the multivariate GARCH (MGARCH), used in this work, it is important to introduce some concepts about the multivariate analysis. Consider the case N series of returns and let r_t be a vector of returns of size $NX1$, such that:

$$r_t = \mu_t + \eta_t, \tag{2.10}$$

$$\eta_t = H^{1/2} \epsilon_t, \tag{2.11}$$

where μ_t is the mean vector conditional on past information which, just as in the univariate case, by simplification, is here considered zero, and $H_t^{1/2}$ is a definite positive NXN matrix. We assume a vector ϵ_t of independent random variables with dimension $NX1$ that satisfies $E(\epsilon_t) = 0$ and $Var(\epsilon_t) = I_N$, where 0 is a vector of zeros of size N and I_N is the identity matrix of order N. Just as in the univariate case ϵ_t is independent of H_{t-j} and r_{t-1-j}, j=0,1,...

Let $H_t^{1/2}$ be an NXN definite matrix such that $(H_t^{1/2})(H_t^{1/2})$'=H_t, which can be obtained, for example, by means of the Cholesky decomposition. Let $\mathcal{F}_t$ be the information set until time t. So:

$$Var(r_t|\mathcal{F}_{t-1}) = Var(\epsilon_t|\mathcal{F}_{t-1}) = (H_t^{1/2})Var(\epsilon_t|\mathcal{F}_{t-1})(H_t^{1/2})' \tag{2.12}$$

Therefore, H_t is the conditional variance matrix of r_t given $\mathcal{F}_{\sqcup-\infty}$. The difference of the multivariate GARCH models lies in the way they treat the conditional covariance matrix.

For a MGARCH model to be considered well developed, it must be flexible enough to represent variances and covariances. In addition, it is necessary for its parameters to be easily interpreted, with the positive covariance matrix being defined by construction, or with at least one estimator producing positive estimates defined in the covariance matrix [Silvennoinen e Teräsvirta (2009)]. The estimator also must be feasible, especially when H_t is high. Next, we present two models that we use to construct our estimate and describe how they treat the H_t matrix.

VEC

Developed by Bollerslev, Engle e Wooldridge (1988), the VEC model can be considered as the first case of direct generalization of the univariate GARCH model for the multivariate case. This pioneer model belongs to the class of conditional covariance matrix models, in which H_t is modeled directly.

In VEC modeling, conditional variances and covariances are functions of their past values, of squares of returns and products crossed between past returns. The general model can be written as:

$$vech(H_t) = C + \sum_{j=1}^{q} A_i vech(r_{t-r}r_{t-r}^{'}) + \sum_{j=1}^{p} B_j vech(H_{t-j}) \tag{2.13}$$

in which vech (.) is an operator that stacks the elements of the lower triangular part of a square matrix, returning a vector, C is a vector of constants of order $N\ (N + 1)/2X1$, and A_i and B_j are arrays of order parameters $N\ (N + 1)/2\ X\ N\ (N + 1)/2$.

For the case of VEC (1,1), where p = q = 1, we have the equation:

$$vech(H_t) = C + Avech(r_{t-r}r'_{t-r}) + Bvech(B_{t-1}) \tag{2.14}$$

If we consider a bivariate model, such as that developed in this essay, the vech operator in Ht results in:

$$vech(H_t) = \begin{bmatrix} h_{11,t} \\ h_{12,t} \\ h_{22,t} \end{bmatrix} \tag{2.15}$$

According to Gouriéroux (2012), despite the generality of the model (2.15) in being able to capture a large amount of information and dependences, there are disadvantages associated with the conditions of H_t positivity and, possibly, the large number of parameters. First, there is no guarantee of H_t being positive definite (cite the author). In addition, the number of parameters is equal to *N (N + 1)/2 X N (N + 1)/2*, making estimation complex and even unfeasible when N increases.

In order to find a solution to this problem, Bollerslev, Engle e Wooldridge (1988) suggested an alternative model: the diagonal VEC, or DVEC. The DVEC model restricts the matrices A_i and B_j, from the equation (2.13), to being diagonal, so that conditional covariates depend only on their past values and innovations, written as follows:

$$H_t = C + \sum_{j=1}^{q} A_i \odot (r_{t-r}r'_{t-r}) + \sum_{j=1}^{p} B_j \odot (H_{t-1}) \tag{2.16}$$

where A_i and B_j are diagonal matrices and $\odot$ is the Hadamard product between two matrices, i.e. the element ij of the resulting square matrix is the product of elements *ij* of the two original square matrices. In this formulation, the model has *(p + q + 1) N (N + 1)/2* parameters, a significantly smaller number. Thus, the DVEC (1,1) [1] has the following form:

$$H_t = C + A \odot (r_{t-r}r'_{t-r}) + B \odot (H_{t-1}) \tag{2.17}$$

BEKK Model

Proposed by Engle e Kroner (1995), this model bears the name of its authors Baba-Engle-Kraft-Kroner (BEKK). According to Bollerslev, Engle e Wooldridge (1988),

[1] To see the positivity conditions of the DVEC as well as its decomposition in ARCH models, see Ding and Engle (2001).

this model can be considered as a restricted version of the VEC model. In this model, Ht is defined as:

$$H_t = CC' + \sum_{j=1}^{q}\sum_{k=1}^{K} A_{kj}' r_{t-r} r_{t-r}' A_{kj} \sum_{j=1}^{p}\sum_{k=1}^{K} B_{kj}' H_{t-j} B_{kj} \tag{2.18}$$

Where A_{kj}, B_{kj} and C are arrays of parameters with dimensions N X N, and C is lower triangular. Known as BEKK *(p, q, K)*, the model has this decomposition of the conditional covariance matrix, which automatically guarantees that it is definite positive.

Let $\otimes$ be the Kronecker product between two matrices, that is, each element ij of the first matrix multiplies the second whole matrix, resulting in a block matrix. The model is stationary if, and only if, the eigenvalues of

$$\sum_{j=1}^{q}\sum_{k=1}^{K} A_{kj} \otimes A_{kj} \sum_{j=1}^{p}\sum_{k=1}^{K} B_{kj} \otimes B_{kj} \tag{2.19}$$

are less than 1 in modulus.

The order K ensures the generality of the model, allowing increasing the number of parameters to try to better the series studied. However, when K> 1, the idenfiability problem arises, because there is no longer a single parameterization to obtain the represented model.[2]

According to Silvennoinen e Teräsvirta (2009), the disadvantage of the BEKK model consists of the large number of parameters: *(p+q)KN*^{2} *+ N(N+1)/2*. In order to simplify the model, we can define B and A as diagonal arrays, resulting in the so-called DBEKK (Diagonal BEKK or BEKK diagonal). The number of parameters decreases to *(p+q)KN + N(N+1)/2*, although it still considered high. Kroner e Ng (1998) introduced a constraint, where $B = \lambda$, where $\lambda > 0$ is a scalar and D is a diagonal matrix. Finally, there is a more restricted version, the BEKK scalar, in which $A = aI_N$ and $B = bI_n$, with a and b are scalars and In is the identity matrix of order N. With this we arrive at: [3]

$$H_t = CC' + A' r_{t-r} r_{t-r}' A + B' H_{t-1} B \tag{2.20}$$

[2] Engle and Kroner (1995) present the conditions for the solution of this identification problem.

[3] In addition to the VEC and BEKK models, the multivariate family still offers conditional correlation models, which separately specify marginal variances and conditional covariates, such as: (i) CCC (Constant Conditional Correlation); (ii) DCC (Dynamic Conditional Correlation) (iii) cDCC (corrected Dynamic Conditional Correlation); and (iv) ADCC (Asymmetric DCC). It is not the intention of this chapter to present all multivariate models for volatility. For this, see Bollerslev (1990), Longin e Solnik (1995), Tse (2000), Engle e Sheppard (2001), Bera e Kim (2002), Aielli (2006) and Silvennoinen e Teräsvirta (2015).

2.3 Data and Methodology

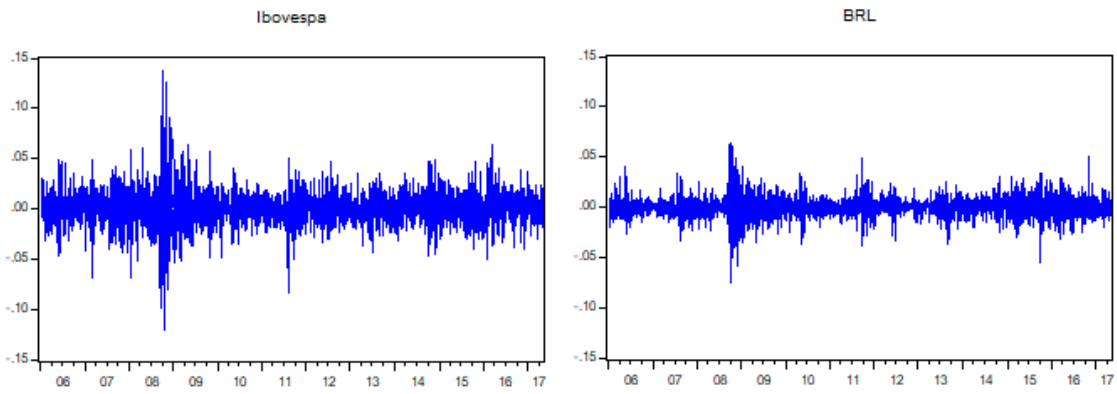
2.3.1 The Data

The dataset consists of daily closing exchange rates and equity market index (Ibovespa) for the Brazilian market (from Bloomberg). The sample period for Brazil runs from 2nd January 2006 to 11th May 2007, yielding 2,853 observations. Daily returns for each series are computed by taking the first difference of the logarithm of total index return and exchange rate multiplied by 100 respectively for the Ibovespa and the exchange rate series. Thus,

$$r_t = log(I_t/I_{t-1}) * 100 \tag{2.21}$$

Where I_t and I_{t-1} denote the current day's closing level and the previous day's closing level respectively. As we are dealing with volatility, we use as dependent variables the return of financial indicators as a proxy for the behavior of the assets as a function of monetary policy. To control for the effects of global volatility and other aspects that may contaminate the behavior of site assets that are not within the scope of monetary policy, we use as control variables the VIX and Brazilian 5-year CDS (such as country risk measures), both obteined from Bloomberg database. Known also as the fear gauge, the index (ticker VIX) is a common measure for the implied volatility of S&P 500 index options. It is therefore an indication of the public's expectation of upcoming volatility in the S%P 500 during the course of the following 30 days.

Figure 1 – Log returns: equity index and exchange rate



Source: Author's creation with Bloomberg data.

Both financial variables exhibit higher leptokurtic behavior and the Jacque-Bera statistics decisively reject the normality assumption associated with the return distribution for the Brazilian market. The rejection of non-normality is inconsistent with a linear model, and this reinforces our motivation for using a nonlinear modeling. The Ljung-Box statistics

show evidence of serial dependence in the return and squared return series (see Figures 12, 13, 14 and 15 - Annex A).

We collected all monetary policy information in Brazil during the sample period. For this, we used as data source the Broadcast terminal of Agencia Estado, which is widely used by the local financial market as a real-time source of financial, economic, poltica, geopolitical and other information. After selecting approximately 55,000 monetary policy items in the period, we filtered the data to select only information involving dynamics of monetary policy, notably with respect to whether the inflation target will be met or not. News headlines were selected using an extensive string search, containing words indicating articles dealing with monetary policy. Specifically, we searched for and discriminated between articles and highlight news with negative and positive connotations about monetary policy's ability to guide inflation to the target.

The data for construction of the news index were collected from Broadcast, in which all the references to the Central Bank in the headline count or contents of reports and alerts were first considered comprehensively in the search. The news items were selected using an extensive search string, containing words as well as macroeconomic variables related to monetary policy and also allowing the distinction between articles with a potentially positive or negative connotation. The distinction for the classification of the news refers to the existence or not of a benign risk or factor for the fulfillment of the inflation target. In this case, the beliefs of the market were also considered regarding the need to extend easing/tightening cycles and dissent/consensus on decisions.

Following Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018), we created an index to analyze the effects of positive and negative news reported by the media. The daily negative (positive) news index is defined as follows:

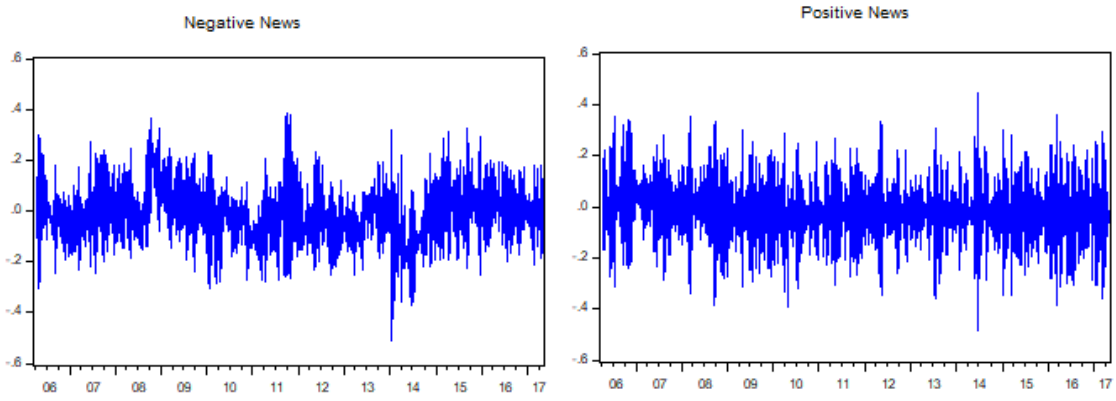
$$Negative(Positive)NewsIndex = ln[e + MPnegative(positive)news] \tag{2.22}$$

2

2.3.2 Descriptive Statistics

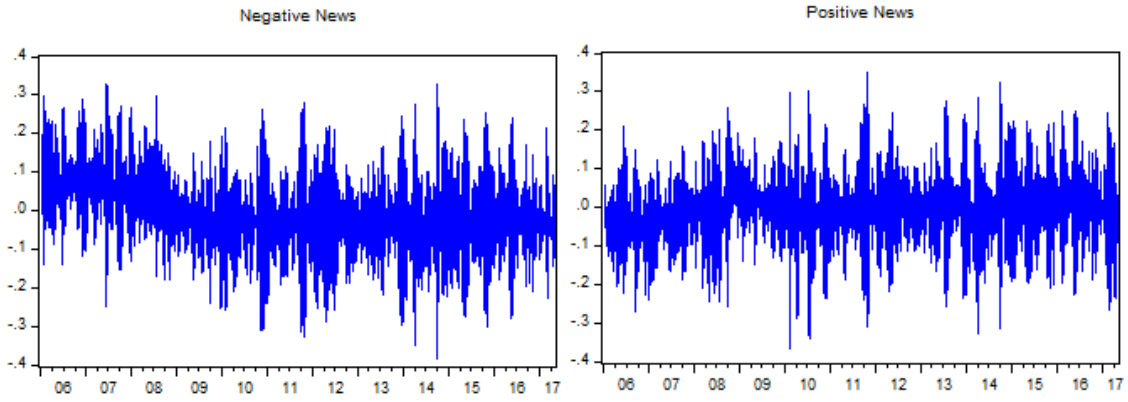
The descriptive statistics presented in Table 1 show that on average the number of negative news releases is bigger than that of positive ones for the full sample. Note that this result may have been influenced by the post-crisis period (due to the larger number of negative news items than positive ones), which was an extremely troubled period in the domestic scenario, also influenced by political issues. Regarding the pre-crisis period (2006-2007), positive news was more common than negative news. This may have been influenced by the favorable economic cycle caused in Brazil by the commodities boom and

Figure 2 – Conditional Correlation between BRL and MP News



Source: Author's creation with Bloomberg data.

Figure 3 – Conditional Correlation between Ibovespa and MP News



Source: Author's creation with Bloomberg data.

the very orthodox position of the BCB in that period regarding inflation, which was very close to the target, and in some moments below it (2006-2007).

Both financial variables exhibit higher leptokurtic behavior and the Jacque-Bera statistics decisively reject the normality assumption associated with the return distribution for the Brazilian market. The rejection of non-normality is inconsistent with a linear model, and this reinforces our motivation for using a nonlinear modeling. The Ljung-Box statistics show evidence of serial dependence in the return and squared return series.

2.3.3 Stationarity

As expected, both series (BRL and Ibovespa) are not stationary in level. Not only is this visible from the Figure 5, but we also applied an ADF test. With one lag included,

Table 1 – Descriptive Statistics - positive and negative news

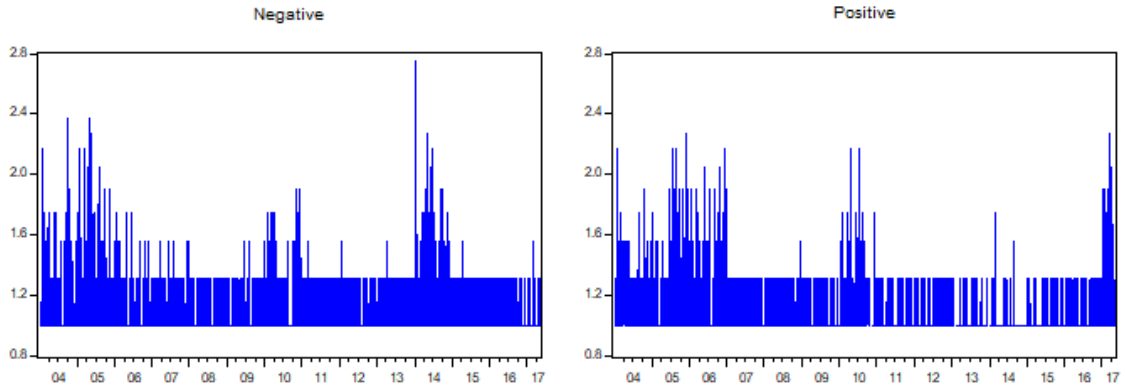
	POSITIVE	NEGATIVE
Mean	1.068964	1.099511
Median	1.000000	1.000000
Maximum	2.274009	2.754824
Minimum	1.000000	1.000000
Std. Dev.	0.156660	0.171980
Skewness	2.690879	1.963006
Kurtosis	12.23062	9.298060
Jarque-Bera	13571.67	6547.533
Probability	0.000000	0.000000
Sum	3049.754	3136.906
Sum Sq. Dev.	69.99505	84.35425

Table 2 – Descriptive Statistics - exchange rate and equity index returns

	RBRL	RIBOV
Mean	0.000102	0.000250
Median	−0.000147	0.000264
Maximum	0.063957	0.136782
Minimum	−0.075872	−0.120961
Std. Dev.	0.010822	0.017607
Skewness	0.245921	0.010847
Kurtosis	7.780984	8.655133
Jarque-Bera	2745.979	3801.741
Probability	0.000000	0.000000
Sum	0.290376	0.712537
Sum Sq. Dev.	0.334019	0.884118
Observations	2853	2853

Notes: The stock market and exchange rate returns are the daily percentage changes in the closing values of the Ibovespa and BRL. News count refer to the local monetary policy media coverage. Note that descriptive statistics refer to raw daily data (story counts). The sample size covers the period 01/02/2006 -15/5/2017, for a total of 2853 observations.

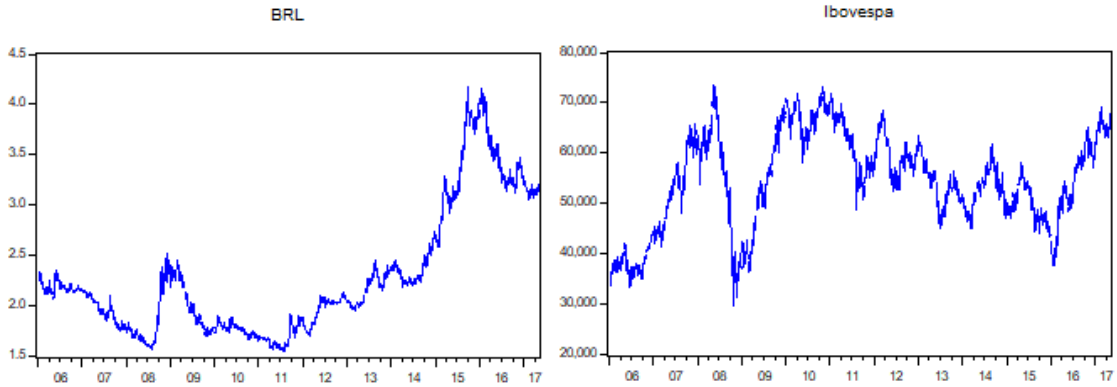
Figure 4 – Daily Monetary Policy News Index (Jan.2006 to May.2017)



Source: Author's creation with Broadcast data.

the p-values for both variables were high enough to reject the null hypothesis.

Figure 5 – Exchange-rate and Stock index (Jan.2006 to May.2017)



Source: Author's creation with Bloomberg data.

To deal with the non-stationary we will tranformed the data to log-returns. The transformation is as follows:

$$\Delta r_t = [log(a_t) - log(a_{t-1})] * 100 = log(\frac{a_t}{a_{t-1}}) * 100, \forall t \geq 2 \tag{2.23}$$

where Δr_t denotes the log returns and a_t and $at - 1$ are values of given dependent variable at time t and $t - 1$, respectively.

After the transformation, the p-values are all significant at 1%, so we can reject the null hypothesis at 99% level. Also, the graphical representation of the transformed

data in Figure 1 indicates that they all fluctuate around constant value of zero. Therefore, the data are now covariance stationary and suitable for further modeling.[4]

Table 3 – Augmented Dickey-Fuller test - ADF test

Variable	Before transformation	After transformation
BRL	0.627	0.000
Ibovespa	0.190	0.000

2.3.4 Serial Correlation

The volatility study requires a series of tests to make the model well specified. One is the serial correlation between residuals and their square values. The presence of serial correlation is a serious problem because the whole model is then misspecified - estimates of standard errors are biased, preventing decisions about the significance of estimated coeficients.

To test the serial correlation we used the Ljung-Box test (1978), also known as Q-test:

$$Q = N(N+2)\sum_{k=1}^{m}\frac{1}{N-k}\hat{\rho}_k^2 \tag{2.24}$$

where the N is the number of observations, m denotes the number of lags specified for the test and $\hat{\rho}_k^2$ is the squared autocorrelation coefficient of k-lags. Q follows χ^2 distribution with m degrees of freedom. Under the null hypoheses the data are independently distributed and there is no serial correlation.

Figures 11 to 14 summarize the Ljung-Box test for both estimates. In addition, the Annex A reports the correlations of the residues that provided by results for the test. The result of the tests suggests that the model is well specificied at the 5% level.

2.3.5 ARCH Effect

Before applying the VAR-GARCH (1,1) model, it is necessary examine whether the residuals of the dependent variables whether they truly evince conditional heteroskedasticity - the ARCH effect. According to Engle (1982), that is achieved by the ARCH-LM test.

As seen in section 2.2.1, the ARCH (q) is a nonlinear model with q lags and consists of two equations: the 2.3 mean equation and the 2.4 conditional variance equation. To confirm the aforesaid presence of conditional heteroskedasticity, Engle (1982) introduced the ARCH-LM (Lagrange Multiplier) test.

[4] After transformation means that both series were transformed into return (log return).

1. First, perform the OLS regression to estimate the autoregressive model AR(q) where q is the length of ARCH lags:

$$r_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i r_{t-1} + e_t \tag{2.25}$$

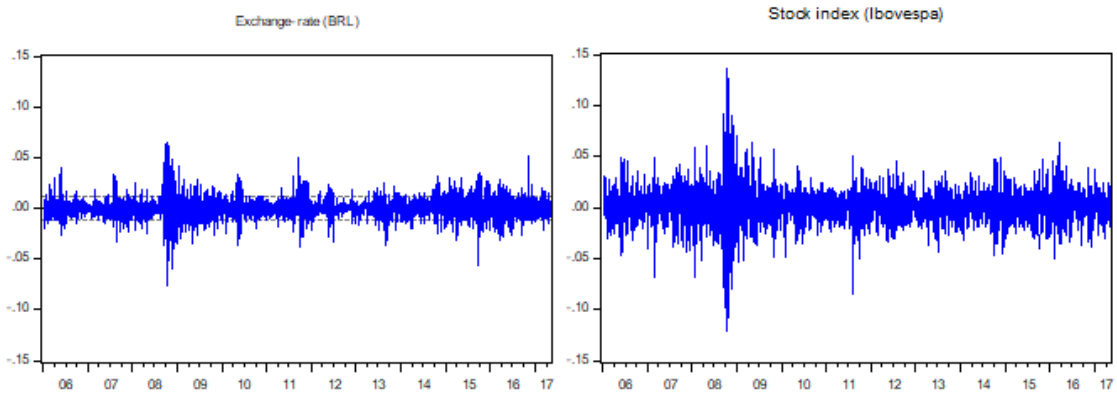
and save the residuals $\hat{e}_t$.

2. Second, perform the OLS regression of squared residuals on a constant and q lagged values:

$$\hat{e_t^2} = \hat{\alpha_0} + \sum_{i=1}^{q} \hat{\alpha_i} \hat{e_{t-i}^2}. \tag{2.26}$$

The null hypothesis, H_0: $\alpha_i = 0 \; \forall \; i \in 1, ..., q$, indicates absence of ARCH effect. The alternative hypothesis is that if the ARCH effects are present at least one of the estimated α_i coefficients must be significantly different from zero.

Figure 6 – Residuals: BRL and Ibovespa returns



Source: Author's creation with Bloomberg data.

The ARCH effect is significant in both series therefore the ARCH models are suitable for further analysis. The results can be found in Table 3 and the residuals in 7a.

Table 4 – ARCH effect

	BRL	Ibovespa
ARCH-LM test	0.000	0.0060

2.3.6 Broock, Dechert and Sheinkman test - BDS test

White noise and white chaos cannot be distinguished by the Ljung-Box statistical tests. To differentiate between the white noise and white chaos , which will help in identifying the type of the nonlinear structure, and, hence, improve the model's formulation, we performed the BDS test of Broock et al. (1996). The BDS test was becomes more compelling given the thin trading adjustments we made to the data. The test is based on the null hypothesis of independent and identically distributed (iid) residuals and tests for the presence of nonlinear dependence in the returns series. The BDS test results, with epsilon values ranging from half to two times the standard deviation for 2 to 6 correlation dimensions are shown in the Table 5. They confirm the presence of chaotic innovations in the series for the market, hence a nonlinear dependence can be inferred.

Table 5 – Brock, Dechert and Sheinkman Test - BDS

Stock Index returns (Ibovespa)				
Dimension Correlation	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.009	0.001	5.935	0
3	0.024	0.002	9.662	0
4	0.035	0.003	11.792	0
5	0.041	0.003	13.349	0
6	0.044	0.003	14.654	0
Exchnge rate returns (BRL)				
Dimension Correlation	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.023	0.001	13.989	0
3	0.05	0.002	18.82	0
4	0.069	0.003	21.878	0
5	0.081	0.003	24.446	0
6	0.086	0.003	26.812	0

2.3.7 The Model

The univariate time series models were pioneers in the volatility studies of the return of financial assets, especially when this volatility has a behavior varying over time. These studies evolved into multivariate cases. In this chapter we will use appropriate models for financial series that present the variance evolving over time. There is a large variety of nonlinear models available in the literature. Here we focus on some extensions of the class of ARCH models (autoregressive with conditional heteroscedasticity), introduced by Engle (1982).

A generalization of ARCH models was suggested by Bollerslev (1986), the so-called GARCH ('generalized ARCH') model. A GARCH model can be used to describe volatility with fewer parameters than an ARCH model.

However in many research situations there is a need to consider more than one asset, and consequently its correlations. Thus, just as time-varying volatility gained momentum in research, the varying correlation began to gain prominence with the multivariate GARCH models (MGARCH).

Following Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018) we represent the first and second moments of stock market, exchange rate and news using a VAR-GARCH (1,1)-in-mean process. To try to capture the possible effects of the global financial crisis of 2008, a dummy variable (denoted by *) is included in the model with a switch on 15 September 2008, that is, on the day of the outbreak of the crisis with the failure of Lehman Brothers. In its most general specification the model takes the following form:

$$X_t = \alpha + \beta X_{t-1} + \delta f_{t-1} + \mu_t \tag{2.27}$$

$$X_t = \begin{bmatrix} return_t \\ News_t \end{bmatrix}, \alpha = \begin{bmatrix} \alpha_{11} \\ \alpha_{21} \end{bmatrix}, \beta = \begin{bmatrix} \beta_{11} & \beta_{12} + \beta_{12}^* \\ \beta_{21} & \beta_{22} \end{bmatrix} \tag{2.28}$$

$News_t$ may contain positive, negative news or the difference between negative and positive news. β_{12} captures the effects of News on average returns. $\beta_{12} + \beta_{12}^*$ measure the effects after the crisis. β_{21} captures the causal effects of returns on news, i.e. how journalists can be influenced by market closure when they write *negative (positive)* news about average returns.

The data on positive and negative News, as reported by the media, was discussed in the previous section. We control for exogenous shocks for Brazil and global financial market shocks by including in the mean equation the Brazilian 5 year-CDS index and the VIX: . The residual vector μ

$$\delta = \begin{bmatrix} \delta_{11} & \delta_{12} \\ 0 & 0 \end{bmatrix} \tag{2.29}$$

δ_{11} and δ_{12} are control parameters for exogenous shocks of country risk perception and global volatility. The Brazilian CDS rate is commonly used to capture domestic effects such as political uncertainty, monetary policy execution and fiscal aspects. The VIX, which measures the volatility of the US stock exchange options represented by the SP500, has broader effect and reflects the spillovers to the international market.

$$H_t = C_0' C_0 + A_{11}' \left[e_{t-1}' e_{t-1} \right] A_{11} + G_{11}' H_{t-1} G_{11} \tag{2.30}$$

The dynamic of H_t process is a linear function of its own past and of the squares of the past innovations. The parameters of this equation are given by C_0, which is restricted to be upper triangular and matrices A_{11} and G_{11}.

$$A_{11} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} + a_{21}^{*} & a_{22} \end{bmatrix} \tag{2.31}$$

The parameter a_{21} measures the causality in variance of negative (positive) news before the crisis and $a_{21} + a_{21}^{*}$ after the crisis.

$$G_{11} = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} + g_{21}^{*} & g_{22} \end{bmatrix} \tag{2.32}$$

The parameter g_{21} measures the causality of the past volatility on the variance of negative (positive) news before the crisis and $g_{21} + g_{21}^{*}$ after the crisis.

2.4 Empirical Results

The quasi-maximum likelihood estimates of the Bivariate VAR-GARCH (1,1) model are reported in Tabels 6 and 7, for the exchange-rate (BRL) and stock index (Ibovespa) returns, respectively. In order to test the adequacy of the models, Ljung-Box portmanteau tests were performed on standardized and squared residuals. Overall, the results indicate that the VAR-GARCH (1,1) specification captures satisfactorily the persistence in returns and squared returns for the exchange rate and equity indexes (Ibovespa). The estimates of the parameters of the VAR-GARCH(1,1) model as well as the associated robust standard errors, p-value and likelihood function values are presented as follows. Then, through the information criterion of Schwartz, we selected the optimal lag length of the mean equation.

Next, we tested for mean and variance the effects of the negative (positive) news of the monetary policy performance in Brazil on the volatility of stock prices and the exchange rate. For this, we worked with four null hypotheses to be tested: (i) negative (positive) news affects the returns before the 2008 crisis (β_{12}=0); (ii) negative (positive) news affects the returns after the 2008 crisis (β_{12}^{*}=0); (iii) negative (positive) news volatility affects the returns' volatility before the 2008 crisis (α_{21} and g_{21}=0); and finally, (iv) negative (positive) news volatility affects the exchange rate and the equity market volatility after the crisis (α_{21}^{*} and g_{21}^{*}=0).[5]

First, in the case of exchange rate returns, according to the values estimated by the model VAR-GARCH (1,1) model for the mean equation in Tabel 6, we reject the null hypothesis that negative (positive) news about the monetary policy performance affects

[5] Joint restrictions (iii) and (iv) are tested by means of the Wald test.

Table 6 – Estimated VAR GARCH (1,1): BRL

Exchange rate returns									
	Negative			Positive			Negative - Positive		
	Coeff.	SE	P-valor	Coeff.	SE	P-valor	Coeff.	SE	P-valor
Conditional mean Equation									
α_1	0.00	0.00	0.67	-0.00	0.00	0.09	0.00	0.00	0.01
α_2	0.98	0.02	0.00	0.93	0.02	0.00	0.029	0.004	0.00
β_{11}	-0.07	0.02	0.00	-0.07	0.022	0.00	-0.07	0.022	0.00
β_{12}	0.00	0.00	0.76	0.00	0.00	0.25	-0.00	0.001	0.19
β^*_{12}	0.00	0.00	0.02	0.00	0.00	0.06	0.00	0.001	0.14
β_{21}	0.32	0.28	0.25	-0.08	0.22	0.68	0.28	0.426	0.50
β_{22}	0.10	0.01	0.00	0.10	0.01	0.00	0.11	0.018	0.00
δ_{11}	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.005	0.00
δ_{12}	-0.00	0.00	0.00	-0.00	0.00	0.01	-0.00	0.002	0.00
Conditional Variance Equation									
c_{11}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c_{12}	0.01	0.1	0.84	0.00	0.021	0.63	-0.00	0.011	0.66
c_{22}	0.00	75.49	1	0.00	828.85	1	-0.02	0.003	0.00
g_{11}	-0.92	0.00	0.00	-0.93	0.00	0.00	0.93	0.005	0.00
g_{12}	-1.90	0.73	0.00	0.42	0.42	0.31	-0.06	0.14	0.62
g_{21}	-0.00	0.00	0.09	0.00	0.00	0.57	0.00	0.00	0.72
g^*_{21}	-0.00	0.00	0.20	-0.00	0.00	0.34	0.00	0.00	0.81
g_{22}	0.97	0.00	0.00	0.98	0.00	0.00	0.98	0.002	0.00
a_{11}	0.34	0.01	0.00	0.33	0.01	0.00	0.35	0.014	0.00
a_{12}	0.38	0.24	0.12	0.15	0.13	0.23	0.65	0.368	0.07
a_{21}	0.00	0.00	0.81	0.00	0.00	0.42	0.00	0.00	0.65
a^*_{21}	0.00	0.00	0.49	-0.00	0.00	0.31	0.00	0.001	0.44
a_{22}	-0.13	0.00	0.00	0.16	0.00	0.00	-0.132	0.008	0.00
LogLik		7872.171			8374			6715	
$LB_{BRL(10)}$		8.5085			8.4728			8.774	
$LB^2_{BRL(10)}$		12.952			13.044			13.122	

The number of positive (negative) newspaper headlines index is defined as follows: positive (negative) NewsIndex=ln[e + negative(positive) MP news). Standard errors (SE) are calculated using the quase-maximum likelihood method of Bollerslev and Wooldridge (1992), which is robust to the distribution of underlying residuals. The parameters not statistically significant at the 5% level are not reported. $LB_{BRL(10)}$ abd $LB^2_{BRL(10)}$ are the Ljung-Box text (1978) of significance of autocorrelations of 10 lags in the standardized and standardized squared residuals, respectively. The parameter β_{12} measures the causality effect of negative (positve) news on the exchange rate returns (BRL), whereas a_{21} measures the causality-in-variance effect of negative (positive) news. The effect of the 2008 financial crisis on the mean equation by (β_{12}+ β^*_{12}), whereas (a_{21}+ a^*_{21}) captures the effects on spread volatilities. The covariance stationarity condition is satisfied by all the estimated models, all the eigenvalues of $a_{11} \otimes a_{11} + g_{11} \otimes g_{11}$ being less than one in modulus. Note that in the conditional variance equation the sign of the parameters cannot be determined.

on this particular variable. Concerning the effects of news on exchange-rate return (β_{12}), we do not find significant causality at any levels (1%, 5% or 10%) before the crisis. For the post-crisis period (β^*_{12}), after September 2008, the results also indicate that negative (positive) news does not cause effects on exchange rate returns.

However, the construction of the model allows us to control and test for the presence of reverse causality (β_{21}), that is the effect of exchange-rate returns behaviour on the number of monetary policy negative and positive news stories. In other words, this coefficient captures the causal effects of returns on the news, that is, how journalists can be influenced by market closure when they write about negative aspects and positvo on the average of exchange rate returns .

According to Birz e Jr (2011), in some cases, as we have found, the news surprises are not statistically significant. According to the authors, this is not a particularly surprising if one considers that specific news items are released on a very small percentage of trading days, in contrast to newspaper coverage which is daily, and therefore can only have a very limited impact [Caporale, Spagnolo e Spagnolo (2018)]. Similar to Caporale, Spagnolo e Spagnolo (2018), the VIX (δ_{12}) is found to be highly significant in all cases, which suggests that uncertainty in the US stock market (a proxy for global instability) tends to widen the spread. In addition, country risk, measured by the 5-years-CDS rate (δ_{11}), which encompasses other variables (fiscal, external accounts, economic activity and institutional issues) not computed in the context of monetary policy news, was also highly significant in explaining the average exchange rate returns.

Concerning the conditional variance equation, the estimated *own-market* coefficients are statistically significant and the estimates of g_{11} suggest a relatively high degree of persistence. The results suggest that negative and positive news volatility has a significant impact on exchange-rate volatility.[6]. On the other hand, the magnitude of the causality effect (a_{21}) is not statistically significant for negative and positive news. In others words, there is evidence that before the crisis, there was no impact of news on volatility. Furthermore, there is no evidence 2008 crisis affecting the causality-in-variance dynamics. In this sense, both positive and negative news also did not cause volatility on the exchange rate in the post-crisis period ($a_{21} + a^*_{21}$).

However, there is evidence of co-movement between exchange rate returns and the news index, as shown by the conditional correlations obtained from the VAR-GARCH(1,1) model (Figure 2). Note that, the conditional correlation between negative news and the BRL returns are generally positive (on average). [7]. Note also that the upward shift in pairwise correlations (between exchange rate returns and the negative news) is evident

[6] As Caporale, Spagnolo e Spagnolo (2018), note that the sign cannot be established

[7] Acording to Caporale, Spagnolo e Spagnolo (2018) , the null hypotesis of a constant correlation has been tested using the Engle e Sheppard (2001) likelihood ratio test, and is rejected in all cases.

for the Brazilian exchange market after 2008, which suggests that this market was under pressure were particularly sensitive to negative news.

Finally, we find that, according to the estimated VAR-GARCH (1,1) model, there is no evidence that the BCB's news about monetary policy had any effect on the behavior of average returns and rate volatility. exchange rate for the period analyzed. However, we can argue that this behavior is not surprising in the Brazilian case. In fact, especially in the post-crisis period, the BCB intervened heavily in the foreign exchange market to contain volatility.

In this regard, Janot e Macedo (2016) used econometrically for intraday and daily high frequency data between October 2011 and March 2015, to test the effects of BCB interventions on the foreign exchange market. Also, to verify that the last signal by the BCB to intervene and the size of the interventions affect the dynamics of the currency market, the authors also considered the impact of surprise in the disclosure of macroeconomic indicators. The authors concluded that the BCB is able to affect market conditions and the participants' feelings when the interventions are carried out by surprising the market and with adequate size, that is, very large or very small interventions may not have the expected effect.

In addition, between 2010 and 2011, the BCB and Brazilian fiscal authorities adopted various macroprudential policies. A number of these measures applied to the foreign exchange market with the objective of mitigating the intensity and volatility of capital flows. According to Portugues (2017), the target was to limit large, short-term and speculative capital inflows, particularly carry trade operations.

Regarding to stock market returns, according to the values estimated by the model VAR-GARCH (1,1) model for the mean equation in Tabel 6, we also reject the null hypothesis that negative (positive) news about the monetary policy performance effects on this particular variable. Concerning the effects of news on equity index return (β_{12}), we do not find significant causality at any level (1%, 5% or 10%) before the crisis either. As for the exchange rate, in the post-crisis period (β^*_{12}), after September 2008, the results also indicate that negative (positive) news did not cause effects on stock index returns. Note that in the VAR-GARCH (1.1) model, the coefficient β_{21} also shows that journalists can also be influenced by market closure when they write about negative and positive news stories about stock market returns .

In the case of the exogenous variables of the model, the country risk (CDS rate) was relevant to explain the behavior of the average Ibovespa returns, which also shows the relevance of other factors in the Brazilian stock market dynamics. On the other hand, the VIX, for both negative and positive news, showed no influence on Ibovespa.

Regarding the conditional variance equation, the estimated *own-market*, coefficients

Table 7 – Estimated VAR GARCH (1,1): Ibovespa

Stock index returns									
	Negative			Positive			Negative - Positive		
	Coeff.	SE	P-valor	Coeff.	SE	P-valor	Coeff.	SE	P-valor
Conditional mean Equation									
α_1	0.00	0.00	0.15	0.00	0.00	0.42	0.00	0.00	0.06
α_2	0.98	0.02	0.00	0.92	0.02	0.00	0.03	0.00	0.00
β_{11}	-0.08	0.02	0.00	-0.08	0.02	0.00	-0.07	0.02	0.00
β_{12}	0.00	0.00	0.56	0.00	0.00	0.79	0.00	0.00	0.17
β^*_{12}	0.00	0.00	0.11	0.00	0.00	0.25	0.00	0.00	0.05
β_{21}	-0.001	0.16	0.40	-0.23	0.14	0.09	0.04	0.26	0.86
β_{22}	0.09	0.01	0.00	0.12	0.01	0.00	0.12	0.01	0.00
δ_{11}	-0.03	0.01	0.00	-0.03	0.00	0.00	-0.03	0.00	0.00
δ_{12}	0.00	0.00	0.30	0.00	0.00	0.25	0.00	0.00	0.28
Conditional Variance Equation									
c_{11}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c_{12}	0.01	0.00	0.02	0.00	0.00	0.72	-0.03	0.00	0.00
c_{22}	0.00	989.84	1	-0.01	0.00	0.00	0.00	810.46	1
g_{11}	0.95	0.00	0.00	0.95	0.00	0.00	0.95	0.00	0.00
g_{12}	0.05	0.08	0.54	-0.03	0.03	0.29	0.82	0.68	0.22
g_{21}	-0.01	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0
g^*_{21}	0.02	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.23
g_{22}	-0.98	0.00	0.00	0.98	0.00	0.00	-0.98	0.00	0.00
a_{11}	0.25	0.01	0.00	0.25	0.01	0.00	0.25	0.01	0.00
a_{12}	-0.02	0.12	0.84	0.11	0.1	0.25	-0.02	0.2	0.89
a_{21}	0.00	0.00	0.09	0.00	0.00	0.19	0.00	0.00	0.08
a^*_{21}	0.00	0.00	0.03	0.00	0.00	0.89	0.00	0.00	0.39
a_{22}	-0.14	0.00	0.00	-0.17	0.00	0.00	-0.14	0.01	0.00
LogLik		6333			6832			5173	
$LB_{Ibov(10)}$		11.218			11.06			11.616	
$LB^2_{BRL(10)}$		15.687			15.482			15.318	

The number of positive (negative) newspaper headlines index is defined as follows: positive (negative) NewsIndex=ln[e + negative(positive) MP news). Standard errors (SE) are calculated using the quase-maximum likelihood method of Bollerslev and Wooldridge (1992), which is robust to the distribution of underlying residuals. The parameters not statistically significant at the 5% level are not reported. $LB_{Ibov(10)}$ abd $LB^2_{Ibov(10)}$ are the Ljung-Box text (1978) of significance of autocorrelations of 10 lags in the standardized and standardized squared residuals, respectively. The parameter β_{12} measures the causality effect of negative (positve) news on the stock index returns (Ibovespa), whereas a_{21} measures the causality-in-variance effect of negative (positive) news. The effect of the 2008 financial crisis on the mean equation is measured by (β_{12}+ β^*_{12}), whereas (a_{21}+ a^*_{21}) captures the effects on spread volatilities. The covariance stationarity condition is satisfied by all the estimated models, all the eigenvalues of $a_{11} \otimes a_{11} + g_{11} \otimes g_{11}$ being less than one in modulus. Note that in the conditional variance equation the sign of the parameters cannot be determined.

are statistically significant and the estimates of g_{11} suggest a relatively high degree of persistence, too. Like the exchange rate market, the results for equity index suggest that negative and positive news volatility has a significant impact on exchange-rate volatility. Diferently from exchange rate volatility, in the equity market the magnitude of the causality effect (a_{21}) is statistically significant for negative news, whereas positive news is not. In others words, there is evidence that before the crisis, there were effects of negative news on volatility. Finally, there is evidence that in the post-crisis period the impact of negative news on the variance (volatility) in the stock market grew substantially. This is important evidence that, even with the BCB's adoption of macroprudential policies, the agents' expectations regarding the next steps in monetary policy have affected market sentiment (stock pricing). ($a_{21} + a_{21}^{ast}$).

However, like for BRL, there is evidence of co-movement between Ibovespa returns and the news index, as shown by the conditional correlations obtained from the VAR-GARCH(1,1) model. Note that the conditional correlation between negative news and the stock index returns are generally positive (on average), as well as on the exchange rate. Also, the upward shift in pairwise correlations (between exchange rate returns and negative news) is evident for the Brazilian foreign exchange market after 2008, which suggests that this market under pressure was particularly sensitive to negative news.

As a robustness check, following Caporale, Spagnolo e Spagnolo (2018), we also considered the difference between negative and positive news indexes (Annex). The causality-in-mean effect and the causality-in-variance spillovers of news are not significant for the BRL. However, for the stock index, the evidence reveals a difference between the news impacts on the pre-crisis mean and on the variance of post-crisis returns in 2008. As already explained, the reason for more stable exchange rate behavior in the face of negative and positive monetary policy news may be due to the BCB's interventions in the foreign exchange market and also to the unconventional measures adopted in the country in 2010 and 2011.

2.5 Conclusion

In the past half century the literature on the behavior of prices of financial assets has made great strides. At the same time, the demand for appropriate modeling has increased, particularly with the development of financial and capital markets and the increasing complexity of financial products.

In this context, since the 1980s there has a considerable advance in this literature, starting from the seminal contributions of Engle (1982)), with the creation of the ARCH model, and later the work of Bollerslev (1986) with extension to the GARCH model. However, with financial globalization, the need to extend previously univariate GARCH

models to the multivariate case was evident. The first of these models was proposed by Bollerslev, Engle e Wooldridge (1988), using the VEC model.

With financial globalization, there has been a breakthrough in studying the interconnections between markets and explaining the influence that some have on others. In this vein, the literature has sought to incorporate the effects of announcements and economic news to assess the reaction of financial assets and the perception of the market on the macroeconomic dynamics, as well as the power of the media to influence the prices of these assets.

Although the literature on the dynamics of the financial market in response to macroeconomic news is vast, no studies have focused on the Brazilian financial market. In this sense, the present essay seeks to fill this gap and advance a research agenda on volatility applied to the Brazilian economy. Besides that, we proposed a different approach to finding the effect of macroeconomic news on stock and exchange rate returns. Specifically, instead of using complex statistical setups to extract the monetary policy meaning of a release, we used news items from an electronic platform to measure the effects of news. Besides reporting statistical facts, newspaper stories also indicate whether the news media perceives something as important and may also indicate how the economy performed relative to expectations. In addition, newspaper stories reveal the meaning of the statistical releases regarding different economic conditions, so they can be an indicator of the actual news associated with the release.

This essay discussed how the daily returns of the exchange rate in Brazil (BRL) and Ibovespa affected by the negative (positive) news specifically about the monetary policy. In other words, we sought to analyze how the market reacts to the performance of the Central Bank of Brazil in fulfilling its mandate under the aegis of the ITR. The main subject of the research was the impact on the conditional mean and the conditional variance (volatility) through the VAR-GARCH (1,1) method.

First, we summarized the literature concerned with topics similar to ours. The main finding revealed by the literature review is that the macroeconomic surprises or macroeconomic news have a relevant impact on assets markets in different economies.

Next, we briefly presented the volatility estimation techniques and specified our model to measure the impacts of news on the volatility returns and financial assets. Then, following Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018), we employed the VAR-GARCH (1,1) model with a BEKK representation, which is considered by the literature as ideal, to test for both mean and volatility linkages between macro news – monetary policy news, precisely – and the exchange rate and equity returns in Brazil before and after the global financial crisis.

The empirical results showed that for the exchange rate, before the crisis negative

(positive) news had no impact on the average returns of this variable. In addition, after the crisis, the results were also statistically non-significant to explain the BRL return. On the other hand, the evidence showed that specialized media are influenced by market behavior, that is, news is affected by market closure when journalists are writing news about the effects of monetary policy on asset returns.

In relation to the exchange rate variance equation, which measures volatility, the results suggest that negative and positive news volatility has a significant impact on exchange rate volatility. On the other hand, the magnitude of the causality effect is not statically significant for negative and positive news. In others words, there is evidence that before the crisis, there was no impact of news on volatility.

The result of the empirical test for the exchange rate can be understood as suggested by Janot e Macedo (2016). For them, volatility can be influenced by BCB interventions in the Brazilian foreign exchange market, although the result is inconclusive to ensure that volatility is influenced in the short term. In addition, as Portugues (2017) shows, the Brazilian authorities adopted a series of macroprudential measures targeted at the foreign exchange market that aimed to contain the country's economic volatility and capital flight in 2009 and 2010.

Finally, the conditional correlations between exchange rate returns and negative news are significant and positive. Furthermore, the upward shift in pairwise correlations (between exchange rate returns and negative news) is evident for the Brazilian foreign exchange market after 2008, which suggests that this market, under pressure, was particularly sensitive to negative news.

Regarding the stock market returns, like the exchange rate before and after the crisis, the results also indicate that negative (positive) news did not cause effects on stock index returns. Also, the evidence shows that specialized media were influenced by market behavior, that is, news was affected by stock market closure when journalists were writing news about the effects of monetary policy on equity returns.

Regarding the conditional variance equation, the estimated own-market, coefficients are statically significant and the estimates suggest a high degree of persistence also. Like the exchange rate market, the results for the equity index suggest that negative and positive news volatility had a significant impact on exchange rate volatility during the period studied. Differently from exchange rate volatility, in the equity market the magnitude of the causality effect is statically significant for negative new, whereas for positive news it is not. In others words, there is evidence that before the crisis, there were effects of negative news on volatility.

There is evidence that in the post-crisis period the impact of negative news has grown substantially on the variance (volatility) in the stock market. This is important

evidence that even with the BCB's adoption of macroprudential policies, the agents' expectations regarding the next steps in monetary policy have affected market sentiment (stock pricing). Furthermore, the conditional correlation between negative news and the stock index returns are generally positive (on average), as is the case for the exchange rate. Also, the upward shift in pairwise correlations (between exchange rate returns and negative news) is evident for the Brazilian foreign exchange market after 2008, which suggests that this market, when under pressure, was particularly sensitive to negative news.

Finally, there are various avenues for further research. First, researchers can assess the effects of monetary policy news on high-frequency data, which might give more evidence of the dynamics of asset prices. Second, the news index can be expanded by including other macroeconomic variables, and creating an extensive database that would be useful for future analysis. Third, other multivariate estimation metrics can be tested (CCC, DCC, ADCC and cDCC) to analyze, in addition to the impacts of macroeconomic news, how financial assets impact each other over a given period. Finally, since there is evidence of macroprudential policy's influences on economic dynamics, there is room to study other qualitative and institutional variables in volatility models to analyze the dynamics of the Brazilian market and to expand the debate about the importance of including other economic policy measures in the conventional toolbox.

3 Unconventional US monetary policy: International spillovers and the impact on the Brazilian market

Introduction

The global financial crisis that began in the US in 2007-08 and the great recession that followed required the implementation of a broad set of unconventional policies, also called macroprudential policies. The devastating effects of the crisis required rapid action from the main central banks (CBs), leading them to reduce interest rates to almost zero in order to stimulate aggregate demand. As no more room was left to achieve the monetary and economic targets, CBs began to implement unconventional monetary policies (UMPs).

According to the literature, there are three types of UMP. The first refers to forward guidance, which consists of the official announcement of monetary policy, describing the current state of the economy, presenting the reasons for the decision, and thus influencing expectations about the long-term interest rate. The second refers to the purchase of assets by the CB, also known as credit easing, by increasing the bank's balance sheet to affect the relative supply of securities in the market. Finally, the third refers to quantitative easing (QE), which also expands the balance sheet of the CB, but on the liabilities side, in order to provide liquidity in the market.

The advance of financial globalization in recent decades has made economies more integrated. Indeed, the world economy has experienced a large number of fundamental changes, substantially influencing the dynamics of the markets. The most relevant change is the high degree of interdependence among national economies, which has led to expansion of the flow of trade and capital. These transformations have significantly shifted the magnitude of economic shocks, their duration and the way they are propagated globally.

In view of the above, while the recent global recession has prompted a large number of studies on crises and economic cycles, the implementation of UMPs has made it imperative to study the effects of these policies on global markets, in particular their propagation between economies. The magnitude of the impact on other economies will depend on the power of the transmission channel as well as the idiosyncrasies of the economies, such as monetary regime, fiscal policy and financial regulation.

In this respect, many researchers have analyzed the effects of UMPs on local and international economic activity, few studies have assessed the impacts on particular financial markets. This study differs from others by investigating the effects of the Fed's

UMPs on the behavior of financial assets on a global scale and the spillover to Brazil. Regarding the methodology, the literature on the subject mainly uses the global vector autoregressive (GVAR) approach, developed by Pesaran (2004) and Pesaran, Pettenuzzo e Timmermann (2006), to evaluate the effects domestic and cross-border effects of UMPs. The key element of this method is how to capture the shocks of UMPs. Mainly, this has ben focused on large-scale asset purchase (LSAP) so that QE is the only UMP considered.

Based on Chen et al. (2016), this chapter studies the medium and long-term potential spillover effects of UMPs of the Fed, through LSAP, to different regions, and in particular the impacts on the Brazilian financial market. First, we investigate whether there are spillover effects from Fed UMPs to Europe, Asia, China and South Africa, and then how the policy shocks reach Brazil, i.e., the transmission channels.

Faced with the difficulties of using changes in the Fed's balance sheet to assess the impacts on other economies, this chapter uses as proxy for UMPs the spread between 10-year and 3-month US Treasury yields, which sets this work apart from the others. In addition, there are no papers, both in the international literature and in Brazil, that evaluate the impacts of UMPs on Brazil specifically. In this sense, the key contribution of this essay is to fill this gap, and consequently to contribute to empirical literature on the impacts of unconventional measures on financial and capital markets.

For this, we use the GVAR model, as it is a useful technique to describe and understand the transmission channels of a specific shock to the system. In addition, generalized impulse response functions (GIRFs) are obtained to interpret the results of the model. Specifically, we investigate the shocks of UMPs of the Fed, represented by the spread between 10-year and 3-month Treasury bond yields, on five-year CDS, inflation (CPI), equity prices, exchange rate, foreign exchange reserves and 10-year Brazilian sovereign bond yields.

The estimated GVAR model uses monthly data for 21 countries grouped into 8 regions (Latin America, Asia, Australia, Brazil, Canada, China, Europe, South Africa and US). The period corresponds to the crisis phase, which runs from September 2007 to November 2014, when the Fed announced the end of QE for 2016. The monetary policy shocks are captured by one standard deviation of the spread between 10-year and 3-month Treasury yields. This approach seems plausible considering that the reduction of long-term interest rates in the target of CBs is subject to the zero lower bound (ZLB), so that all UMP types are covered by this variable.

The GVAR performance provides important empirical evidence of the overflow effects of Fed policies on global markets, and Brazil in particular. The results are disseminated in global markets, but with a wide effect on the variables, which indicates that the sensitivity to unconventional measures is affected by the variables of these regions, in line with the results found in the specialized literature. In relation to Brazil, the main

objective of this analysis, the Fed UMPs affected all variables, as expected, with emphasis on 10-year Treasuries, stock prices, inflation and country risk.

Besides this introduction, this paper is organized into five more sections. The second section defines and describes the UMPs adopted by the Fed during the global financial crisis starting in 2008. In addition, it discusses the related literature regarding spillover effects from UMPs. Section three presents the GVAR model. The fourth section outlines the data while the fifth section presents the method and the findings. Finally, the sixth presents the main conclusions.

3.1 Identifying US unconventional monetary policy shocks

3.1.1 Literature Review

The literature that addresses the effects of unconventional monetary policies (UMPs) on the economy in general is not extensive. Moreover, the papers are mostly concerned with analyzing the effects of these policies on the real side of the economy. Using the GVAR method, we assess the spillover effects of the Fed's monetary policy on emerging economies (EMEs) in particular.

One of the first works to use the GVAR method to evaluate the overflow effects of UMPs was Chen et al. (2012). In this study, the authors analyzed the cross-border impact of QE announcements on EMEs, with a focus on emerging Asia. The authors compared their results to the impact of QE programs in Japan, the UK and Europe. They used two-day windows as way to calibrate opening and closing times of emerging markets and estimated the cumulative two-day impact of major financial indicators across emerging financial markets. They found that QE1 impacts were stronger than those of QE2. In the short run, the cumulative impact of QE lowered emerging Asian bond yields, boosted equity prices globally and helped to stabilize the financial markets after the global financial crisis. The result of QE1 was more significant on the short-term yield curve, where the 2-year yields fell on average across Asia by about 45 basis points, and 10-year yields decreased by almost 80 points. However, during the QE2, 2-year and 10-year yields declined only 9 basis points.

Regarding the CDS spreads, the announcements of Fed during QE1 substantially reduced emerging Asian credit risk on sovereign debt, when compared to responses to QE2. According to Chen et al. (2012), the main reason was possibly linked to the commitment by the Fed. In other words, "the QE1 announcements were seen as [a] credible Federal Reserve commitment, backed up with a demonstrated readiness to act on its balance sheet to combat the intense headwinds coming from the crisis and recession" (Ibid, p. 13). In fact, the surprise factor was lost over time after QE1 and led agents to believe that

QE2 would be a follow up to this initial commitment, which led the market to better understand the asset purchase program.

Through the panel data method, Moore et al. (2013) analyzed the impact of the LSAP announcements by the Fed between 2004 and 2010. Specifically, they analyzed the influence of UMP on US capital flows to EMEs and how the pass-through impact from US long-term bond yields to those of EMEs. The empirical evidence suggested that LSAPs boosted portfolio flows to many EMEs. The main result indicated that a 10 basis point decrease in the US 10-year sovereign bond yield increased by an average of 0.4 percentage point the foreign share in government bond markets of EMEs, which in turn reduced their government bond yields by about 1.7 bases points.

In the same line, Neely et al. (2010) evaluated the effects of LSAP by the Fed on international long-term bond yields and exchange rates with intraday data (daily window) from December 2008 to February 2010. To illustrate the size of LSAP announcements with ordinary news, the authors compared the LSAP reaction to the historical distributions of two-day asset price changes. In other words, they compared the LSAP effects with those of FOMC announcements that contained no information about the LSAP. The result indicated that LSAP buy announcements reduced real long-term US bond yields, long-term foreign bond yields and the spot value of the dollar. According Neely et al. (2010), this effect was stronger after the announcements and could be interpreted as reflecting expectations of much weaker growth over a period of many years. This was also caused by a higher demand for safe assets that increased the effect on US bond yields but mitigated the predicted exchange rate effects. To sum up, the authors concluded that the success of the LSAP showed that central banks remained strong, even in the face of a ZLB scenario, and that LSAP policy can influence both domestic and international long rates.

Glick, Leduc et al. (2013) also studied the international effects of LSAP announcements. Precisely, they distinguished monetary policy surprises from changes in interest rate future prices in narrow windows around policy announcements. Regarding only UMP, they used all FOMC announcements between November 2008 and January 2013, with intraday windows. The results suggested that the exchange rate reacted substantially after an UMP surprise. In particular, both conventional and unconventional monetary policy surprises had the same bang surprise on the value of the exchange rate of about six basis points per surprise unit.

With the use of the VAR method applied to monthly data from September 2008 to March 2013, Chinn (2013) studied the effects of UMP, via LSAP, on exchange rates and asset prices. The author concluded that the implementation of an UMP can cause volatility in the global market, but in general it will also support global rebalancing by encouraging the revaluation of emerging market currencies. Furthermore, the effectiveness of the UMP may vary with the state of economy and financial markets, i.e., the effects

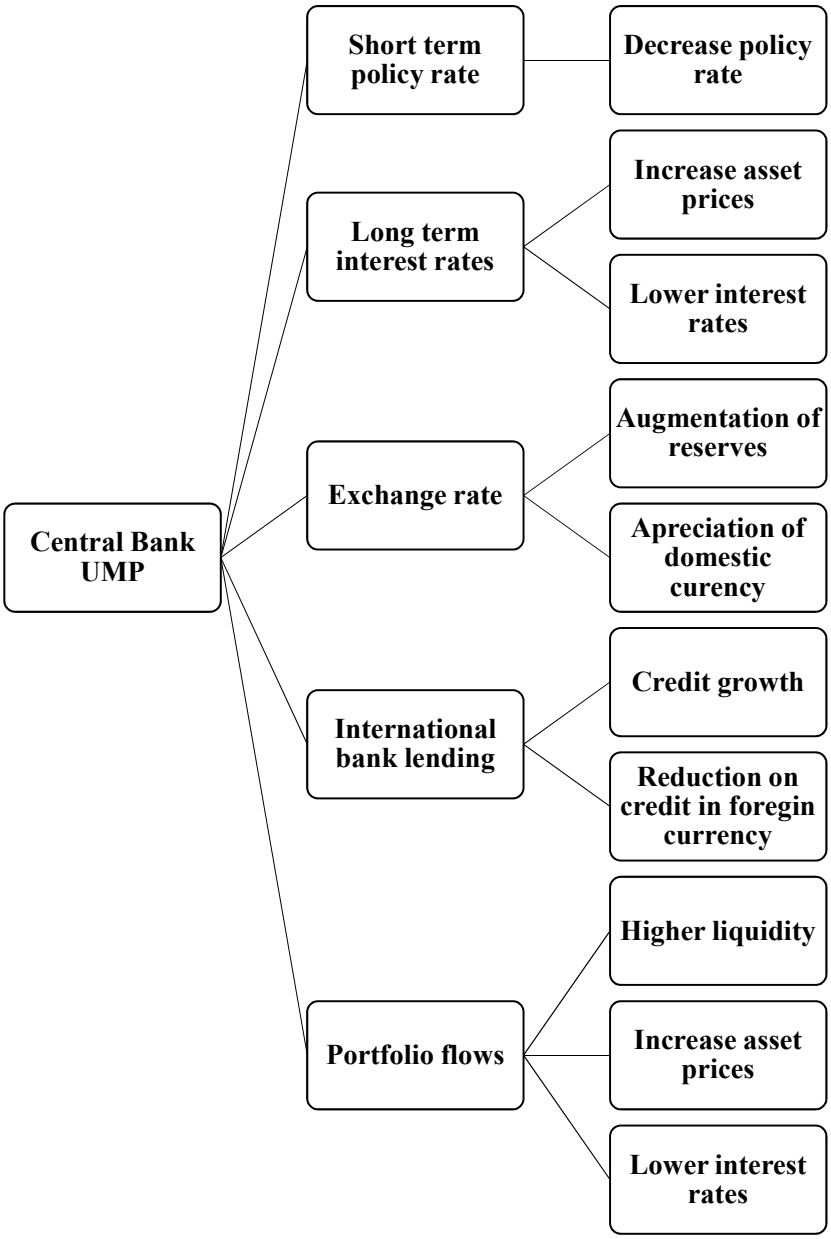
were heterogeneous between QE1 and QE2. Although UMPs put upward pressure on the currencies of emerging countries with near full employment and/or with current account surpluses, the implementation of these policies was beneficial to the global economy in the period studied.

Another study on cross-border effects of UMP announcements was conducted by Fratzscher, Duca e Straub (2018). They built a panel data model for 52 countries using daily data on portfolio equity and bond investment flows from January 2008 to December 2012. Differently from the other studies presented here, the authors used several UMP measures, such as liquidity operations, purchases of MBS and US Treasuries. The objective was to analyze why the effects of QE1 was stronger than those of QE2. The evidence suggested that the QE1's effects had success, raising bond yields and equity prices, and consequently appreciating the exchange rate. However, QE2 increased the equity prices in other global markets and led to US dollar depreciation. Finally, they concluded that the capital flows to EMEs were procyclical to the Fed's UMPs and countercyclical regarding US capital inflows.

With a dynamic term structure, using daily data from 2008 to 2012 (QE1, QE2 and QE3), Bauer e Neely (2014) estimated changes in short-rate expectations and term premia around key LSAP announcements. Precisely, the authors explored the effects of UMP over the bond yields of the US, Canada, Japan, Germany and Australia. Their results suggested that both the signaling channel and the portfolio balance channel support the decline of bond yields. These findings about UMP channels were consistent with predictions based on interest rate dynamics during normal periods. In this sense, signaling effects tended to be larger for countries with a strong yield response to conventional US monetary policy surprises and portfolio balance effects were associated with the degree of substitutability among international bonds, as well as the interest rate behavior during normal periods.

Finally, the international effects of UMPs are very significant on the yields of foreign bonds with past sensitivity to conventional monetary policy surprises and the covariance of foreign and US bond returns. Proposing an alternative analysis to estimate the effects of QE on EMEs, Tillmann (2014) used low-frequency data close to the dates of the LSAP announcements. He employed Qual VAR method, estimated by integrating binary information of QE announcements. He explained that there are two advantages in of the Qual VAR method: (i) UMP is acknowledged to endogenously respond to US business cycle variables, and (ii) it is possible study the effects of QE in terms of shocks. The results suggested that the effects from QE on EMEs may explain the strong increase of capital inflows, equity prices, exchange rates and lower bond spreads. Additionally, he also compared the spillovers of UMP with those of conventional monetary policy, and found that a typical QE shock led to the same responses on EMEs' bond spreads. According to the author, in this sense the results cast doubt on the notion of a "new normal" characterizing

Figure 7 – Unconventional Monetary Policy: Transmission channels and effects



Source: Author's creatin from Takáts e Vela (2014) and González (2015)

the international financial system.

To analyze the spillovers from Japan's UMP to Emerging Asia, (GANELLI; TAWK, 2016) used a GVAR model with a monthly dataset from January 2000 to December 2014. They combined financial and trade channels to link the countries together and explored the effects through the bilateral trade and foreign direct investment channels. The conclusion had two points. First, despite an appreciation of exchange rates, the impact in Emerging Asia was significant, because the expectation of future growth was positive.

Horvarth and Voslarova (2016) examined how the ECB UMP influenced macroeconomic stability in the Czech Republic, Hungary and Poland. For this, they estimated various panel vector autoregression (PVAR) models using monthly data from 2008 to 2014. As an unconventional policy they applied shadow policy rate and the APP. Their results suggested the existence of sizable spillover effects from ECB UMP, mainly on the economic activity for these countries. They found that the peak response of output among these countries occurred with a lag of roughly six months and the UMP could explain approximately 11-14% of the effect.

Recently, Elbourne et al (2018) investigated the effects of ECB UMP in the euro area as a whole and its individual countries. They used a VAR model to evaluate the effect of unconventional policy shocks on inflation, output growth, CISS, shadow rate, EONIA spread and equity prices, with monthly data for the period from January 2009 to November 2016. The results from the SVAR framework using zero and sign restrictions for identification provided weak evidence that expansionary UMP shocks increase output growth. However, the effects on inflation in euro region as whole were insignificant. Furthermore, they also found that larger peak output responses were linked to healthier banking systems. Finally, the authors warned that the sample was very small, making precise estimation difficult, and correlation does not necessarily mean causation, even though their empirical evidence was consistent with some of the main theories about the transmission of UMPs.

The application of the GVAR method to Brazil is still incipient. Although the studies of regional interdependence and shock propagation still have a wide field for future analysis, we highlight the contributions of JUNIOR Athayde; SEGANTI (2014), JNETO Zanetta; CERA (2014) and, more recently, MORCERF (2017).

To analyze the process of predicting the occupation rate in the Brazilian labor market, JUNIOR Athayde; SEGANTI (2014) applied the GVAR method to 27 Brazilian states (counting he Federal District). Their hypothesis considered that the spatial proximity between states (regions) can be an indicator of the intensity with which shocks on the employment data, in each regional unit, will affect the others, depending on the spatial distance. The main results were as expected and according to macroeconomic fundamentals. In this sense, positive impacts on industrial production, for example, increased the number

of new jobs. On the other hand, increases in the real interest rate negatively impacted the level of employment in most Brazilian states.

However, according to JUNIOR Athayde; SEGANTI (2014),the evidence is not clear to support the hypothesis that regional proximity is a relevant factor to define the impact of certain shocks on the other regions. The reasons for this result may be related to the Brazilian economic characteristics, such as the fact that economic activity is concentrated in the Southeast region. A solution to this case would be the adoption of a weighting matrix that instead of using the concept of dichotomy as a function of the contiguity between the boundaries, used the distance between states.

To evaluate the effect of economic shocks from many selected countries on Brazilian economic growth, JNETO Zanetta; CERA (2014) used the global trade flow as a transmission channel. For this, the authors used quarterly data from 27 countries (developed and emerging) from 1990 to 2013 to estimate the effects on Brazilian GDP of shocks in the Chinese, American and Argentine economies. The results found by JNETO Zanetta; CERA (2014) were significant in terms of impact on Brazilian GDP, especially in relation to China and the US, both for positive (negative) shocks on economic activity and for the variables exports and imports. In relation to Argentina, the results were inconclusive.

It is important to mention that the empirical results found by JNETO Zanetta; CERA (2014) reveal the leading role of the Chinese economy on the behavior of Brazilian GDP, which intensified especially after the global financial crisis of 2008-09. This conclusion is supported by the influence, for example, of a positive Chinese GDP shock, which is 40% greater than the impact of one standard deviation of US GDP, helping to explain why Brazil emerged so rapidly after that crisis. The authors also pointed out that a large part of this impact occurred through the trade channel, with relevant impacts on imports, exports and consequently Brazilian GDP, in addition to causing depreciation of the real exchange rate.

Finally, an important result pointed out by Neto (JNETO ZANETTA; CERA, 2014) was the vulnerability of the Brazilian economy to the Chinese economic cycle. Because Brazil has a relatively closed economy in terms of the current account and balance of payments, and is much more dependent on China than the US, this indicates that a future situation of American economic expansion and Chinese contraction could have negative than positive effects on Brazil.

In a more recent contribution, MORCERF (2017) studied the influence of agricultural and mineral commodities on the Brazilian economy. In addition to the variables used byJNETO Zanetta; CERA (2014) GDP, exports, imports and real exchange rate – the author included Brazil main stock price index, the Ibovespa, which has strong presence of companies directly linked to the commodities market. The GVAR model was constructed with data from 57 countries, representing 87% of global GDP according to the IMF. To

make the analysis more consistent, due to the existence of small economies with little global relevance (which could cause some distortion in the results), the author grouped some countries into regions.

The main results found by MORCERF (2017) revealed the strong vulnerability of the Brazilian economy to changes in international commodity prices, with a greater impact on GDP, exports and imports. On the other hand, the real exchange rate and stock index variables had inconclusive results, which according to the author can be attributed to the low relevance of commodities in the financial market.

Moreover, according to MORCERF (2017), both positive shocks in agricultural and mineral commodities have a limited effect on GDP over time, which respond quickly in the first quarters, but are not sustained, leading to a downward GDP trend. The same result was also found for exports and imports. On the other hand, negative shocks have greater relevance and contrary effects to positive shocks, with emphasis on agricultural commodities in the Brazilian economy, overcoming the impacts of mineral commodities.

Finally, the methodology used by MORCERF (2017) to identify the economies with the greatest influence on the price of agricultural and mineral commodities was based on the response of the GDP of each country to the price of these commodities. The results support the conclusion of Neto JNETO Zanetta; CERA (2014), indicating China as the economy that most influences the price variation of these commodities, followed by the US, while Brazil does not exert any influence on the value of commodities.

The application of the GVAR method to Brazil is restricted to a few studies analyzing the propagation of economic shocks in some countries to real domestic economic activity. In addition, there is no empirical literature, both national and international, analyzing the effects of unconventional economic policies on financial activities.

In particular, we did not find any studies applied exclusively to Brazil regarding the effects of UMPs on the financial market. To fill this gap, we undertake this analysis, through the GVAR method, using six financial variables that represent the behavior of asset prices in the Brazilian market.

3.1.2 US Unconventional Monetary Policy

The deep recession that followed the 2008 crisis led major CBs to act in a timely manner. The first step - conventional monetary policy - was to aggressively reduce the nominal policy interest rate close to zero. In addition, since inflation in developed economies remained very low, this meant that real interest rates were negative. Given this unusual scenario, CBs had to explore new alternatives to restore the functioning of the financial market and stimulate aggregate demand, in addition to providing an accommodative monetary policy by the ZLB.

According to Bernanke e Reinhart (2004), there are three alternative ways to stimulate aggregate demand when interest rates are near or at zero. The first is forward guidance (FG), which consists of anchoring short-term interest rate expectations, keeping them artificially lower than what is currently expected. The second refers to credit easing (CE), based on altering the composition of the CB's balance sheet to change the relative supply of securities in the market. Finally, quantitative easing (QE) or large-scale asset purchases (LSAP) operates by expanding the size of CB' balance sheet beyond the level needed or by selling securities to affect the overall supply of reserves and money stock.

Forward guidance (FG) aims to anchor market expectations about the future interest rate trajectory. Specifically, it consists of the official announcement of the short-term interest rate target in conjunction with a series of information on the current state of the economy and the motivation that led to the decision, guiding the public on the future trajectories of the policy interest rate. According to Coeuré (2013), FG aims to ensure that market expectations about future monetary policy are indeed consistent with the policy intentions of the respective CB.

In situations of abnormality such as ZLB, CBs are required to provide more details and clarifications so as not to undo the expectations of agents about the future trajectory of monetary policy [González (2015)]. In this sense, when the economy is in a ZLB situation, FG usually leads to an expectation of falling nominal long-term interest rates and an expected inflation increase, affecting the long-term yield curve. However, when the ZLB is in effect, the CB's role becomes challenging in an attempt to convince the market that this situation will last for a long period and thereby open space for the appreciation of other financial assets and increase the expectation of economic recovery.

In order for the FG is successful, the announcement has to be credible. In others words, CB have to commit to what was obtain a higher impact, i.e., the impact of the FG also depends on how clearly the message is passed on to the public and therefore the aim and the next steps of monetary policy are fully understood.

Regarding the effect of FG on the financial market, Filardo e Hofmann (2014) found evidence that it has been successful to shape market expectations because it was very clear in policy decisions and, consequently, softened the volatility on the future trajectory for the short term interest rate. Besides that, they found evidence that for the US, futures rates and long term bond yields decreased on most announcement days. Nevertheless, the study was unclear about the effects on interest rate expectations and how the financial market reacted to the news about monetary policy and its consequences.

In relation to credit easing (CE), this measure consists of manipulating the composition of assets in the balance sheet of CBs, with the objective of affecting the relative prices of those assets and affecting the real economy. There is a subtle difference between CE and QE: CE consists only of modifying the allocation of the assets of the CB's balance sheet

and does not increase it. According to Carlson et al. (2009), CE can be classified as: (i) direct provision of liquidity to financial institutions, acting as a LLR; (ii) direct provision of liquidity to borrowers and investors in key credit markets; and (iii) the prurchase of longer term securities.

In order to promote the private credit market and reduce the spread, the main central banks have adopted the EC. Regarding the US, the topic of this essay, since the beginning of the global financial crisis, the Fed provided abundant liquidity in specific credit markets and institutions as well as disclosed lending operations to financial institutions.

According to González (2015), as the FG, QE aims to affect long term interest rates. This tool is to increase the CB balance sheet with the objective of providing liquidity in the financial system beyond what is necessary, focusing on the liability side. The QE differs from the conventional open market operations tool by giving volume to the banking system's balance sheet by expanding reserves beyond the level required to keep the overnight interest rate at zero. 7

For Bernanke e Reinhart (2004), the EQ also has the capacity to affect the economy by signaling the future trajectory of the interest rate in a way analogous to the CB's commitment. In effect, there is a reallocation in the market portfolios when different assets are imperfect substitutes lowering long term yield. Table 8 summarizes the UMPs applied by the Fed since the start of the crisis.

Table 8 – Unconventional Monetary Policy - Fed

Date	UMP	Announcement
25.11.2008	QE	Intention to start LSAP-I.
01.12.2008	QE	Potential purchase of Treasury securities.
16.12.2008	FG	Anticipation of low levels of federal funds rate
18.03.2009	QE	Start of LSAP-I (US$300 billion over the next
10.08.2010	QE	Announcement of the intention of LSAP-II.
09.08.2011	FG	Anticipation of low levels of federal funds rate
21.09.2011	CE	Start of the Maturity Extension Program (MEP)
25.01.2012	FG	Anticipation of low levels of federal funds rate
20.06.2012	CE	Continuation of the MEP until end of 2012.
13.09.2012	FG	Anticipation of low levels of federal funds rate
	QE	Announcement of LSAP-III.
12.12.2012	FG	Target range for the federal funds rate will be
	QE	Increase of LSAP-III to US$85 billion per month.
19.06.2013	FG	Intention to start tapering asset purchases later
18.12.2013	QE Exiting	Announcement of the beginning of the tapering
19.03.2014	FG	Announcement that interest rates will be kept
29.10.2014	QE Exiting	Fed concludes its asset purchase program.

Source: González (2015), Fratzscher, Duca e Straub (2018), Fed and IMF.

3.2 The Global VAR Methodology

Economic globalization is a reality and requires researchers to deepen the analysis of existing economic relations that are not always so obvious based on traditional textbooks, making it a real challenge and motivation for research. Studying and quantifying these relations and their transmission from economic events is fundamental for a better understanding of the functioning of a capitalist economy and thus broadening the policy options, not always conventional, to try to keep the economy on an even keel.

As seen in the previous sections, the advance of commercial and financial globalization requires policymakers to consider the relationships between economies and markets and their idiosyncrasies and complexities. Better understanding the dynamics of global markets and their connections and interdependences facilitates the implementation of public policy, investment decisions and the formulation of macroeconomic policies.

The GVAR method was developed with the objective of reducing complexity in the construction of models designed to capture the effects of global economic relations in large economic scenarios. In this sense, "The GVAR methodology provides a general yet practical global modelling framework for the quantitative analysis of the relative importance of different shocks and channels of transmission mechanisms. This makes it a suitable tool for policy analysis" Galesi e Lombardi (2013). Moreover, in this study, the methodology helps us to capture the long and variable lags that characterize the effect of monetary policy.

Undoubtedly, the greatest challenge in the study of global economic relations is the fact of dealing with a range of variables that must be considered in the construction of hypotheses and models, in view of the need to make scenarios closer to reality. In this sense, each new economy in the model contributes new variables for inclusion the equations that compose the global model to be estimated.

To facilitate the study of global economic relations by reducing complexity in the construction of models that represent the diverse economic scenarios, (PESARAN, 2004) developed a powerful tool that allows evaluating shock transmission channels trade flows and financial (capital) flows, among others. The GVAR model is a macroeconomic framework to address how foreign variables influence a domestic economy and vice versa.

One way to develop this type of study is to look at global macroeconomic variables, such as oil prices, together with a list of local variables of each economy, such as GDP, inflation, exchange rate and others. From these variables econometric models are constructed that represent global economic relations. With the models, the relations and economic impacts of research interest are estimated, and their results analyzed.

This essay analyzes the impact of UMPs on the global financial market and the Brazil market in particular. Thus, we apply the spread between 10-year and 3-month government bond yields. Thus, given the size of the US and its strong influence on the

world economy, we considered oil price variable to be endogenous for that country. That is, the US macroeconomic and financial variables have a significant impact on the oil price index.

In this essay, the GVAR method is utilized to model the potential spillover effects from Fed policy to the international and Brazilian financial markets. Consequently, impulse responses are computed to the UMP shocks on five-year CDS yields, inflation (CPI), equity prices, exchange rate, foreign reserves and 10-year Brazilian sovereign bonds.

As seen in the previous section, the GVAR method allows dealing with the complexity of the global modeling problem through two steps. First, each country is modeled individually by a VAR, treating foreign and global variables as exogenous, i.e., the VARX model. According to Pesaran (2004), the main characteristic of the model is that, for each country model, weak exogeneity is assumed for foreign and global variables. In the second step, the global model is constructed by combining all country-specific models and connecting them to a predetermined matrix, which has trade links between countries.

The next section describes in detail the methodology for modeling the GVAR and data used for analysis. Then we analyze the effects of UMPs, through the GIRFs, on the variables corresponding to the regions, and Brazil in particular.

3.2.1 Specification of Local Models

The GVAR model is a macroeconomic framework to address how foreign variables affect a domestic economy and vice versa. The method as used here follows the development of (MAURO; PESARAN, 2013). In line with (DEES et al., 2007) we suppose $N+1$ countries (or region), or any other agent that you want to model, indexed by $i = 1, \ldots, N$. The exogenous variables included in the individual models of each country are defined by vector, $x_{i,t}$ and the endogenous variables are defined by the vector $y_{i,t}$, where t is the time. Each of these N countries is modeled as a $VARX(q_i, p_i)$, where p_i the lags of exogenous variables and q_i the lags of the endogenous variables.

Therefore, the local models can be represented by the following equation:

$$y_{i,t} = a_i + \sum_{j=1}^{p_i} \Phi_{i,j}\, y_{i,t-j} + \sum_{l=0}^{q_i} \Lambda_{i,l}\, x_{i,t-l} + u_{i,t} \tag{3.1}$$

Where $y_{i,t}$ is the vector of endogenous variables with dimension k_i x 1, $x_{i,t}$ is the vector of exogenous variables with dimension k_i^* x 1 and $u_{i,t}$ is the vector of errors. The terms a_i ,$\Phi_{i,j}$ and $\Lambda_{i,l}$ are matrices of the coefficients of the equations.The main feature of the model is that each in country's model weak exogeneity is assumed for foreign and global variables. After the estimation of the partial system, the results are connected

through a link matrix or global vector so that the global model can be built. [(DEES et al., 2007)].

The vector $x_{i,t}$ can be considered the basis of the GVAR. This vector is formed by multiplying the weight of relations between countries by the variables of each study member. This creates a relationship between country i and all other countries, through the matrix of weights i and all other countries, through the matrix of weights $w_{i,j}$. Below is the formula for calculating the vector $x_{i,t-l}$:

$$x_{i,t} = \sum_{j=i}^{N} w_{i,j}\, y_{j,t} \tag{3.2}$$

The weight matrix $w_{i,j}$, has three restrictions that are:

1. $w_{i,i} = 0$; there is no relation of an economy to itself.
2. $\sum_{j=1}^{N} w_{i,j} = 1$; the weights of all relations of an economy must always be equal to one. Thus, only relations with countries that make up the model are considered.
3. $w_{i,j} \geq 0$; there is no negative relationship between economies.

The matrix $w_{i,j}$ is usually difficult to estimate, which implies taking this matrix as given. The information used to construct the matrix comes from the inter-country trade statistics provided by the IMF. The $w_{i,j}$ represents the weight relative importance of the economy j on i capturing the spillover effects such that $\sum_{j=1}^{N} w_{i,j} = 1$ and $w_{i,j} = 0$. According to Chudik e Pesaran (2013), the weights of $w_{i,j}$ are not estimated but build aplying data from bilateral foreign trade or capital flows and can be either fixed or time-varying.

There are some refinement proposals in the literature for constructing the weight matrix. An example is the study by Gruss (2014), who created the matrix using a combination of commercial and financial relationships. And in Gruss (2014) presents a form of weight estimation and also shows that using weights can cause bias in the estimates. Finally, Gray (2013) describes an application with the weight matrix estimated by the method proposed in Gruss (2014).

In the GVAR model, a time-varying weight matrix from bilateral trade with two-year window is used, since trade linkages between countries tend to fluctuate and/or evolve. This is an important feature given that commercial relationships between economies can be affected in certain periods.

According to Cesa-Bianchi et al. (2012) the use of trade statistics is ideal to create the weight matrix for three reasons. First, trade relations tend to exist before financial relations, and trade in goods and commodities is the most important transmission channel

for shocks between countries. Second, trade relations between countries tend to reflect existing political, cultural and technological relations, as well as being a good thermometer for measuring relations generally between countries. Third, among the alternatives that can be used to create the weight matrix, transactions are perhaps the most reliable because data for almost all countries are available from international bodies while financial relationship data are not always available or reliable.

The solution of the local models is done by least squares since the models $VARX(q_i, p_i)$ are regular VAR models.

Being Γ_i, the matrix formed by the model parameters and $\widetilde{y}_{i,t}$ the matrix variables as follows:

$$\Gamma_i = (a_i \ \Phi_{i,1} \ \ldots \ \Phi_{i,pi} \ \Lambda_{i,0} \ \ldots \ \Lambda_{i,qi}) \tag{3.3}$$

$$\widetilde{y}_{i,t} = (1 \ y'_{i,t-1} \ldots \ y'_{i,t-pi} \ \ x'_{i,t} \ldots \ x'_{i,t-qi}) \tag{3.4}$$

Finally the local equations can be written as follows:

$$y_{i,t} = \Gamma_i \widetilde{y}_{i,t} + u_{i,t} \tag{3.5}$$

And the solution is obtained by simple multiplication.

$$\widehat{\Gamma}_i = (\widehat{a}_i \ \widehat{\Phi}_{i,1} \ \ldots \ \widehat{\Phi}_{i,pi} \ \widehat{\Lambda}_{i,0} \ \ldots \ \widehat{\Lambda}_{i,qi}) = \sum_{t=i}^{T} y_i \widetilde{y}'_{i,t} \left(\sum_{t=i}^{T} y_i \widetilde{y}'_{i,t} \right)^{-1} \tag{3.6}$$

In order for the model to be valid, the assumption is that the exogenous variables are weakly exogenous. This assumption is important because it allows each model to be estimated individually without bias. Economically this means that each country can be treated as an open economy relative to the rest of the world. This also ensures that the number of countries does not need to be large to use the GVAR model. The weak exogeneity test will be performed more often.

3.2.2 Solution of the Global Model

The GVAR solution strategy is to use all local models estimated to build the global model. For this, we use the weight matrices, the previously estimated parameters for each model and the global vector y_t. The vector y_t is composed of all endogenous variables and has dimension $k = \sum_{i=1}^{n} k_i$. Here the global solution is also obtained by ordinary least squares.

First, we must rewrite the local model equations, equation 2.1, as a function of the global model. This should be, $z_{i,t} = (y'_{i,t} \ x'_{i,t})$. In order to simplify, the lags of the

endogenous and exogenous vectors will be $q_i = p_i$. Rewriting the equation 2.1 we will have the following equation:

$$A_{i,0}z_{i,t} = a_i + \sum_{j=1}^{pi} A_{i,j}z_{i,t-j} + u_{i,t} \tag{3.7}$$

where

$$A_{i,0} = (I, -\Lambda_{i,0}),\ A_{i,j} = (\Phi_{i,j}, \Lambda_{i,j}) \tag{3.8}$$

The global vector, y_t, of size k x 1 where $k = \sum_{i=1}^{N} k_i$, is defined as:

$$y_t = \begin{pmatrix} y_{1,t} \\ y_{2,t} \\ \vdots \\ y_{N,t} \end{pmatrix} \tag{3.9}$$

The weight matrix W_i which contains the previously calculated weights is formed by the combination of all the weight matrices of the individual models.

Thus it is possible to obtain the vectors of the local models by combining the global vector and the weight matrix.

$$z_{i,t} = W_i y_t \tag{3.10}$$

Replacing 3.10 in the model 3.7 the model for countries i has the following equation:

$$A_{i,0}W_i y_t = a_i + \sum_{j=1}^{p_i} A_{i,j}W_i y_{t-j} + u_{i,t} \tag{3.11}$$

Once again, by matching the lags, making $p = q$, you can rewrite the template 3.11 as follows:

$$G_0 y_t = a + \sum_{j=1}^{p} G_j y_{t-j} + u_t \tag{3.12}$$

where

$$G_j = \begin{pmatrix} A_{1,j}W_1 \\ A_{2,j}W_2 \\ \vdots \\ A_{N,j}W_N \end{pmatrix}, \quad a = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_N \end{pmatrix}, \quad u = \begin{pmatrix} u_{1,t} \\ u_{2,t} \\ \vdots \\ u_{N,t} \end{pmatrix}$$

Multiplying both sides of equation 3.12 by G_0^{-1} , produces the reduced form of the global model:

$$y_t = b + \sum_{j=1}^{p} F_j y_{t-j} + e_t \tag{3.13}$$

where

$$F_{j=} G_0^{-1} Gj, \quad b = G_0^{-1} a, \quad e_t = G_0^{-1} u_t,$$

The equation 3.13, can be by simple multiplication.

According to Mauro e Pesaran (2013) , the GVAR allows interactions between economies through three distinct channels: (i) contemporary dependence on domestic variables, $x_{i,t}$ in exogenous variables, $x^*_{i,t}$ and in lagged values, (ii) dependence on domestic variables, $x_{i,t}$, in global exogenous variables, (iii) contemporary dependence on shocks between countries.

As will be seen shortly, the final GVAR specifications were chosen considering stability, i.e., no eigenvalue lies outside the unit circle and the persistence profiles converge to zero. In addition, to interpret the GVAR results, impulse response analysis is necessary. This analysis helps to investigate the dynamic properties of the model, by simulating how a country responds to a common specific shock through future states of a dynamic system.

3.3 The Data

We collected data from 21 countries, which are listed in Table 1. Since some of these countries have small economies and thus little relevance in global terms, we grouped them by region so as not to distort the results while preserving the relevant information. The 21 countries selected represent more than 63% of global GDP, according to the IMF.

Table 9 – Countries and Groups

America	**Asia**	**China**	**Europa**	**Other Countries**
Argentina	India	China	Euro Area	Brazil
Chile	Indonesia	Hong Kong	Russian	Canada
Mexico	Israel		United Kingdom	South Africa
	Japan			EUA
	Korea			
	Malaysia			
	Philippines			
	Singapore			
	Thailand			

The main idea of the estimated GVAR model is to capture spillover effects for these regions to the Brazilian market. Therefore, the countries included were selected according to data availability to obtain maximum number of countries.

The weight attributed to each country, in its respective group, follows the methodology adopted by Dees et al. (2007) and MORCERF (2017). It is calculated by the ratio of purchasing power parity (PPP) in terms of GDP of each country with the sum of the GDP values measured by PPP of all countries considered in the group. The GDP PPP values used in the calculation refer to the average between the years 2013 and 2015. The weights of each country are summarized in table 13 in Annex B.

The dataset comprises monthly macroeconomics and financial data, from March 2007 to December 2017. The following country-specific variables are used for the GVAR model: (i) equity prices (stock price index) as EQ_{it}, CPI (inflation) as CPI_{it}, exchange rate spot as EX_{it} as CDS 5 years as CDS_{it}, interest rate 10 years as IR_{it} and foreign-exchange reserve as FER_{it}. Differently from other studies that use the GVAR methodology focused on the economy, and for this use as global variable the oil price, in this essay we will use the 10-year and 3-month spread of US securities as a global variable. SPR_t, the spread between 10-year and 3-month government bonds yields, is an important external variable to analyze global effects of UMPs. In this sense, external variables produce a link between the evolution of the domestic economy and the rest of the world. The model developed here considers this spread variable for the US to be endogenous. The data were collected from Bloomberg. The software used to estimate the GVAR model of this assay was MATLAB.

Some countries presented discontinuity in some series, so these variables were excluded from the model for these economies to avoid inconsistency in the results. The construction and data collection are described in more detail in the Annex. The variables used in the model were deflated and log-transformed as described below:

$$eq_{it} = ln(EQ_{it}), \quad cpi_{it} = ln(CPI_{it}), \quad exit = ln(EX_{it})$$
$$cds_{it} = ln(CDS_{it}), \quad ir_{it} = ln(ir_{it})$$
$$fer_{it} = ln(FER_{it}), \quad spr_t^0 = ln(spr_t^0)$$

The GVAR model requires, as an essential step, the inclusion of external variables. For each domestic variable of each country in our sample, the respective external variable is constructed based on a weighted average of the corresponding variables of its commercial pairs. The weighting mode is usually chosen to highlight the economic relationship of one country to another. As in Mauro e Pesaran (2013) and MORCERF (2017), tthe weight matrix used in the study has fixed weights and considers the averages of commercial transactions between countries from 2014 to 2016 (considering our sample), and can be seen in Table 14 in Annex B.

The model specification follows the method proposed by Pesaran, Schuermann e Weiner (2004) and Dees et al. (2007). Considering both works, we treat the dominant unit in the sense of Chudik e Pesaran (2016), Georgiadis (2015) and MORCERF (2017),to account for its substantial role in the global economy. Furthermore, in line with the contributions of MORCERF (2017), Georgiadis (2015), Gauvin e Rebillard (2015) and Gruss (2014), we also give special treatment to China due to its extraordinary role in the global market, as the second largest economy. Therefore, in addition to Brazil, which is the focus here, the US and China are considered individually, with the other countries being treated together as regional blocks. Except for the US, each country's GVAR consists of seven domestic endogenous variables: (i) equity prices (stock price index), CPI (inflation), spot exchange rate, five-year CDS rate, 10-year sovereign bond interest rate, and foreign exchange reserves.

As mentioned above, in the case of the US, the spread between 10-year and 3-month bond yields is considered an endogenous variable. By specifying the model in this way the US macroeconomic variables have stronger effect on this spread. That is, only the US is able to affect the spread between 10-year and 3-month sovereign bond yields. Table 10 shows how the models for each country were specified.

Table 10 – Especification of models for Groups and Contries

Variables	Other Countries		EUA	
	End.	Exo.	End.	Exo.
Equity Prices	eq_{it}	eq^*_{it}	eq_{it}	eq^*_{it}
CPI	cpi_{it}	cpi^*_{it}	cpi_{it}	cpi^*_{it}
Exchange Rate	ex_{it}	ex^*_{it}	ex_{it}	ex^*_{it}
CDS 5 years	cds_{it}	cds^*_{it}	cds_{it}	cds^*_{it}
Interest Rate 10 Years	ir_{it}	ir^*_{it}	ir_{it}	ir^*_{it}
Foreign-Exchange Reserve	fer_{it}	fer^*_{it}	fer_{it}	fer^*_{it}
Spread	-	spr^0_t	spr^0_t	-

3.4 Statistical Tests of Specific Models by Region

The specification of the GVAR model can be developed both in terms of stationary variables and integrated variables of order I(1). However, in general the literature uses I(1) variables with the objective of distinguishing the short and long-term relationships, which makes it possible to investigate the existence of cointegration MORCERF (2017). Thus, following the proposal of Dees et al. (2007), we assume that the variables included in the models specific to each country are I (1).

First, we perform the unit root test to analyze if the series are stationary. This test is necessary to determine the optimal number of lags in the autoregressive process. In

addition, it is important that the series be non-stationary to provide cointegration between the variables. Otherwise, the non-stationarity of the series, or the presence of a unit root, implies there is a temporal relationship between the mean and the variance, which can lead to biased results, causing errors of statistical inference, and also lead to inconclusive results according to economic theory.

3.4.1 Unit Root Tests

In the GVAR method, two unit root tests can be used. The commonly used test in time series is the augmented Dickey-Fuller (ADF), proposed by Dickey e Fuller (1979), for univariate unit root tests. The second test, indicated for small samples, where the ADF test loses power [Pesaran, Smith e Smith (2005)], is the ADF test of Symmetrical Weights (WS-ADF).

These tests, henceforth WS, exploit the time reversibility of stationary autoregressive processes in order to increase their power performance Dees et al. (2007). Furthermore, Pantula, Gonzalez-Farias e Fuller (1994) and Smith et al. (2004) provide evidence of superior performance of the SW-ADF test statistic compared to the standard one. The lag length employed in the SW unit root tests is selected by the Akaike information criterion (AIC). Due to the size of the series, 92 observations, we chose to use the WS-ADF test considering four lags, as suggested by Galesi e Lombardi (2013).

After defining the maximum lag, the selection of the optimal lag is done by minimizing the AIC value. This process was done for each series studied and the results of the SW-ADF tests, with significance of 5%, are presented in Table 15 until 18 in Annex B. The results indicate that for most variables, the unit root hypothesis cannot be rejected at 5% and they are mostly integrated with order 1 (I (1)). Thus, the results of the tests support the hypothesis of this work that the variables included in the specific model of each country can be treated as I (1) in the construction of the GVAR model.

3.4.2 Lag Order Selection, Cointegration Relations and Persistence Profiles

For the country-specific models, VARX, the number of lags and the cointegration stationarity are calculated considering the hypothesis that the external variables are weakly exogenous and that the parameters of the individual models are stable over time. Thus, the models consider two parameters for lags: one for endogenous variables (pi); and another for exogenous variables (qi). Following Cashin et al. (2012) and Mauro e Pesaran (2013), given the constraints imposed by data limitations we set the maximum lag orders to $p_i \leq 2$ to endogenous variables and $q_i = 1$ to exogenous variables. After this limitation, the lag is chosen that minimizes the AIC value.

After stabilizing the order of 6 VARX models, we determine the number of long-

run relations for the purpose of cointegration analysis, in which the models are subject to reduced rank condition Johansen (1992). For this, the vector error correction of the individual equations (VECMX) is estimated.

Cointegration tests with the null hypothesis of no cointegration, one cointegration relation, and so on are carried out using Johansen's maximal eigenvalue and trace statistics, as developed in Pesaran, Shin e Smith (2000) for models with weakly exogenous I(1) regressors, unrestricted intercepts and restricted trend coefficients. Following Pesaran (2006), Cesa-Bianchi et al. (2012), Gruss (2014), Georgiadis (2015) and Chen, Griffoli e Sahay (2014),we choose the number of cointegration relations regarding the trace test statistics, given that it has better small sample properties than the maximum eigenvalue test, initially using the 95% critical values. The results for all models can be seen in Tables 19 to 21 in Annex. The table 11 shows the final lags of *pi* and *qi* for each VARX model as well as the of the cointegration relation.

Table 11 – VARX* Order of Individual Models

País	p_i	q_i	Cointegrating relation
America	2	1	1
Asia	2	2	4
Australia	2	2	1
Brazil	2	2	3
Canada	2	2	1
China	1	2	1
Europa	2	1	4
South Africa	2	1	2
EUA	2	2	2

We then consider the effects of system-wide shocks on the identified cointegration vectors using persistence profiles (PP), as developed by Lee e Pesaran (1993) and Pesaran e Shin (1996). According to MORCERF (2017), the PP is defined as the time profile of the effects of the system or as the profile of the shocks of specific variables on the cointegration relation in the GVAR model. One impact PPs are normalized to take the value of one, but the rate at which they tend to zero provides information on the speed with which equilibrium correction takes place in response to shocks. The PPs can initially overshoot, thus exceeding one, but must eventually tend to zero if the vector under consideration is indeed cointegrated Cashin et al. (2012). In other words, the PPs provide information on the speed with which the cointegration ratio returns to its equilibrium.

3.4.3 Weak Exogeneity Test

As mentioned earlier, the model treats the external variables as weakly exogenous. In this case, a weakly exogenous variable is defined as being independent of its contemporary

values, although this may depend on its lagged values. According to Johansen (1992) and Harbo et al. (1998), this assumption allows the appropriate identification of the cointegration relationships between variables.

The weak exogeneity test consists of evaluating the joint significance of the estimates of the error correction terms in the auxiliary equations for the specific exogenous variables of the individual models of each country. In this case, individual models are first estimated under the null hypothesis that external variables are weakly exogenous. In summary, the weak exogeneity test is an F-test with joint hypothesis, in which for the terms to be exogenously weak, the error correction term should not be significant in the F-test MORCERF (2017). Following Pesaran, Smith e Smith (2005), for the tests of weak exogeneity we consider two periods of delay in all the models.

As can be seen in table 22 in Annex B, the weak exogeneity hypothesis cannot be rejected at the 5% significance level for most of the considered variables. The exception occurs for: all regions, excepet Canada and China, in relation to the CPI; Asian, in relation to 10-years bond yields, foreign reserves variables and the US treasuries spread; for Latin America in relation to exchange rate and foreign reserves; for Europe with the 10-years bond yields; and the US in relation to foreign reserves.

In relation to Brazil, all the variables can be considered weakly exogenous, except for CPI. This was already expected due to the low representativeness of the Brazilian economy in the global context. Although the works applied to the Brazilian economy up to this time have focused on the effects on economic activity through commercial relations, whose explanation for this result is the low degree of economic openness, in our analysis the low representativeness may be associated with the low market power of Brazilian capital in affecting the price of assets on a global scale.

3.4.4 Structural Breaks Test

The structural break test is of great importance in econometric analysis. Indeed, this aspect may be even more relevant when it comes to emerging countries, which are more subject to crises of political and social instability, a situation that can undermine any analysis mainly involving time seriesPesaran, Smith e Smith (2005).Despite the advances in research using the GVAR model, it is not immune to this type of problem. The crux of the matter is how to deal with future structural breaks that may arise in the prediction and shocks of models.

On the other hand, the GVAR model is able to accommodate the structural breaks, since it is more robust in dealing with the problem compared to the simpler VAR models or to the model of individual equations, because it deals with a greater number of variables, making it possible to smooth the impacts. In Brazil, for example, structural breaks are

found in years when the country was subjected to shocks that coincided with political events. Recognizing that this evidence is problematic, we follow the initial works on the GVAR [Pesaran (2004), Dees et al. (2007) Cashin et al. (2012)].

In order to perform the tests, we consider only the stability of the series in the short term, in line with the proposal of Pesaran, Smith e Smith (2005), due to the limitation of data for the method, which makes it impossible to apply the test for long-term stability. Moreover, short-term stability is more important when cross-country shocks are studied since in the long run the greater concern is stability of the model, as seen in section 3.4.4.

Following Cashin et al. (2012), we tested the null hypothesis using the residuals from the individual reduced-form country-specific error correction equations, initially looking at the maximum OLS cumulative sum statistic (PKsup) and its mean square variant (PKmsq), as developed by Ploberger e Krämer (1992). Additionally, in order to verify the stability of the variables, we used the $\mathscr{R}$ test as proposed by Nyblom (1989).We also performed several tests similar to the Wald test for single structural changes with unknown point changes. More specifically, we employed the mean Wald statistic of Hansen (1992) (MW), the Wald form of the Quandt (1960) likelihood ratio statistic (QLR), and the Andrews e Ploberger (1994) Wald statistics based on the exponential average (APW). Finally, we also examine the heteroscedasticity-robust versions of $\mathscr{R}$, MW, QLR, and APW.

A summary of the results of the structural break tests can be seen in the Annex. The results of the tests may vary according to the applied test, considering that the tests with more robust estimates of heteroscedasticity present a smaller number of structural breaks.

3.4.5 Generalized Impulse Response Analysis

To analyze the effects of the UMPs by the Fed, the impulse response is estimated to a negative shock on the US Treasury spread, as the monetary policy indicator, during the crisis. Thus, the negative shock occurs when there is a reduction of sovereign bond yields. With the monetary policy rate at zero, the reduction in the spread necessarily reflects a decrease in the long-term yield.

The use of the spread of government bond yields is justified by the accuracy of immediately capturing the market reaction in response to each measure's announcement, so that any UMP can be represented by this variable. This view is adequate considering that the reduction of the long-term interest rate is the target of central banks in the ZLB Gilchrist, López-Salido e Zakrajšek (2015).

The empirical literature finds strong evidence of the effects on sovereign bond spreads in response to UMP. Gilchrist, López-Salido e Zakrajšek (2015), for example,

concluded that both conventional monetary policy and UMP affect this spread. According to them, however, conventional monetary policy flattens the real yield curve, but it has a pronounced effect on the long-run interest rate curve. The objective of a UMP is to flatten the yield curve, and to have a more pronounced effect on the real long-term yield curve.

Similarly, Neely et al. (2010) found that LSAP announcements substantially reduced both international and US long term bond yields after the announcement, indicating that the market interprets the "declines in bond yields as reflecting expectations of much weaker growth over a period of many years." That study found that during the UMP period, U.S. real 10-year Treasury yields fell by a total of 187 basis points during the five LSAP buy windows. In addition, several researchers, like Moore et al. (2013), Chen et al. (2012), Neely et al. (2010) and Glick, Leduc et al. (2013) have studied the effects of UMPs captured by changes on long-term Treasury yields.

The GVAR estimation process involves analysis of the influence of shocks on the variables of the model and the analysis of the results obtained. These shocks are applied using the generalized response impulse function (GIRF). The analysis of the impulse response function helps to study the dynamic properties of GVAR, as it is a useful tool to interpret by simulation how a country responds to a common specific shock through future states of a dynamic system.

This section presents the results of the generalized impulse response functions (GIRF) for analysis of the transmission of a negative shock on the US monetary policy indicator (Treasury spreads) to Brazil. To estimate the impulse response, we identify the monetary shocks using a recursive Cholesky scheme. However, the GIRF does not have the property of being invariant to the order of shocks in variables and countries. This property makes the GIRF an important tool in the present study, because there is no information or assumption that allows ordering of the variables or countries, as necessary to execute the shocks. In addition, we follow Dees et al. (2007) and by assuming that the US economy affects but does not respond to developments in other economies contemporaneously. According to Chen et al. (2016), this is equivalent to placing the US model as the first country block in the GVAR.

We start with the analysis for the GIRFs from Fed's negative shock to measure the relative importance of the US economy in the American, Asian, Chinese and Europe economies and the spillovers to Brazil, the main objective of this work, given the strong commercial linkage. Additionally, according to Chen, Griffoli e Sahay (2014), tthe results are heterogeneous among the countries. This may indicate different transmission channels and adjustment mechanisms in different countries.

Essentially, a key element in the GVAR model is to capture the UMP shocks on the system. The literature mainly uses CBs' balance sheet changes as a proxy for studies of QE shocks. However, the challenge lies in trying to find a single variable that can involve

Figure 8 – US Treasury Spreads

Source: Author's creatin from Bloomberg.

and represent the many different types of UMPs. Thus, for the present study, we use as a monetary policy indicator for the US the spread between the long-term interest rate, represented by 10-year Treasury yield, and short-term interest rate, represented by the corresponding three-month yield. The shocks are quantified for the six financial variables that compose the GVAR model: five-year CDS rate; CPI, exchange rate, 10-year interest rate, foreign exchange reserves; and stock index (equity prices). The GIRFs show the shocks, with a 95% confidence interval.

The estimated GVAR provided empirical evidence about spillover effects from unconventional monetary policy to Brazil. Unlike the traditional VAR model errors, the shocks in the GVAR model are weakly correlated, as seen previously, which makes the use of the GIRFs more appropriate to analyze the transmission of shocks between countries. Following Chen et al. (2016), twe estimated the GVAR for the initial crisis period, starting from the outbreak of the US subprime mortgage crisis in March 2007 to December 2017.

Figure 9 presents the GIRFs of the impact of US monetary policy shock on Brazil. As can be seen, the reduction of Treasury yield spreads had positive effects on the Brazilian financial market during the crisis. Evidence shows that during this period, the channels with greatest impact were stock prices, international reserves and the exchange rate.

For the period from beginning of the crisis to the implementation of the UMPs by

the Fed, a negative shock on the spread between the 10-year and the 3-month yields affected all six variables. The five-year CDS (country risk measure) rose in the first four months, but soon thereafter fell substantially and stabilized after the 30th month. This movement is as expected and can be explained by the global contagion effect and macroprudential policies implemented in Brazil.

As expected, inflation (CPI) declined immediately, by approximately one percentage point, and stabilized only in the 40th month. This result has ambiguous interpretation. On the one hand, the fall in inflation was due to the economic recession that ensued. On the other hand, UMPs tend to push the short-term target policy rate down, and in response to FG, agents should expect higher inflation in the future. Moreover, as can be observed, the effect was the same for all regions (Annex B), except for Latin America, which showed a slight increase, but soon stabilized.

In relation to stock prices, the monetary policy change in the US was followed by a decline in the Brazilian stock index, but this was followed by a strong recovery from the fourth month, although it only stabilized after three years. This evidence indicates a possible flow of portfolio investments to Brazil in response to the negative reaction to the monetary policy, as a sign of a weaker outlook for the US economy.

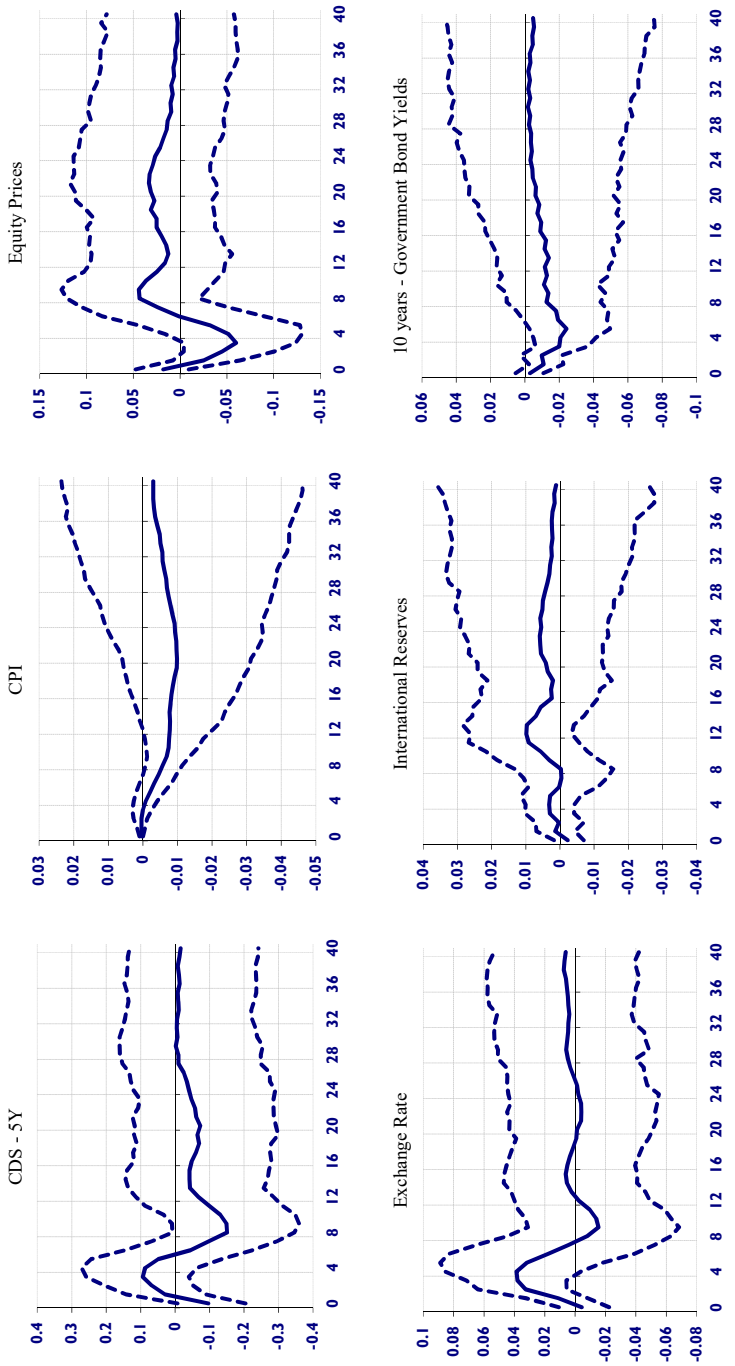
In the case of the exchange rate, the positive impact (stronger currency) is associated with the strong flow of capital that to the country. The effect of the negative monetary policy shock in the US was immediate and led to a real appreciation close to 5% in the first quarter, although the exchange rate stabilized after six months.

With regard to international reserves, the positive impact was in line with the result for the foreign exchange market. The accumulation of reserves in response to the Fed's UMP reflects capital movements in search of assets with more attractive prices, where higher yields in Brazil than in other countries may have been a determining factor.

Finally, 10-year yields of Brazilian sovereign bonds initially declined by 2 percentage points and stabilized in the long run, starting at the 36th month. This movement is understandable, given the strong movement of capital to long-term fixed-income securities.

In summary, the results show that the Brazilian asset market was subject to changes in the monetary policy of the Fed. In particular, the variables country risk, inflation, stock index, exchange rate, international reserves and 10-year sovereign bond yields of government securities (all six variables analyzed in the model), were impacted by the UMP implemented in the US in response to the global financial crisis.

Figure 9 – US 1se Negative Shock to UMP indicator - Brazil



3.4.6 Robustness Check

In order to the test whether the impulse response analysis from all models are robust, these were re-estimated using a different sample. To do this, we do the same research for the period between 2007 and 2017 to analyze the effects before and after the crisis, according to Figure 13.

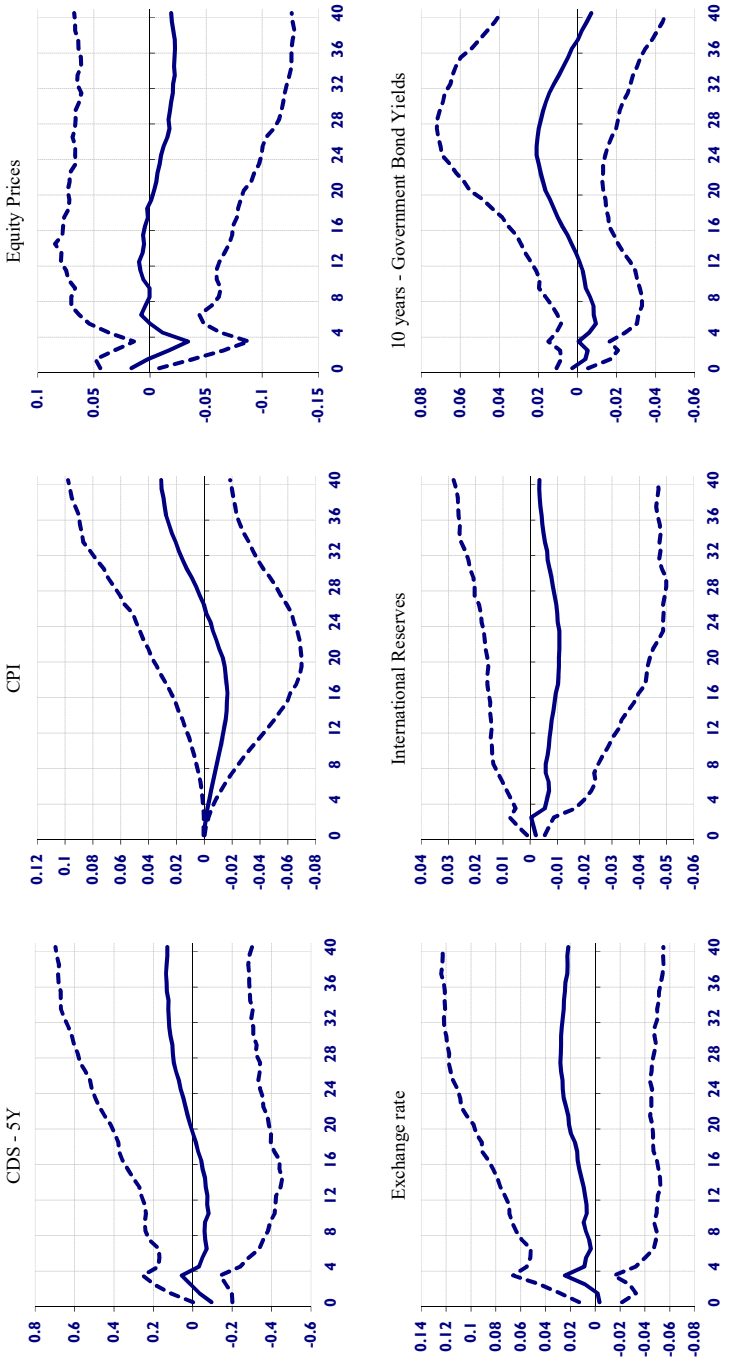
The result for Brazilian market presents some differents results in comparison to the crisis times. The response of a negative shock on the US Treasury yield spread, considering the post-crisis period, has a more timid effect on CDS Brazil. The response of a negative shock, considering the post-crisis period, has a more timid effect on CDS Brazil. An economic explanation for this is the advancement of Brazil's external accounts over time. In other words, the robust volume of reserves and the participation of portfolio investments from abroad mitigate short-term default risk, even though it is an economy with no degree of investment.

On the other hand, inflation (CPI) behaves similarly to the period of the crisis. That is, a negative shock on the US UMP variable, the CPI falls back to the twentieth month. However, as of the twenty-fourth month, inflation increases by around 4% and without signaling convergence until the fortieth month.

The exchange rate also behaves quietly in response to a negative monetary policy shock in the US. There is initially a slight increase until the second year, but it converges immediately. In contrast, international reserves decline by 1% over 24 months, once again to stabilize.

Finally, considering the post-crisis period, a UMP negative shock on 10-year government bond yields has the same expected effect of declining in the early months, as well as in the crisis period. On the other hand, it grows again on average by 2% stabilizing in the long run. This is not surprising since a reduction of interest rates in the short term raise the expectations of interest increase in the periods ahead in normality situation of the current state of the economy.

Figure 10 – US 1se Negative Shock to UMP indicator - Brazil (all sample)



3.5 Conclusion

This study shows that the recent global financial crisis led policymakers to adopt a set of unconventional measures to mitigate the recession by stimulating aggregate demand. These policies came in a variety of ways, from countercyclical fiscal measures, through exchange rate measures, to policies to expand liquidity by the main central banks, which played the important role of LLR. These policies are also known as macroprudential measures.

Unlike other works on the subject, the focus here is on the spillover effects of UMPs on the financial and capital markets. This raises important hypotheses to be tested and rekindles the debate about the role of CBs. Among these hypotheses that contribute to the empirical literature is the effectiveness of discretionary monetary policy. However, the discretionary nature suggested here does not mean abandoning inflation control, but rather the inclusion of new mandates, through risk and financial (macroprudential) policies, without insubordination to the ITR. We also summarize several papers, whose empirical evidence has revealed the effectiveness of these policies, with emphasis on the contributions of Chen et al. (2012), Moore et al. (2013), Neely et al. (2010), Chen, Griffoli e Sahay (2014), Chinn (2013), Glick, Leduc et al. (2013), Fratzscher, Duca e Straub (2018) and Bayoumi e Vitek (2013). However, the main concern of those papers was to investigate the effects on the real economy.

We applied the GVAR method to build a model of global financial relations. As a basis for this model, we investigated the spillover effects of the Fed's UMP on the Brazilian economy. In contrast to the empirical GVAR literature, this analysis focused on the dynamics of asset prices, represented by financial variables, in response to monetary policy.

Our results provide empirical evidence of the effects on the Brazilian financial market resulting from a negative shock from the spread between the 10-year and three-month US Treasury yields, where this spread was used as a proxy for the UMP implemented by the Fed through LSAP. For this, we used monthly data on financial variables (equity prices, inflation, exchange rate, CDS yields, foreign reserves and 10-year sovereign bond yields) to construct the model.

The impulse response analysis using the GVAR model suggested stock prices, 10-year bond yields, exchange rate and international reserves as being the main transmission channels to the Brazilian market. The negative shock of Treasury spreads was transmitted to Brazil, indicating the effectiveness of the Fed's UMPs. So, we further investigated the effects of monetary policy shocks in country level models to gain more insight into the transmission of UMP.

However, our results are naturally subject to a considerable degree of uncertainty.

Indeed, the sample period is short, which made precise estimation difficult, and correlation does not necessarily mean causation. Nonetheless, our empirical evidence is consistent with some of the main theories for the transmission of UMP.

To sum up, the UMPs of the Fed had had a significant impact on the global economy, especially on the behavior of financial markets, which reinforces the preponderant role of these unconventional measures and is consistent with the results also found in the specialized literature through a wide range of methodological approaches. This leads to reflection on the true role of monetary policy in a capitalist economy, where its elements and tools should not be restricted to a single goal. Consequently, it becomes necessary to broaden the debate in favor of discretionary CB action, to promote price stability and protect the financial system in an equitable manner.

Monetary policies that include other mandates, in parallel and not submissive to controlling inflation by means of rules, is important for the economic health of countries. Therefore, further research should be conducted to propose new monetary policy ideas and solutions.

Conclusion

The three essays presented here come to independent conclusions, which were presented at the end of each one. However, the unifying theme of the essays and their logical sequence, whether monetary policy or the financial system, also allows a unified conclusion of this thesis.

The global financial crisis of 2007-09 led to a revision of mainstream thinking regarding the conventional paradigm of rules-based monetary policy. However, while the conventional theory of the NMC recognized the absence of important elements in EMH, such as the lack of risk management policy and financial policy (macroprudential), the theoretical bases of orthodoxy were maintained. In this sense, the inclusion of these tools is subject to monetary policy, with the use of the short-term interest rate, thus subordinate to the ITR.

Given the above, the objective of the first essay was inspired by the absence of new unconventional elements in the conduction of monetary policy. In other words, the proposal was to add to the debate between rules and discretion of monetary policy a theoretical contextualization containing elements of political economy, notably legal, institutional and power relations aspects.

In this sense, the proposal seeks a theoretical alternative that can base the expansion of the CB's mandate, leading it to assume the role of LLR, which favors discretionary monetary policy. In this first essay, therefore, the LTF appears as a possible theoretical solution in favor of discretionary monetary policy. As seen, its hypotheses and its pillars make this theory challenging to the NMC. That is, it is an approach that recognizes the intrinsic instability of modern capitalism, as post-Keynesian theory points out, and incorporates key points regarding agents with more or less power within the system (central and peripheral), the hierarchy of assets and the protagonist role of CBs.

Pistor with her LTF notes that financial systems are unstable and consequently will never reach equilibrium. In addition, this also points out that while laws can provide credibility and predictability to contracts, under conditions of fundamental uncertainty this can become a source of financial instability. In crisis situations, the survival of institutions and agents is determined by central, not peripheral, actors. As such, those who are closer to the center and farther from the periphery will be more likely to benefit from a relaxation of the rules.

A discretionary role of the CB requires credibility. That is, the greater its accountability, the greater will be the room for monetary policy to act, especially in times of high uncertainty. However, the heart of the matter is over who benefits from a rigid rules-based

monetary policy. So the discussion depends in the relations of power.

The convention in favor of conservatism in monetary policy explains the maintenance of monetary policy rules. In this case, in developing countries (periphery), especially those that adopt ITR, the CBs tend to be more conservative, thus favoring financial asset holders. This means that the conduction of monetary policy in the framework of rules is not only a macroeconomic problem but is also linked to a range of interests, translated into the principal-agent problem, in which the CB (agent) is captured by rentiers (principals).

The convergence of LTF to the rule-versus-discretion debate of monetary policy, identified in the first essay, is prominent. Based on the conservatism convention in the conduct of policies, LTF converges to this discussion. Therefore, it is necessary to redesign the current monetary policy strategy, since the control of inflation through interest rates causes harmful side effects on the growth and development of a developing economy, i.e., it is necessary to discuss the importance of discretionary action to the detriment of a policy based on rules.

The first essay served as inspiration for the latter two. The second essay examined who the biggest beneficiaries are of a rules-based monetary policy. For this, we investigated the behavior of assets in the Brazilian economy, before, during and after the outbreak of the global financial crisis.

Following the proposal of Caporale, Spagnolo e Spagnolo (2016) and Caporale, Spagnolo e Spagnolo (2018), through the VAR-GARCH method, the specific objective was to evaluate the interpretation of the Brazilian financial market of the CB's performance regarding its (singular) mandate in the ITR. Specifically, we tried to capture the market reaction when, for some reason, CB proved unable to drive inflation to the central target.

For this, we constructed a negative (positive) news index of the performance of the Central Bank of Brazil. Then, with daily data between January 2006 and May 2017, we evaluated the impacts of news on the return of financial assets, represented by the stock market index (Ibovespa) and the exchange rate.

There is no evidence that the negative and positive news affected the mean returns an the volatility. The results suggested that the impact of news was neutralized by interventions by the Brazilian Central Bank in the foreign exchange market and macroprudential policies. In other words, such measures helped to allay market concerns and softened the effects of monetary policy news on asset prices. Finally, the conditional correlations between the returns and negative news were significant and positive, and their absolute value increased during the financial crisis, indicating higher sensitivity of the asset prices to negative news about monetary policy in Brazil.

To sum up, the second essay concluded that the volatility following negative news provides new evidence of the role played by uncertainty (as proxied by conditional volatility)

in this context. Of particular note is the finding that the Brazilian market became even more sensitive compared to the pre-crisis period. The links between the news on monetary policy and the financial market clearly became stronger in Brazil in this new financial context. This finding sheds light on the need to include other unconventional elements to the CB's mandate, besides the inflation targeting, to provide greater discretion to monetary policy.

The third and final test evaluates the spillover effects on the international market and Brazil due to the Fed's UMPs. This essay provided an empirical evidence of spillover effects to regions, and the Brazilian financial market, from a negative shock on the US spread between 10-year and 3-month Treasury yields.

The impulse response analysis of the estimated GVAR suggested that liquidity growth, stock prices and international reserves were the main transmission channels to Brazil. The increase of liquidity suggests a possible co-movement of policy rates in Brazil and the US, or the consequence of high accumulation of reserves. The evidence on stock prices indicates capital flowed to Brazil looking for better yields after the ZLB in the US.

In sum up, the Fed's UMPs had a significant impact on the global economy, especially on the behavior of financial markets, which reinforces the preponderant role of these unconventional measures and is consistent with the results also found in the specialized literature in varied analyses. This suggests that policymakers need to reflect on the true role of monetary policy in a capitalist economy, where its elements and tools should not be restricted to a single goal. Consequently, it is necessary to broaden the debate in favor of central banks with discretion to promote price stability and to preserve the financial system in an equitable manner.

A monetary policy that includes in its scope other mandates, in parallel and not submissive to the control of inflation by means of rules, is important for the development of a country, and consequently its economic growth. Therefore, research on the subject of this thesis is necessary to propose new ideas, solutions and design for alternative monetary policy.

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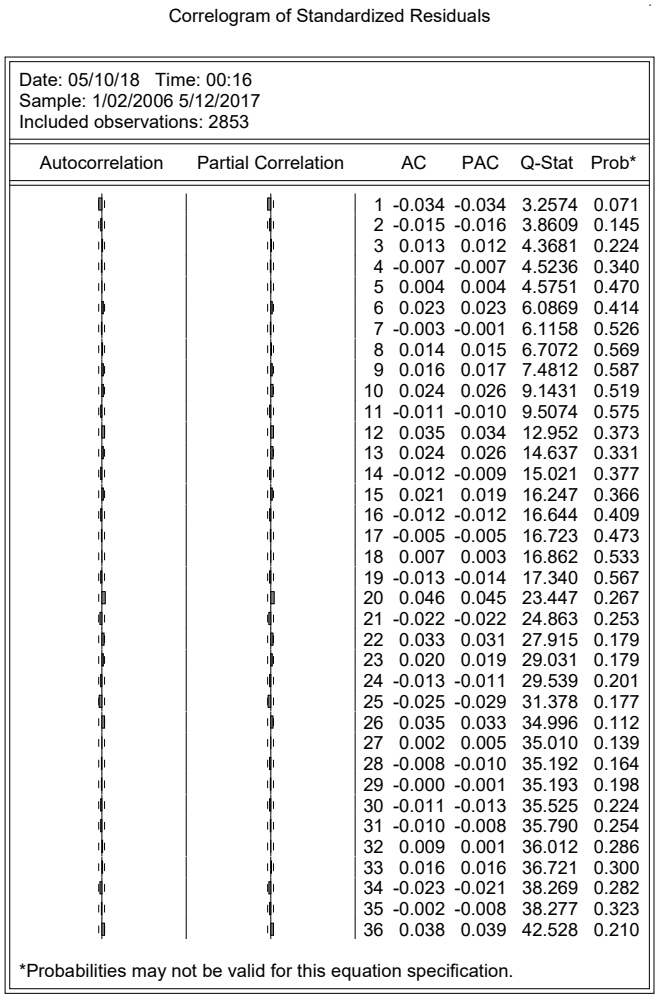
ANNEX A – CHAPTER 2

Table 12 – Descriptive Statistics - exchange rate and equity index returns

	CDS	VIX
Mean	182.7688	19.74126
Median	147.1250	16.87000
Maximum	586.4110	80.86000
Minimum	61.50000	9.770000
Std. Dev.	95.33524	9.533754
Skewness	1.493776	2.415420
Kurtosis	4.707263	10.70739
Jarque-Bera	1407.505	9835.814
Probability	0.000000	0.000000
Sum	521439.5	56321.81
Sum Sq. Dev.	25921279	259225.3
Observations	2853	2853

Figure 11 – Correlogram Q-statistics: exchange rate rerurn



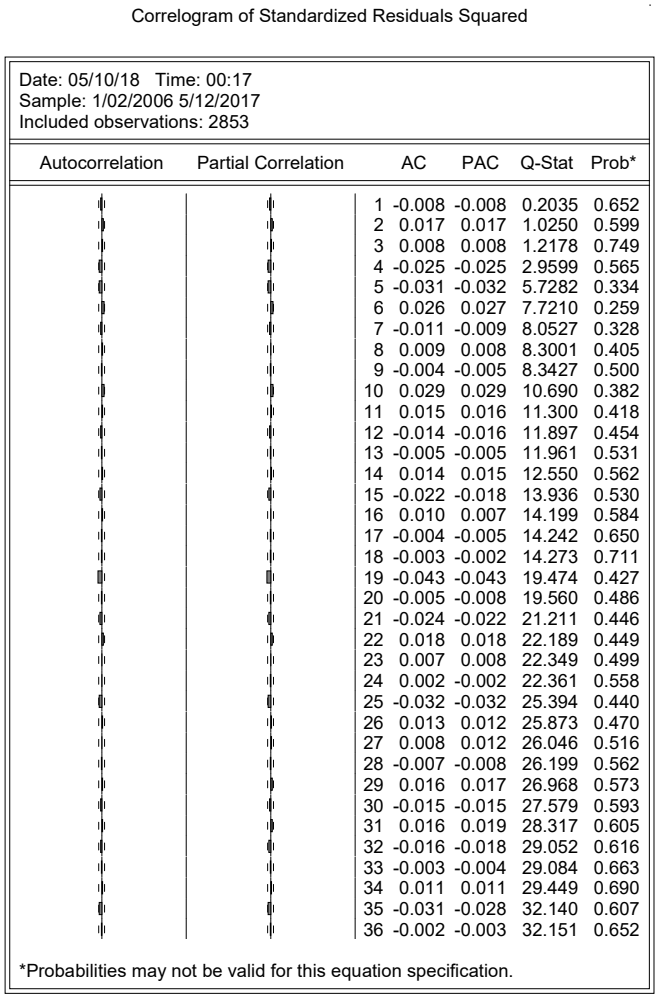
Correlogram of Standardized Residuals

Date: 05/10/18 Time: 00:16
Sample: 1/02/2006 5/12/2017
Included observations: 2853

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.034	-0.034	3.2574	0.071
		2	-0.015	-0.016	3.8609	0.145
		3	0.013	0.012	4.3681	0.224
		4	-0.007	-0.007	4.5236	0.340
		5	0.004	0.004	4.5751	0.470
		6	0.023	0.023	6.0869	0.414
		7	-0.003	-0.001	6.1158	0.526
		8	0.014	0.015	6.7072	0.569
		9	0.016	0.017	7.4812	0.587
		10	0.024	0.026	9.1431	0.519
		11	-0.011	-0.010	9.5074	0.575
		12	0.035	0.034	12.952	0.373
		13	0.024	0.026	14.637	0.331
		14	-0.012	-0.009	15.021	0.377
		15	0.021	0.019	16.247	0.366
		16	-0.012	-0.012	16.644	0.409
		17	-0.005	-0.005	16.723	0.473
		18	0.007	0.003	16.862	0.533
		19	-0.013	-0.014	17.340	0.567
		20	0.046	0.045	23.447	0.267
		21	-0.022	-0.022	24.863	0.253
		22	0.033	0.031	27.915	0.179
		23	0.020	0.019	29.031	0.179
		24	-0.013	-0.011	29.539	0.201
		25	-0.025	-0.029	31.378	0.177
		26	0.035	0.033	34.996	0.112
		27	0.002	0.005	35.010	0.139
		28	-0.008	-0.010	35.192	0.164
		29	-0.000	-0.001	35.193	0.198
		30	-0.011	-0.013	35.525	0.224
		31	-0.010	-0.008	35.790	0.254
		32	0.009	0.001	36.012	0.286
		33	0.016	0.016	36.721	0.300
		34	-0.023	-0.021	38.269	0.282
		35	-0.002	-0.008	38.277	0.323
		36	0.038	0.039	42.528	0.210

*Probabilities may not be valid for this equation specification.

Figure 12 – Correlogram Squared residuals: exchange rate rerurn



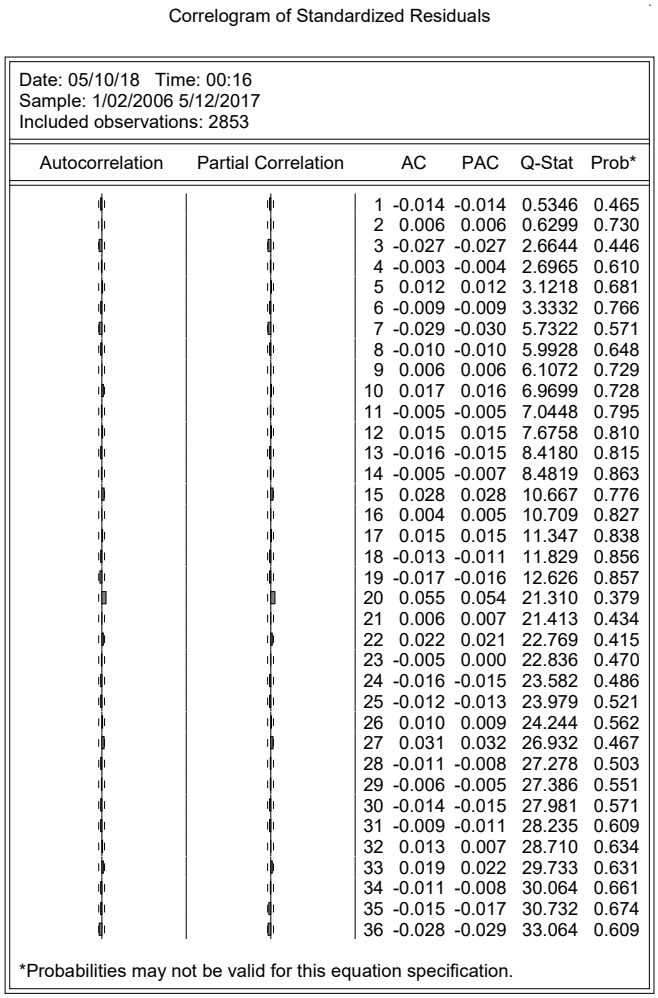
Correlogram of Standardized Residuals Squared

Date: 05/10/18 Time: 00:17
Sample: 1/02/2006 5/12/2017
Included observations: 2853

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.008	-0.008	0.2035	0.652
		2	0.017	0.017	1.0250	0.599
		3	0.008	0.008	1.2178	0.749
		4	-0.025	-0.025	2.9599	0.565
		5	-0.031	-0.032	5.7282	0.334
		6	0.026	0.027	7.7210	0.259
		7	-0.011	-0.009	8.0527	0.328
		8	0.009	0.008	8.3001	0.405
		9	-0.004	-0.005	8.3427	0.500
		10	0.029	0.029	10.690	0.382
		11	0.015	0.016	11.300	0.418
		12	-0.014	-0.016	11.897	0.454
		13	-0.005	-0.005	11.961	0.531
		14	0.014	0.015	12.550	0.562
		15	-0.022	-0.018	13.936	0.530
		16	0.010	0.007	14.199	0.584
		17	-0.004	-0.005	14.242	0.650
		18	-0.003	-0.002	14.273	0.711
		19	-0.043	-0.043	19.474	0.427
		20	-0.005	-0.008	19.560	0.486
		21	-0.024	-0.022	21.211	0.446
		22	0.018	0.018	22.189	0.449
		23	0.007	0.008	22.349	0.499
		24	0.002	-0.002	22.361	0.558
		25	-0.032	-0.032	25.394	0.440
		26	0.013	0.012	25.873	0.470
		27	0.008	0.012	26.046	0.516
		28	-0.007	-0.008	26.199	0.562
		29	0.016	0.017	26.968	0.573
		30	-0.015	-0.015	27.579	0.593
		31	0.016	0.019	28.317	0.605
		32	-0.016	-0.018	29.052	0.616
		33	-0.003	-0.004	29.084	0.663
		34	0.011	0.011	29.449	0.690
		35	-0.031	-0.028	32.140	0.607
		36	-0.002	-0.003	32.151	0.652

*Probabilities may not be valid for this equation specification.

Figure 13 – Correlogram Q-statistics: equity index rerurn



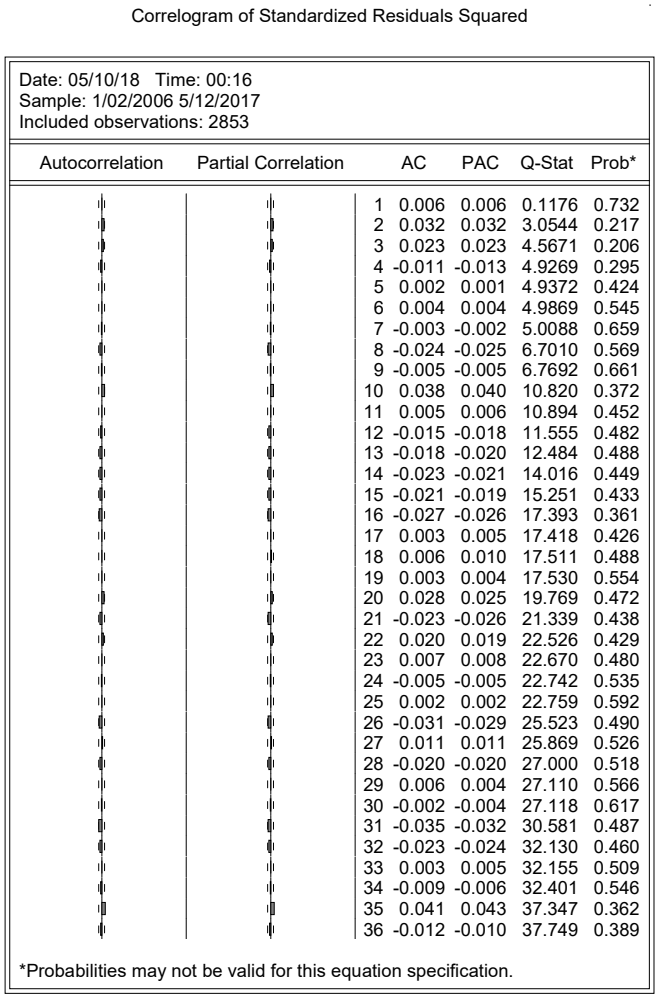
Correlogram of Standardized Residuals

Date: 05/10/18 Time: 00:16
Sample: 1/02/2006 5/12/2017
Included observations: 2853

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.014	-0.014	0.5346	0.465
		2	0.006	0.006	0.6299	0.730
		3	-0.027	-0.027	2.6644	0.446
		4	-0.003	-0.004	2.6965	0.610
		5	0.012	0.012	3.1218	0.681
		6	-0.009	-0.009	3.3332	0.766
		7	-0.029	-0.030	5.7322	0.571
		8	-0.010	-0.010	5.9928	0.648
		9	0.006	0.006	6.1072	0.729
		10	0.017	0.016	6.9699	0.728
		11	-0.005	-0.005	7.0448	0.795
		12	0.015	0.015	7.6758	0.810
		13	-0.016	-0.015	8.4180	0.815
		14	-0.005	-0.007	8.4819	0.863
		15	0.028	0.028	10.667	0.776
		16	0.004	0.005	10.709	0.827
		17	0.015	0.015	11.347	0.838
		18	-0.013	-0.011	11.829	0.856
		19	-0.017	-0.016	12.626	0.857
		20	0.055	0.054	21.310	0.379
		21	0.006	0.007	21.413	0.434
		22	0.022	0.021	22.769	0.415
		23	-0.005	0.000	22.836	0.470
		24	-0.016	-0.015	23.582	0.486
		25	-0.012	-0.013	23.979	0.521
		26	0.010	0.009	24.244	0.562
		27	0.031	0.032	26.932	0.467
		28	-0.011	-0.008	27.278	0.503
		29	-0.006	-0.005	27.386	0.551
		30	-0.014	-0.015	27.981	0.571
		31	-0.009	-0.011	28.235	0.609
		32	0.013	0.007	28.710	0.634
		33	0.019	0.022	29.733	0.631
		34	-0.011	-0.008	30.064	0.661
		35	-0.015	-0.017	30.732	0.674
		36	-0.028	-0.029	33.064	0.609

*Probabilities may not be valid for this equation specification.

Figure 14 – Correlogram Squared residuals: equity index rerurn



Correlogram of Standardized Residuals Squared

Date: 05/10/18 Time: 00:16
Sample: 1/02/2006 5/12/2017
Included observations: 2853

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.006	0.006	0.1176	0.732
		2	0.032	0.032	3.0544	0.217
		3	0.023	0.023	4.5671	0.206
		4	-0.011	-0.013	4.9269	0.295
		5	0.002	0.001	4.9372	0.424
		6	0.004	0.004	4.9869	0.545
		7	-0.003	-0.002	5.0088	0.659
		8	-0.024	-0.025	6.7010	0.569
		9	-0.005	-0.005	6.7692	0.661
		10	0.038	0.040	10.820	0.372
		11	0.005	0.006	10.894	0.452
		12	-0.015	-0.018	11.555	0.482
		13	-0.018	-0.020	12.484	0.488
		14	-0.023	-0.021	14.016	0.449
		15	-0.021	-0.019	15.251	0.433
		16	-0.027	-0.026	17.393	0.361
		17	0.003	0.005	17.418	0.426
		18	0.006	0.010	17.511	0.488
		19	0.003	0.004	17.530	0.554
		20	0.028	0.025	19.769	0.472
		21	-0.023	-0.026	21.339	0.438
		22	0.020	0.019	22.526	0.429
		23	0.007	0.008	22.670	0.480
		24	-0.005	-0.005	22.742	0.535
		25	0.002	0.002	22.759	0.592
		26	-0.031	-0.029	25.523	0.490
		27	0.011	0.011	25.869	0.526
		28	-0.020	-0.020	27.000	0.518
		29	0.006	0.004	27.110	0.566
		30	-0.002	-0.004	27.118	0.617
		31	-0.035	-0.032	30.581	0.487
		32	-0.023	-0.024	32.130	0.460
		33	0.003	0.005	32.155	0.509
		34	-0.009	-0.006	32.401	0.546
		35	0.041	0.043	37.347	0.362
		36	-0.012	-0.010	37.749	0.389

*Probabilities may not be valid for this equation specification.

Figure 15 – Difference between Negative and Positive MP News Index (Jan.2006 to May.2017)

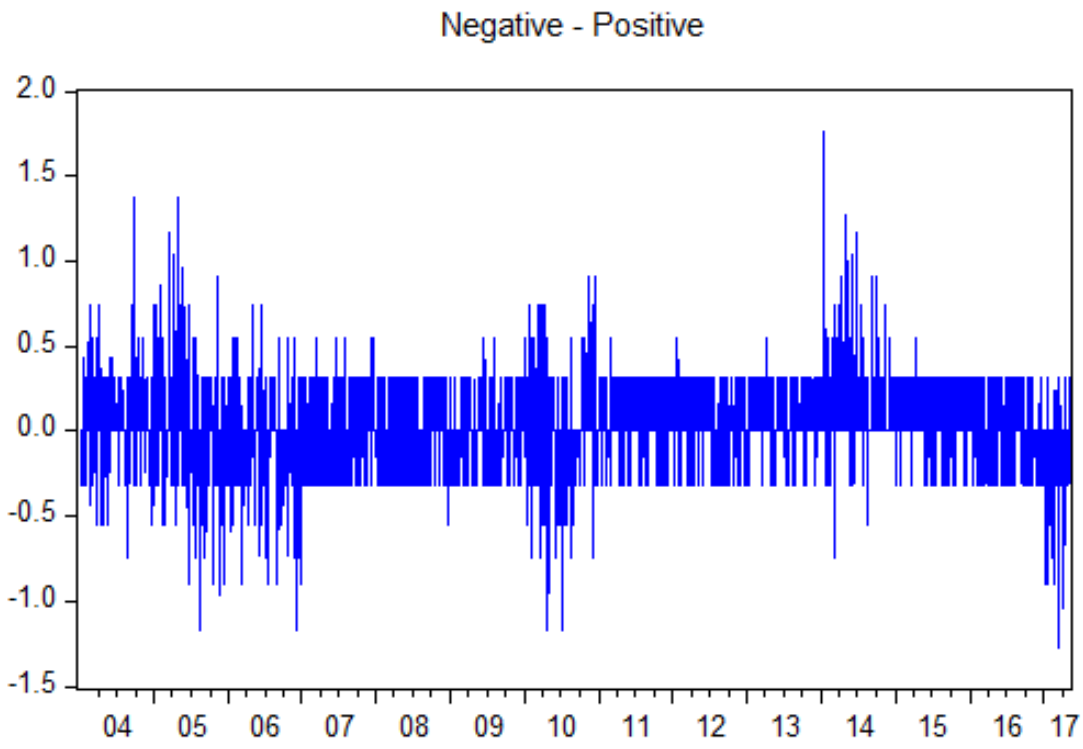


Figure 16 – Conditional Correlation between Ibovespa and MP (Negative-Positive) News

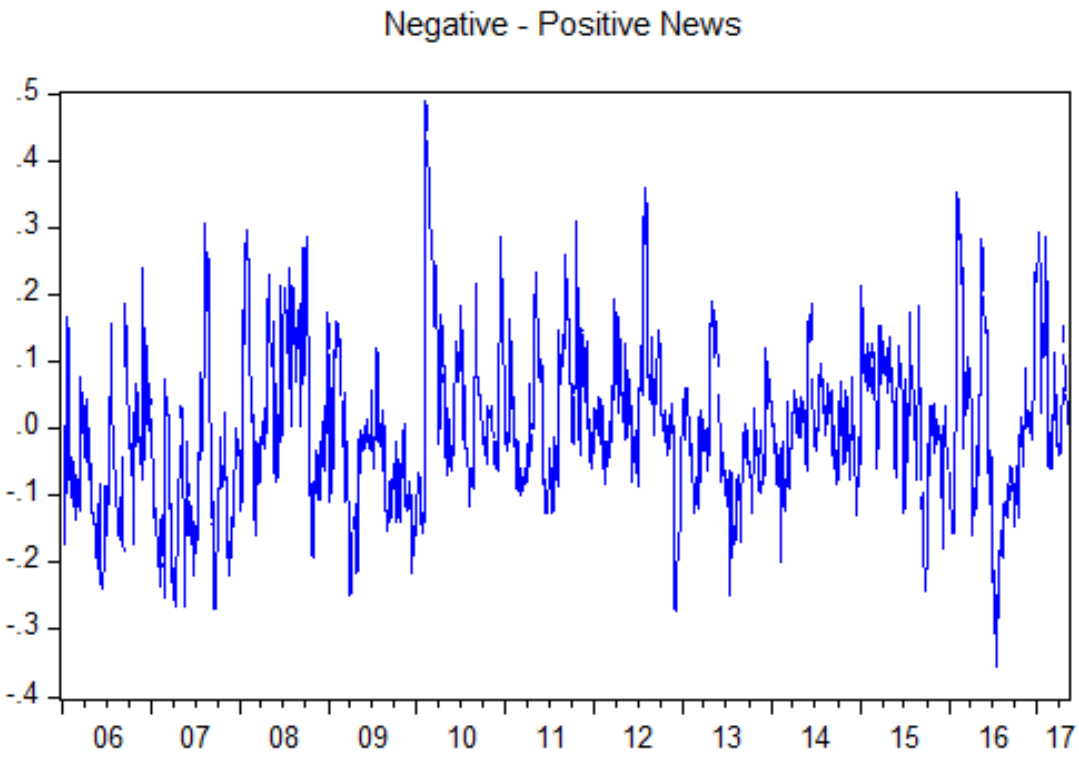


Figure 17 – Conditional Correlation between BRL and MP (Negative-Positive) News

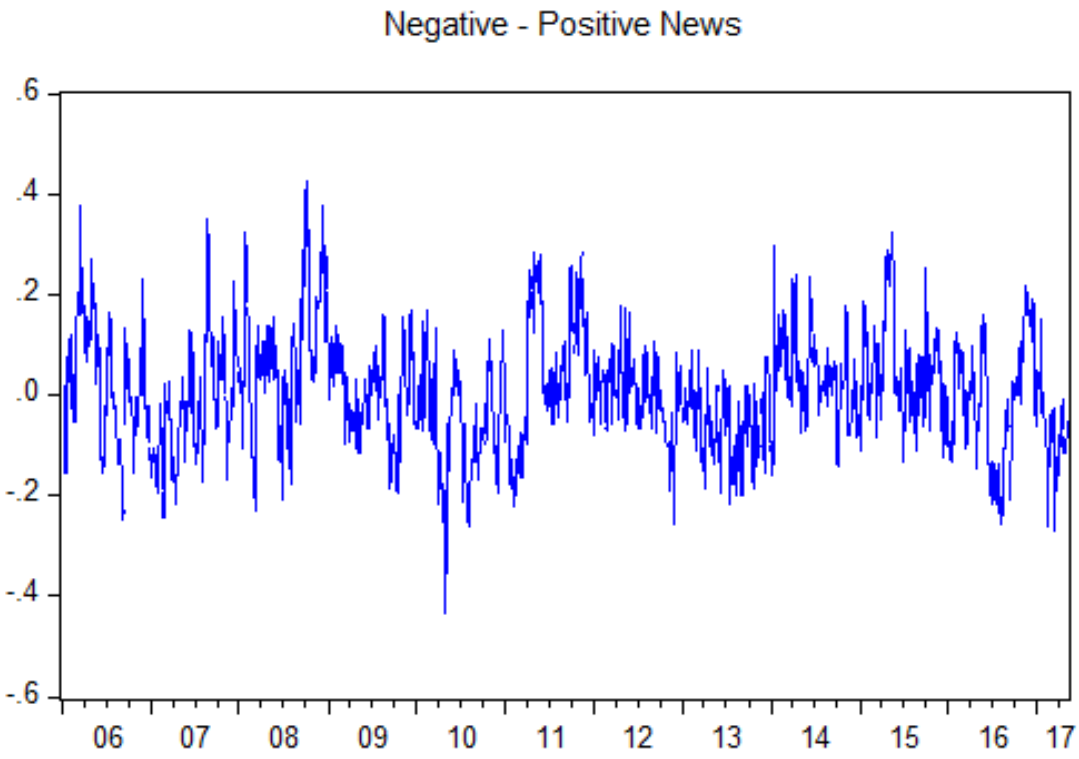


Figure 18 – Estimation output - VAR-GARCH: BRL X Negative News

LogL: TVGARCH_NEGATIVA
Method: Maximum Likelihood (OPG - BHHH / Marquardt steps)
Date: 04/03/18 Time: 11:21
Sample: 1/02/2006 5/11/2017
Included observations: 2852
Evaluation order: By observation
Estimation settings: tol= 1.0e-05, derivs=numeric
Initial Values: A(1)=5.2e-05, DL(1)=0.01729, DL(2)=-0.00556, B(1)= -0.06508, B(3)=-0.00065, B(5)=0.00062, A(2)=0.98349, B(2)=0.20445, B(4)=0.10271, C1(1)=0.00053, A1(1)=0.35588, A1(2)=0.00000, A1(5)=0.00000, G(1)=0.93028, G(2)=0.00000, G(5)=0.00000, C1(2)=0.00000, C1(3)=0.00000, A1(3)=0.18543, A1(4)=0.00000, G(3)=0.97862, G(4)=0.00000
Convergence achieved after 24371 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
A(1)	-0.000375	0.000902	-0.415268	0.6779
DL(1)	0.017285	0.005777	2.991723	0.0028
DL(2)	-0.006030	0.002191	-2.752192	0.0059
B(1)	-0.072429	0.022340	-3.242095	0.0012
B(3)	-0.000260	0.000867	-0.300288	0.7640
B(5)	0.000656	0.000297	2.209229	0.0272
A(2)	0.981241	0.021735	45.14564	0.0000
B(2)	0.322536	0.282627	1.141206	0.2538
B(4)	0.101232	0.019023	5.321471	0.0000
C1(1)	0.001117	0.000422	2.644789	0.0082
A1(1)	0.341916	0.013856	24.67665	0.0000
A1(2)	-0.000394	0.001667	-0.236491	0.8131
A1(5)	0.001240	0.001836	0.675428	0.4994
G(1)	-0.927046	0.007634	-121.4291	0.0000
G(2)	-0.006992	0.004186	-1.670386	0.0948
G(5)	-0.001253	0.000985	-1.271047	0.2037
C1(2)	0.019618	0.100029	0.196121	0.8445
C1(3)	-2.47E-05	75.49372	-3.27E-07	1.0000
A1(3)	0.384926	0.249592	1.542222	0.1230
A1(4)	-0.138606	0.008233	-16.83560	0.0000
G(3)	-1.901165	0.736777	-2.580382	0.0099
G(4)	0.976101	0.005410	180.4303	0.0000

Log likelihood	7872.171	Akaike info criterion	-5.505029
Avg. log likelihood	2.760228	Schwarz criterion	-5.459086
Number of Coefs.	22	Hannan-Quinn criter.	-5.488461

Figure 19 – Estimation output - VAR-GARCH: BRL X Positve News

LogL: TVGARCH_POSITIVA
Method: Maximum Likelihood (OPG - BHHH / Marquardt steps)
Date: 04/03/18 Time: 10:48
Sample: 1/02/2006 5/11/2017
Included observations: 2852
Evaluation order: By observation
Estimation settings: tol= 1.0e-05, derivs=numeric
Initial Values: A(1)=-0.00115, DL(1)=0.01651, DL(2)=-0.00392, B(1)= -0.05532, B(3)=0.00010, B(5)=0.00093, A(2)=0.92509, B(2)= -0.14290, B(4)=0.12107, C1(1)=0.00711, A1(1)=0.46796, A1(2)=0.00000, A1(5)=0.00000, G(1)=0.83007, G(2)=0.00000, G(5)=0.00000, C1(2)=0.00000, C1(3)=0.00000, A1(3)=0.17676, A1(4)=0.00000, G(3)=0.98312, G(4)=0.00000
Convergence achieved after 2329 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
A(1)	-0.001630	0.000976	-1.669979	0.0949
DL(1)	0.015292	0.005772	2.649275	0.0081
DL(2)	-0.005449	0.002204	-2.472548	0.0134
B(1)	-0.073417	0.022350	-3.284803	0.0010
B(3)	0.000991	0.000876	1.130585	0.2582
B(5)	0.000556	0.000302	1.839293	0.0659
A(2)	0.936659	0.020661	45.33393	0.0000
B(2)	-0.089047	0.222272	-0.400624	0.6887
B(4)	0.106379	0.018714	5.684532	0.0000
C1(1)	0.001153	0.000106	10.88422	0.0000
A1(1)	0.336958	0.013503	24.95498	0.0000
A1(2)	0.000854	0.001066	0.801164	0.4230
A1(5)	-0.001449	0.001431	-1.012457	0.3113
G(1)	-0.937835	0.004810	-194.9581	0.0000
G(2)	0.001361	0.002398	0.567823	0.5702
G(5)	-0.003330	0.003530	-0.943412	0.3455
C1(2)	0.009976	0.021012	0.474791	0.6349
C1(3)	2.60E-07	828.8514	3.14E-10	1.0000
A1(3)	0.159520	0.135309	1.178931	0.2384
A1(4)	0.165820	0.005288	31.35548	0.0000
G(3)	0.423957	0.426017	0.995165	0.3197
G(4)	0.984187	0.001070	920.0836	0.0000

Log likelihood	8373.832	Akaike info criterion	-5.856825
Avg. log likelihood	2.936126	Schwarz criterion	-5.810883
Number of Coefs.	22	Hannan-Quinn criter.	-5.840257

Figure 20 – Estimation output - VAR-GARCH: BRL X Neg.-Pos. News

LogL: TVGARCH_NEG_POS
Method: Maximum Likelihood (OPG - BHHH / Marquardt steps)
Date: 04/03/18 Time: 11:40
Sample: 1/02/2006 5/11/2017
Included observations: 2852
Evaluation order: By observation
Estimation settings: tol= 1.0e-05, derivs=numeric
Initial Values: A(1)=-0.00030, DL(1)=0.01729, DL(2)=-0.00579, B(1)=-0.06167, B(3)=-0.00168, B(5)=0.00218, A(2)=0.03233, B(2)=0.34153, B(4)=0.11767, C1(1)=0.00110, A1(1)=0.35343, A1(2)=0.00000, A1(5)=0.00000, G(1)=0.93148, G(2)=0.00000, G(5)=0.00000, C1(2)=0.00000, C1(3)=0.00000, A1(3)=0.15994, A1(4)=0.00000, G(3)=0.98157, G(4)=0.00000
Convergence achieved after 15473 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
A(1)	-0.000358	0.000145	-2.477297	0.0132
DL(1)	0.018782	0.005657	3.320281	0.0009
DL(2)	-0.005790	0.002204	-2.627442	0.0086
B(1)	-0.073805	0.022230	-3.320103	0.0009
B(3)	-0.001405	0.001092	-1.286634	0.1982
B(5)	0.001848	0.001263	1.462378	0.1436
A(2)	0.029725	0.004841	6.140607	0.0000
B(2)	0.285477	0.426891	0.668736	0.5037
B(4)	0.116859	0.018397	6.351935	0.0000
C1(1)	0.001216	0.000117	10.42824	0.0000
A1(1)	0.353389	0.014039	25.17208	0.0000
A1(2)	-0.000441	0.000999	-0.440914	0.6593
A1(5)	0.000890	0.001156	0.769606	0.4415
G(1)	0.931353	0.005279	176.4416	0.0000
G(2)	-9.30E-05	0.000265	-0.351005	0.7256
G(5)	4.46E-05	0.000186	0.239439	0.8108
C1(2)	-0.004968	0.011525	-0.431109	0.6664
C1(3)	-0.026132	0.003929	-6.651682	0.0000
A1(3)	0.657761	0.368482	1.785054	0.0743
A1(4)	-0.132706	0.008978	-14.78064	0.0000
G(3)	-0.067869	0.140566	-0.482828	0.6292
G(4)	0.985183	0.002246	438.7271	0.0000

Log likelihood	6714.856	Akaike info criterion	-4.693448
Avg. log likelihood	2.354438	Schwarz criterion	-4.647506
Number of Coefs.	22	Hannan-Quinn criter.	-4.676880

Figure 21 – Estimation output - VAR-GARCH: Ibovespa X Negative News

LogL: TVGARCH_NEGATIVA
Method: Maximum Likelihood (OPG - BHHH / Marquardt steps)
Date: 04/10/18 Time: 16:52
Sample: 1/02/2006 5/11/2017
Included observations: 2852
Evaluation order: By observation
Estimation settings: tol= 1.0e-05, derivs=numeric
Initial Values: A(1)=0.00225, DL(1)=-0.03491, DL(2)=-0.00473, B(1)=-0.06722, B(3)=-0.00089, B(5)=-0.00089, A(2)=0.98331, B(2)=-0.09230, B(4)=0.10290, C1(1)=0.00273, A1(1)=0.25837, A1(2)=0.00000, A1(5)=0.00000, G(1)=0.95284, G(2)=0.00000, G(5)=0.00000, C1(2)=0.00000, C1(3)=0.00000, A1(3)=0.18553, A1(4)=0.00000, G(3)=0.97863, G(4)=0.00000
Failure to improve likelihood (non-zero gradients) after 387 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
A(1)	0.002450	0.001724	1.421020	0.1553
DL(1)	-0.035090	0.010120	-3.467467	0.0005
DL(2)	-0.004585	0.004506	-1.017480	0.3089
B(1)	-0.081810	0.023381	-3.499079	0.0005
B(3)	-0.000957	0.001681	-0.569124	0.5693
B(5)	-0.000999	0.000631	-1.583723	0.1133
A(2)	0.986310	0.021962	44.90899	0.0000
B(2)	-0.140121	0.169007	-0.829087	0.4071
B(4)	0.096868	0.019479	4.972828	0.0000
C1(1)	-0.002488	0.000235	-10.60094	0.0000
A1(1)	0.257582	0.012766	20.17784	0.0000
A1(2)	0.004300	0.002567	1.675102	0.0939
A1(5)	-0.006170	0.002945	-2.095010	0.0362
G(1)	0.953191	0.004600	207.2079	0.0000
G(2)	-0.017178	0.007144	-2.404480	0.0162
G(5)	0.021326	0.007569	2.817766	0.0048
C1(2)	0.019237	0.008828	2.179073	0.0293
C1(3)	-1.69E-07	989.8487	-1.71E-10	1.0000
A1(3)	-0.023981	0.121205	-0.197851	0.8432
A1(4)	-0.149429	0.008831	-16.92148	0.0000
G(3)	0.051248	0.084455	0.606815	0.5440
G(4)	-0.981955	0.002047	-479.6820	0.0000

Log likelihood	6332.521	Akaike info criterion	-4.425331
Avg. log likelihood	2.220379	Schwarz criterion	-4.379388
Number of Coefs.	22	Hannan-Quinn criter.	-4.408763

Figure 22 – Estimation output - VAR-GARCH: Ibovespa X Positive News

LogL: TVGARCH_POSITIVA
Method: Maximum Likelihood (OPG - BHHH / Marquardt steps)
Date: 04/10/18 Time: 16:51
Sample: 1/02/2006 5/11/2017
Included observations: 2852
Evaluation order: By observation
Estimation settings: tol= 1.0e-05, derivs=numeric
Initial Values: A(1)=0.00101, DL(1)=-0.03473, DL(2)=-0.00473, B(1)= -0.06603, B(3)=9.6e-05, B(5)=-0.00074, A(2)=0.92432, B(2)= -0.22054, B(4)=0.12183, C1(1)=0.00444, A1(1)=0.25679, A1(2)=0.00000, A1(5)=0.00000, G(1)=0.95336, G(2)=0.00000, G(5)=0.00000, C1(2)=0.00000, C1(3)=0.00000, A1(3)=0.17643, A1(4)=0.00000, G(3)=0.98316, G(4)=0.00000
Convergence achieved after 6587 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
A(1)	0.001522	0.001896	0.802607	0.4222
DL(1)	-0.036064	0.009959	-3.621073	0.0003
DL(2)	-0.005153	0.004570	-1.127505	0.2595
B(1)	-0.083335	0.023726	-3.512353	0.0004
B(3)	-0.000453	0.001741	-0.260411	0.7945
B(5)	-0.000682	0.000604	-1.129278	0.2588
A(2)	0.922423	0.020572	44.83922	0.0000
B(2)	-0.230933	0.140049	-1.648951	0.0992
B(4)	0.120987	0.018782	6.441474	0.0000
C1(1)	-0.002312	0.000245	-9.418585	0.0000
A1(1)	0.255880	0.012672	20.19210	0.0000
A1(2)	-0.002546	0.001973	-1.290062	0.1970
A1(5)	0.000352	0.002623	0.134077	0.8933
G(1)	0.956294	0.004418	216.4536	0.0000
G(2)	-0.000687	0.000363	-1.892579	0.0584
G(5)	0.000362	0.000511	0.707559	0.4792
C1(2)	-0.000979	0.002804	-0.349363	0.7268
C1(3)	-0.010162	0.001232	-8.247337	0.0000
A1(3)	0.117271	0.104030	1.127278	0.2596
A1(4)	-0.174393	0.005791	-30.11485	0.0000
G(3)	-0.032875	0.031147	-1.055469	0.2912
G(4)	0.982598	0.001087	904.1681	0.0000

Log likelihood	6832.098	Akaike info criterion	-4.775665
Avg. log likelihood	2.395546	Schwarz criterion	-4.729723
Number of Coefs.	22	Hannan-Quinn criter.	-4.759097

Figure 23 – Estimation output - VAR-GARCH: Ibovespa X Neg.-Pos. News

LogL: TVGARCH_NEG_POS
Method: Maximum Likelihood (OPG - BHHH / Marquardt steps)
Date: 04/10/18 Time: 16:52
Sample: 1/02/2006 5/11/2017
Included observations: 2852
Evaluation order: By observation
Estimation settings: tol= 1.0e-05, derivs=numeric
Initial Values: A(1)=0.00063, DL(1)=-0.03480, DL(2)=-0.00447, B(1)=
-0.06576, B(3)=0.00141, B(5)=-0.00324, A(2)=0.03227,
B(2)=0.09308, B(4)=0.11830, C1(1)=0.00285, A1(1)=0.25661,
A1(2)=0.00000, A1(5)=0.00000, G(1)=0.95360, G(2)=0.00000,
G(5)=0.00000, C1(2)=0.00000, C1(3)=0.00000, A1(3)=0.15942,
A1(4)=0.00000, G(3)=0.98170, G(4)=0.00000
Failure to improve likelihood (non-zero gradients) after 504 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
A(1)	0.000510	0.000280	1.820499	0.0687
DL(1)	-0.035542	0.009921	-3.582500	0.0003
DL(2)	-0.004892	0.004551	-1.074996	0.2824
B(1)	-0.079117	0.023265	-3.400673	0.0007
B(3)	0.003283	0.002395	1.370914	0.1704
B(5)	-0.005058	0.002677	-1.889158	0.0589
A(2)	0.030936	0.004842	6.389711	0.0000
B(2)	0.046271	0.262943	0.175972	0.8603
B(4)	0.121271	0.018648	6.503169	0.0000
C1(1)	-0.002316	0.000249	-9.302678	0.0000
A1(1)	0.254553	0.012740	19.98017	0.0000
A1(2)	-0.002488	0.001427	-1.743919	0.0812
A1(5)	0.001395	0.001640	0.850752	0.3949
G(1)	0.953012	0.005422	175.7574	0.0000
G(2)	0.008208	0.002769	2.964095	0.0030
G(5)	-0.003491	0.002963	-1.178157	0.2387
C1(2)	-0.030248	0.005536	-5.464066	0.0000
C1(3)	1.59E-07	810.4670	1.96E-10	1.0000
A1(3)	-0.025327	0.200430	-0.126365	0.8994
A1(4)	-0.144238	0.010010	-14.40877	0.0000
G(3)	0.829515	0.689257	1.203493	0.2288
G(4)	-0.980278	0.004263	-229.9454	0.0000

Log likelihood	5173.000	Akaike info criterion	-3.612202
Avg. log likelihood	1.813815	Schwarz criterion	-3.566260
Number of Coefs.	22	Hannan-Quinn criter.	-3.595634

Figure 24 – Matching the notation used with Eviews results

$$\alpha = \begin{bmatrix} \alpha_{11} \\ \alpha_{21} \end{bmatrix} = \begin{bmatrix} a(1) \\ a(2) \end{bmatrix}$$

$$\beta = \begin{bmatrix} \beta_{11} & \beta_{12} + \beta_{12}^{*} \\ \beta_{21} & \beta_{22} \end{bmatrix} = \begin{bmatrix} b(1) & b(3) + b(5) \\ b(2) & b(4) \end{bmatrix}$$

$$\delta = \begin{bmatrix} \delta_{11} & \delta_{12} \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} dl(1) & dl(2) \\ 0 & 0 \end{bmatrix}$$

$$A_{11} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} + a_{21}^{*} & a_{22} \end{bmatrix} = \begin{bmatrix} a1(1) & a1(3) \\ a1(2) + a1(5) & a1(4) \end{bmatrix}$$

$$G_{11} = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} + g_{21}^{*} & g_{22} \end{bmatrix} = \begin{bmatrix} g(1) & g(3) \\ g(2) + g(5) & g(4) \end{bmatrix}$$

$$C_0 = \begin{bmatrix} c_{11}^{0} & c_{12}^{0} \\ 0 & c_{22}^{0} \end{bmatrix} = \begin{bmatrix} c1(1) & c1(2) \\ 0 & c1(3) \end{bmatrix}$$

ANNEX B – CHAPTER 3

Table 13 – Weight or Countries in the Groups

Group	Country	Weight
America	Argentina	25%
	Chile	11%
	Mexico	62%
Asia	India	37%
	Indonesia	13%
	Israel	1%
	Japan	24%
	Korea	8%
	Malaysia	3%
	Philippines	3%
	Singapore	2%
	Thailand	5%
China	China	97%
	Hong Kong	2%
Europa	Euro Area	68%
	Russian	18%
	United kingdom	13%

Table 14 – Weight Matrix 2014 - 2016

Country	America	Asia	Australia	Brazil	Canada	China	Europa	South Africa	EUA
America	0%	2%	1%	14%	4%	3%	4%	1%	17%
Asia	10%	0%	42%	15%	6%	41%	26%	25%	18%
Australia	0%	6%	0%	0%	0%	4%	2%	1%	1%
Brazil	5%	2%	0%	0%	0%	3%	4%	1%	2%
Canada	2%	1%	0%	1%	0%	1%	3%	0%	20%
Chinaa	12%	40%	32%	23%	8%	0%	28%	22%	19%
Europa	11%	23%	13%	26%	9%	23%	0%	34%	20%
South Africa	0%	1%	0%	0%	0%	2%	2%	0%	0%
EUA	57%	21%	8%	17%	69%	20%	28%	11%	0%

Table 15 – Unit Root Tests for the Domestic Variables at the 5% Significance Level

Domestic Variables	Statistic	Critical Value	America	Asia	Australia	Brazil
eq (with trend)	-3.45	-3.32	-3.08	-2.43	-2.79	-2.83
eq (with trend)	-3.24	-3.17	-3.1	-2.14	-2.68	-2.8
eq (no trend)	-2.89	-0.45	-1.03	-2.54	-2.78	-2.54
eq (no trend)	-2.55	-0.72	-1.31	-2.15	-2.71	-2.69
Deq	-2.89	-5.95	-6.07	-3.96	-5.84	-4.89
Deq	-2.55	-6.06	-6.16	-4.14	-5.84	-4.97
DDeq	-2.89	-9.58	-9.33	-12.5	-8.88	-10.15
DDeq	-2.55	-9.81	-9.6	-12.72	-9.09	-10.35
cpi (with trend)	-3.45	-2.67	-3.7	-2.29	-1.84	-3.71
cpi (with trend)	-3.24	-2.69	-3.17	-1.99	-0.22	-3.84
cpi (no trend)	-2.89	-1.24	-0.84	-1.63	1.54	-0.23
cpi (no trend)	-2.55	-0.09	0.47	0.36	-0.45	0.53
Dcpi	-2.89	-1.67	-3.65	-3.93	-3.06	-2.36
Dcpi	-2.55	-2	-3.9	-4.15	-1.86	-2.55
DDcpi	-2.89	-7.29	-4.32	-3.32	-4.49	-5.45
DDcpi	-2.55	-7.53	-4.51	-3.48	-4.38	-5.67
ex (with trend)	-3.45	-2.41	-1.29	-2	-2.24	-2.6
ex (with trend)	-3.24	-2.65	-1.42	-2.27	-2.03	-2.86
ex (no trend)	-2.89	-0.93	-0.54	-2.01	-1.49	-2.64
ex (no trend)	-2.55	-0.63	-0.94	-2.06	-1.71	-2.82
Dex	-2.89	-6.2	-7.14	-6.4	-5.62	-6.9
Dex	-2.55	-6.32	-7.22	-6.57	-5.68	-6.7
DDex	-2.89	-11.46	-8.46	-12.61	-10.6	-11.29
DDex	-2.55	-11.69	-8.6	-12.86	-10.83	-11.45
cds (with trend)	-3.45	-3.16	-2.93	0	-3.15	0
cds (with trend)	-3.24	-1.56	-1.65	0	-2.91	0
cds (no trend)	-2.89	-3.11	-2.85	0	-3.23	0
cds (no trend)	-2.55	-1.35	-1.67	0	-2.8	0
Dcds	-2.89	-4.09	-4.8	0	-4.84	0
Dcds	-2.55	-4.2	-4.74	0	-4.88	0
DDcds	-2.89	-10.5	-7.44	0	-7.36	0
DDcds	-2.55	-10.12	-7.1	0	-7.57	0
ir (with trend)	-3.45	-2.67	-3.53	-2.47	-2.8	-2.18
ir (with trend)	-3.24	-2.84	-3.77	-2.64	-2.42	-2.44
ir (no trend)	-2.89	-2.27	-2.06	-1.18	-2.29	-1.37
ir (no trend)	-2.55	-2.15	-2.12	-1.15	-2.37	-1
Dir	-2.89	-6.11	-6.44	-6.45	-5.35	-7.44
Dir	-2.55	-6.29	-6.66	-6.62	-5.27	-7.52
DDir	-2.89	-8	-10.74	-9.7	-8.02	-8.04
DDir	-2.55	-8.3	-11.04	-9.96	-6.62	-8.3
fer (with trend)	-3.45	-1.19	-3.43	-5.22	-0.97	-3.5
fer (with trend)	-3.24	-1.21	-2.87	-3.13	-0.49	-3.59
fer (no trend)	-2.89	-1.67	-2.02	-4.09	-1.31	-0.6
fer (no trend)	-2.55	0.95	-0.23	-2.97	1.22	0.36
Dfer	-2.89	-4.7	-3.21	-5.69	-4.8	-7.99
Dfer	-2.55	-4.53	-3.31	-5.62	-0.44	-8.18
DDfer	-2.89	-9.54	-12.67	-7.15	-6.53	-8.51
DDfer	-2.55	-9.49	-12.93	-6.97	-5.05	-8.76

Table 16 – Unit Root Tests for the Domestic Variables at the 5% Significance Level

Domestic Variables	Statistic	Canada	China	Europa	South Africa	EUA
eq (with trend)	ADF	-2.83	-3.85	-2.97	-1.84	-2.62
eq (with trend)	WS	-2.8	-3.99	-2.71	-1.52	-2.11
eq (no trend)	ADF	-2.54	-3.14	-3.17	0	-0.62
eq (no trend)	WS	-2.69	-3.12	-2.59	-0.4	-0.97
Deq	ADF	-4.89	-3.39	-6.44	-6.02	-3.14
Deq	WS	-4.97	-3.12	-6.59	-6.17	-3.38
DDeq	ADF	-10.15	-10.05	-10.1	-9.89	-10.16
DDeq	WS	-10.35	-10.26	-10.31	-10.15	-10.29
cpi (with trend)	ADF	-3.71	-6.87	-2.92	-3.75	-3.07
cpi (with trend)	WS	-3.84	-6.69	-2.59	-2.61	-2.87
cpi (no trend)	ADF	-0.23	-1.09	-2.19	-1.66	-0.94
cpi (no trend)	WS	0.53	0.03	-0.36	0.2	0.61
Dcpi	ADF	-2.36	-3.45	-2.54	-1.59	-3.03
Dcpi	WS	-2.55	-3.68	-2.79	-1.91	-3.22
DDcpi	ADF	-5.45	-3.29	-4.31	-3.58	-5.32
DDcpi	WS	-5.67	-2.85	-4.48	-3.8	-5.5
ex (with trend)	ADF	-2.6	-2.78	-3.69	-1.77	-3.83
ex (with trend)	WS	-2.86	-1.53	-3.84	-2.05	-3.8
ex (no trend)	ADF	-2.64	-2.72	-3.54	-1.04	-3.45
ex (no trend)	WS	-2.82	1.51	-3.77	-1.14	-3.58
Dex	ADF	-6.9	-4.41	-4.54	-6.49	-4.23
Dex	WS	-6.7	-4.53	-4.74	-6.66	-4.43
DDex	ADF	-11.29	-6.81	-7.28	-8.92	-7.14
DDex	WS	-11.45	-7.14	-7.3	-9.16	-7.13
csd (with trend)	ADF	0	-3.3	-3.05	-3.64	0
csd (with trend)	WS	0	-1.48	-2.28	-1.7	0
csd (no trend)	ADF	0	-3.71	-3.19	-4.04	0
csd (no trend)	WS	0	-0.86	-2	-1.22	0
Dcsd	ADF	0	-5.38	-4.34	-4.77	0
Dcsd	WS	0	-5.27	-4.46	-4.68	0
DDcsd	ADF	0	-7.56	-9.17	-7.24	0
DDcsd	WS	0	-7.06	-8.8	-7.42	0
ir (with trend)	ADF	-2.18	-2.63	-2.69	-3.24	-2.44
ir (with trend)	WS	-2.44	-2.81	-2.84	-2.78	-2.58
ir (no trend)	ADF	-1.37	-3.02	-0.78	-2.51	-1.92
ir (no trend)	WS	-1	-3.21	-0.4	-2.61	-1.17
Dir	ADF	-7.44	-5.84	-7.34	-7.23	-7.82
Dir	WS	-7.52	-5.36	-7.42	-7.41	-7.99
DDir	ADF	-8.04	-6.94	-10.17	-9.31	-9.52
DDir	WS	-8.3	-7.09	-10.4	-9.64	-9.78
fer (with trend)	ADF	-3.5	-1.26	-2.85	-2.28	-1.61
fer (with trend)	WS	-3.59	-0.15	-2.96	-0.82	-0.79
fer (no trend)	ADF	-0.6	-2.43	-2.23	-2.77	-2.22
fer (no trend)	WS	0.36	0.67	-1.69	1.08	-0.74
Dfer	ADF	-7.99	-2.91	-3.48	-3.75	-6.31
Dfer	WS	-8.18	-2.51	-3.52	-3.44	-6.49
DDfer	ADF	-8.51	-13.23	-12.15	-7.47	-7.54
DDfer	WS	-8.76	-13.49	-12.27	-7.63	-7.59

Table 17 – Unit Root Tests for the Foreign Variables at the 5% Significance Level

Foreign Variables	Statistic	Critical Value	America	Asia	Australia	Brazil
eqs (with trend)	-3.45	-2.98	-3.33	-3.39	-3.3	-2.86
eqs (with trend)	-3.24	-2.85	-3.43	-3.51	-3.32	-2.58
eqs (no trend)	-2.89	-2.34	-3.52	-3.34	-3.09	-1.89
eqs (no trend)	-2.55	-2.5	-3.44	-3.48	-3.2	-2.09
Deqs	-2.89	-5.85	-5.4	-5.27	-5.43	-3.34
Deqs	-2.55	-5.85	-5.23	-5.15	-5.39	-3.57
DDeqs	-2.89	-10.11	-9.89	-9.56	-9.9	-10.24
DDeqs	-2.55	-10.29	-10.06	-9.79	-10.11	-10.4
cpis (with trend)	-3.45	-3.67	-7.78	-5.77	-4.85	-3.49
cpis (with trend)	-3.24	-3.41	-7.54	-5.1	-4.09	-3.13
cpis (no trend)	-2.89	-1	-1.38	-1.27	-1.63	-1.06
cpis (no trend)	-2.55	0.33	0.27	0.38	0.27	0.42
Dcpis	-2.89	-2.65	-3.76	-3.41	-3.31	-2.74
Dcpis	-2.55	-2.89	-4	-3.65	-3.56	-2.96
DDcpis	-2.89	-4.62	-2.79	-2.87	-3.58	-4.85
DDcpis	-2.55	-4.79	-2.77	-2.91	-3.7	-5.02
exs (with trend)	-3.45	-2.19	-1.56	-1.09	-1.13	-3.32
exs (with trend)	-3.24	-2	-0.19	-0.92	-1.19	-3.25
exs (no trend)	-2.89	-2.04	-3.11	-1.28	-0.73	-2.93
exs (no trend)	-2.55	-1.97	0.35	-0.93	-0.99	-3.04
Dexs	-2.89	-6.19	-4.4	-6.74	-5.95	-4.23
Dexs	-2.55	-6.34	-4.41	-6.78	-5.99	-4.43
DDexs	-2.89	-7.04	-8.03	-8.37	-7.13	-7.16
DDexs	-2.55	-7.11	-8.57	-8.59	-7.47	-7.19
csds (with trend)	-3.45	-3.12	-3.2	-3.1	-3.09	-3.09
csds (with trend)	-3.24	-1.84	-1.72	-1.6	-1.73	-1.74
csds (no trend)	-2.89	-3.38	-3.52	-3.38	-3.36	-3.37
csds (no trend)	-2.55	-1.54	-1.21	-1.36	-1.41	-1.43
Dcsds	-2.89	-4.75	-4.82	-4.86	-4.57	-4.6
Dcsds	-2.55	-4.71	-4.78	-4.79	-4.57	-4.59
DDcsds	-2.89	-9.33	-6.8	-7.13	-9.41	-9.39
DDcsds	-2.55	-8.82	-6.45	-6.71	-8.93	-8.9
irs (with trend)	-3.45	-2.44	-2.54	-2.73	-2.65	-2.56
irs (with trend)	-3.24	-2.67	-2.77	-2.94	-2.88	-2.72
irs (no trend)	-2.89	-1.83	-1.86	-2.08	-1.74	-1.89
irs (no trend)	-2.55	-1.27	-1.79	-2.12	-1.52	-1.21
Dirs	-2.89	-7.38	-6.08	-5.53	-6.04	-7.51
Dirs	-2.55	-7.54	-6.08	-5.57	-6.1	-7.66
DDirs	-2.89	-9.34	-8.51	-8.51	-8.4	-9.32
DDirs	-2.55	-9.59	-8.69	-8.7	-8.58	-9.57
fers (with trend)	-3.45	-1.68	-1.36	-2.62	-2.28	-1.61
fers (with trend)	-3.24	-0.29	-0.58	-1.66	-1.53	-0.52
fers (no trend)	-2.89	-2.99	-2.32	-2.04	-2.04	-2.82
fers (no trend)	-2.55	0.78	1.33	0.4	0.36	0.18
Dfers	-2.89	-3.74	-4.23	-3.02	-3.26	-6.04
Dfers	-2.55	-3.87	-3.91	-2.94	-3.18	-6.22
DDfers	-2.89	-7.17	-13.05	-13.55	-13.81	-7.43
DDfers	-2.55	-7.33	-13.19	-13.8	-14.02	-7.52

Table 18 – Unit Root Tests for the Foreign Variables at the 5% Significance Level

Foreign Variables	Statistic	Canada	China	Europa	South Africa	EUA
eqs (with trend)	ADF	-2.86	-3.04	-3.31	-3.26	-3.39
eqs (with trend)	WS	-2.58	-2.91	-3.4	-3.31	-3.48
eqs (no trend)	ADF	-1.89	-2.1	-2.96	-3.3	-3.15
eqs (no trend)	WS	-2.09	-2.33	-3.15	-3.33	-3.32
Deqs	ADF	-3.34	-4.15	-5.39	-5.47	-5.23
Deqs	WS	-3.57	-4.3	-5.26	-5.44	-5.2
DDeqs	ADF	-10.24	-9.7	-9.77	-9.79	-9.39
DDeqs	WS	-10.4	-9.94	-9.98	-10.01	-9.61
cpis (with trend)	ADF	-3.49	-3.6	-5.08	-4.82	-4.85
cpis (with trend)	WS	-3.13	-2.83	-4.63	-4.1	-4.14
cpis (no trend)	ADF	-1.06	-1.24	-1.08	-1.52	-1.27
cpis (no trend)	WS	0.42	0.35	0.43	0.3	0.21
Dcpis	ADF	-2.74	-2.88	-3.35	-3.27	-2.89
Dcpis	WS	-2.96	-3.1	-3.6	-3.53	-3.13
DDcpis	ADF	-4.85	-4.09	-3.69	-3.63	-3.39
DDcpis	WS	-5.02	-4.28	-3.81	-3.76	-3.51
exs (with trend)	ADF	-3.32	-1.09	-1.91	-0.36	-1.41
exs (with trend)	WS	-3.25	-1.18	-1.66	-0.59	-1.5
exs (no trend)	ADF	-2.93	-0.06	-1.71	-0.75	-0.98
exs (no trend)	WS	-3.04	-0.5	-1.63	-0.62	-1.28
Dexs	ADF	-4.23	-6.63	-6.47	-3.52	-6.17
Dexs	WS	-4.43	-6.68	-6.57	-3.65	-6.04
DDexs	ADF	-7.16	-7.84	-7.38	-7.81	-8.65
DDexs	WS	-7.19	-8.09	-7.52	-8.27	-8.81
cds (with trend)	ADF	-3.09	-2.98	-3.14	-3.08	-3.07
cds (with trend)	WS	-1.74	-1.84	-1.59	-1.8	-1.73
cds (no trend)	ADF	-3.37	-3.1	-3.45	-3.33	-3.33
cds (no trend)	WS	-1.43	-1.76	-1.31	-1.53	-1.44
Dcds	ADF	-4.6	-4.52	-5.02	-4.6	-4.56
Dcds	WS	-4.59	-4.53	-4.92	-4.6	-4.56
DDcds	ADF	-9.39	-7.69	-7.31	-9.35	-9.53
DDcds	WS	-8.9	-7.75	-6.91	-8.85	-9.03
irs (with trend)	ADF	-2.56	-2.69	-2.55	-2.63	-2.56
irs (with trend)	WS	-2.72	-2.91	-2.79	-2.85	-2.78
irs (no trend)	ADF	-1.89	-1.58	-2.05	-1.59	-1.44
irs (no trend)	WS	-1.21	-1.29	-1.95	-1.45	-1.25
Dirs	ADF	-7.51	-6.96	-6.29	-6.13	-5.65
Dirs	WS	-7.66	-7.13	-6.4	-6.19	-5.68
DDirs	ADF	-9.32	-9.53	-8.64	-8.92	-8.3
DDirs	WS	-9.57	-9.79	-8.86	-9.12	-8.51
fers (with trend)	ADF	-1.61	-2.82	-1.82	-2.83	-2.21
fers (with trend)	WS	-0.52	-2.55	-0.91	-2.2	-1.82
fers (no trend)	ADF	-2.82	-1.94	-2.96	-1.87	-1.56
fers (no trend)	WS	0.18	-0.4	1.63	0.15	0.61
Dfers	ADF	-6.04	-3.55	-3.45	-3.16	-3.52
Dfers	WS	-6.22	-3.52	-3.36	-3.02	-3.31
DDfers	ADF	-7.43	-13.27	-13.55	-13.46	-14.08
DDfers	WS	-7.52	-13.45	-13.78	-13.65	-14.21

Table 19 – Detailed Cointegration Results for the Maximum Eigenvalue Statistic at the 5% Significance Level

Country	America	Asia	Australia	Brazil	Canada	Chinaa	Europa	South Africa	EUA
endogenous variables	6	6	5	6	5	6	6	6	6
foreign (star) variables	7	7	7	7	7	7	7	7	6
r=0	88.07	98.38	78.34	92.72	66.87	80.89	114.46	89.84	92.28
r=1	66.97	66.18	70.12	85.81	51.19	69.46	72.27	75.3	66.08
r=2	52.37	53.15	52.98	68.77	40.61	59.18	64.42	67.95	58.7
r=3	41.81	47.84	33.38	53.2	33.86	37	55.32	41.62	40.85
r=4	30.58	27.66	30.66	36.58	16.42	31.92	41.94	33.98	28.52
r=5	23.31	20.76	0	29.08	0	21.8	16.11	29.55	23.41

Table 20 – Detailed Cointegration Results for the Trace Statistic at the 5% Significance Level

Country	America	Asia	Australia	Brazil	Canada	Chinaa	Europa	South Africa	EUA
endogenous variables	6	6	5	6	5	6	6	6	6
foreign (star) variables	7	7	7	7	7	7	7	7	6
r=0	303.14	314.01	265.5	366.18	208.96	300.28	364.55	338.26	309.88
r=1	215.06	215.62	187.15	273.46	142.08	219.38	250.09	248.42	217.59
r=2	148.08	149.43	117.03	187.64	90.89	149.92	177.81	173.11	151.51
r=3	95.71	96.27	64.04	118.87	50.28	90.73	113.39	105.16	92.8
r=4	53.9	48.43	30.66	65.66	16.42	53.73	58.06	63.53	51.94
r=5	23.31	20.76	0	29.08	0	21.8	16.11	29.55	23.41

Table 21 – Critical Values for Trace Statistic at the 5% Significance Level (MacKinnon. Haug. Michelis. 1999)

Country	America	Asia	Australia	Brazil	Canada	Chinaa	Europa	South Africa	EUA
endogenous variables	6	6	5	6	5	6	6	6	6
foreign (star) variables	7	7	7	7	7	7	7	7	6
r=0	210.8	210.8	167.47	210.8	167.47	210.8	210.8	210.8	197.7
r=1	167.47	167.47	128	167.47	128	167.47	167.47	167.47	156.44
r=2	128	128	92.29	128	92.29	128	128	128	119.03
r=3	92.29	92.29	60.22	92.29	60.22	92.29	92.29	92.29	85.44
r=4	60.22	60.22	31.35	60.22	31.35	60.22	60.22	60.22	55.5
r=5	31.35	31.35	0	31.35	0	31.35	31.35	31.35	28.81

Figure 25 – Persistence Profile of the Effect of System-Wide Shocks to the Cointegrating Relations of the GVAR Model - Bootstrap Median estimates

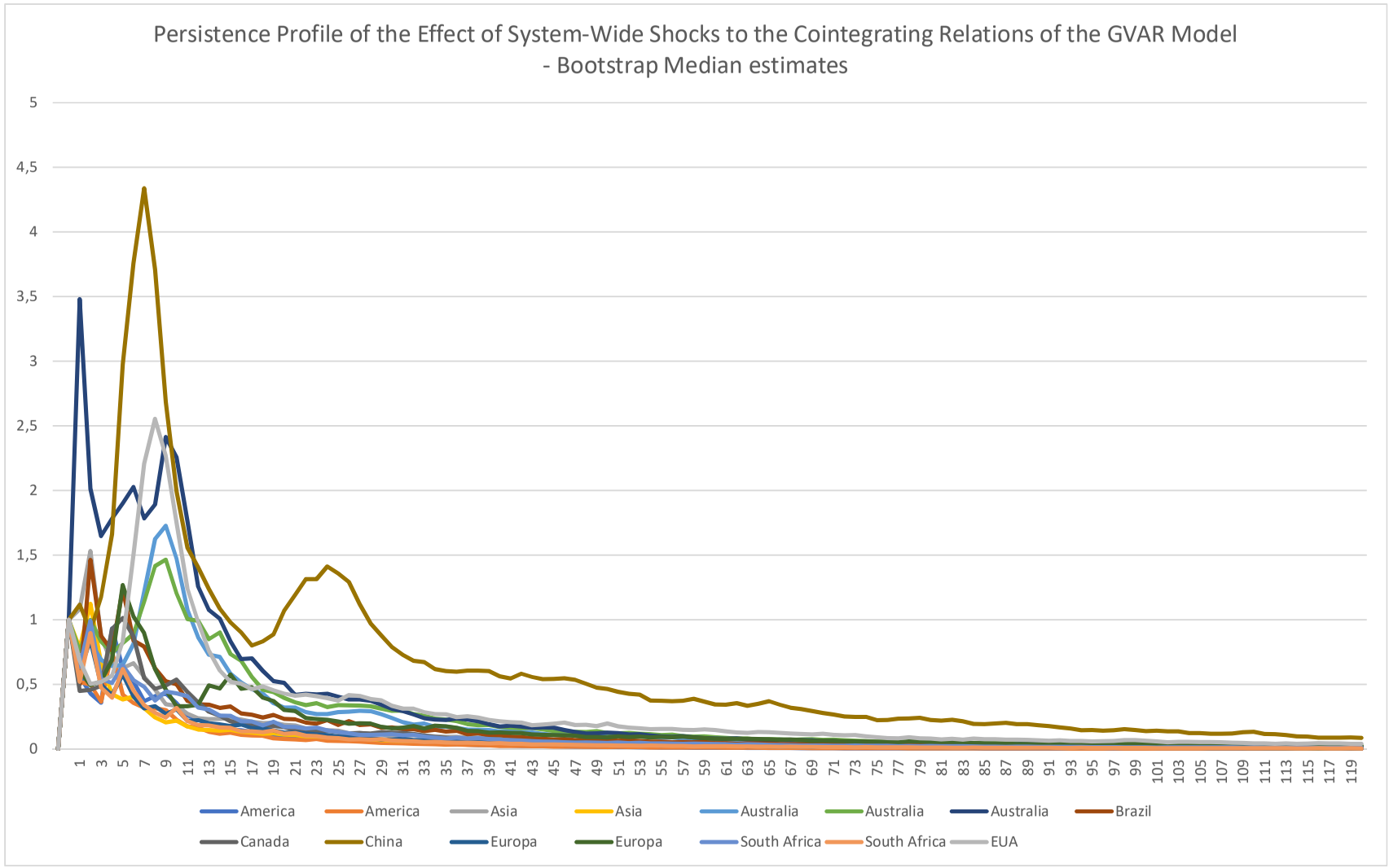


Table 22 – Test for Weak Exogeneity at the 5% Significance Level

Country	F test	Fcrit 0.05	eqs	cpis	exs	csds	irs	fers	spr
America	F(2.73)	3.12	1.52	7.62	4.65	1.85	0.31	4.91	0.71
Asia	F(2.73)	3.12	2.92	5.5	2.25	5.1	4.06	0.81	6.73
Australia	F(3.73)	2.73	0.78	4.48	1.49	0.03	1.9	2.28	0.87
Brazil	F(1.74)	3.97	1.11	5.76	0.05	0.69	1.47	0	1.27
Canada	F(1.75)	3.96	0.4	0.13	3.08	2.72	0.98	2.53	0.24
China	F(1.60)	4	0.07	0.57	3.05	0	0.11	1.63	2.16
Europa	F(2.73)	3.12	1.52	4.28	0.82	1.22	3.55	1.25	0.06
South Africa	F(2.73)	3.12	2.71	3.36	2.29	2.98	2.8	2.64	2.04
EUA	F(1.75)	3.96	0.22	9.87	1.77	0.34	0.1	5.82	0

Table 23 – Structural Stability Tests: Break Dates for QLR Tests

Variables	eq	cpi	ex	csd	ir	fer	spr
America	2009M2	2011M11	2009M2	2012M4	2009M3	2009M2	
Asia	2009M6	2009M7	2009M2	2012M9	2009M5	2009M4	
Australia	2009M8	2009M3	2010M7		2009M2	2009M2	
Brazil	2012M3	2012M8	2009M3	2012M3	2012M9	2009M3	
Canada	2009M1	2010M2	2009M2		2012M10	2010M12	
Chinaa	2009M2	2011M5	2012M2	2009M2	2009M2	2009M7	
Europa	2010M12	2009M10	2010M12	2008M8	2011M6	2009M1	
South Africa	2009M4	2009M12	2009M10	2009M3	2012M4	2011M11	
EUA	2009M5	2009M1	2011M5		2009M4	2009M3	2008M12

Table 24 – Contemporaneous Effects of Foreign Variables on Domestic Counterparts

Country		eq	cpi	ex	csd	ir	fer
America	Coefficient	0.84	-0.31	1.46	0.52	0.02	-0.42
America	Standard error	0.15	0.12	0.45	0.09	0.11	0.35
America	t-ratio	5.55	-2.47	3.2	5.49	0.24	-1.18
America	White's adjusted SE	0.15	0.1	0.37	0.08	0.07	0.34
America	t-ratio White	5.55	-2.87	3.94	6	0.38	-1.23
America	Newey-West's adjusted SE	0.15	0.1	0.38	0.08	0.07	0.39
America	t-ratio NeweyWest	5.38	-3.1	3.78	5.99	0.39	-1.06
Asia	Coefficient	0.63	0.55	1.96	0.75	0.38	0.63
Asia	Standard error	0.1	0.12	0.47	0.05	0.07	0.07
Asia	t-ratio	6.25	4.46	4.09	12.75	5.31	8.96
Asia	White's adjusted SE	0.12	0.1	0.48	0.04	0.06	0.06
Asia	t-ratio White	5.02	5.17	4.07	15.35	6.07	9.67
Asia	Newey-West's adjusted SE	0.12	0.11	0.54	0.04	0.05	0.06
Asia	t-ratio NeweyWest	5.14	4.97	3.57	15.12	6.49	10.16
Australia	Coefficient	0.28	-0.15	-1.2	0	1.29	1.9
Australia	Standard error	0.09	0.11	0.35	0	0.13	1.19
Australia	t-ratio	2.95	-1.36	-3.4	0	9.5	1.58
Australia	White's adjusted SE	0.11	0.12	0.33	0	0.16	1
Australia	t-ratio White	2.39	-1.2	-3.64	0	7.97	1.88
Australia	Newey-West's adjusted SE	0.12	0.12	0.31	0	0.18	1.08
Australia	t-ratio NeweyWest	2.31	-1.22	-3.83	0	7.01	1.75
Brazil	Coefficient	0.66	0.18	2.65	0.83	0.15	0.59
Brazil	Standard error	0.19	0.08	0.75	0.11	0.14	0.12
Brazil	t-ratio	3.51	2.24	3.53	7.25	1.09	4.76
Brazil	White's adjusted SE	0.21	0.06	0.76	0.11	0.14	0.11
Brazil	t-ratio White	3.16	2.76	3.48	7.01	1.08	4.99
Brazil	Newey-West's adjusted SE	0.19	0.06	0.77	0.12	0.13	0.12
Brazil	t-ratio NeweyWest	3.51	2.8	3.42	6.67	1.16	4.88
Canada	Coefficient	0.71	0.72	0.77	0	0.84	-0.43
Canada	Standard error	0.13	0.09	0.41	0	0.05	0.5
Canada	t-ratio	5.51	8.04	1.83	0	14.46	-0.85
Canada	White's adjusted SE	0.13	0.09	0.34	0	0.05	0.55
Canada	t-ratio White	5.4	7.39	2.21	0	15.31	-0.78
Canada	Newey-West's adjusted SE	0.13	0.08	0.31	0	0.07	0.59
Canada	t-ratio NeweyWest	5.43	8.73	2.44	0	11.72	-0.72
China	Coefficient	0.69	0.16	0	1.13	0.6	0.53
China	Standard error	0.35	0.19	0.08	0.14	0.13	0.09
China	t-ratio	1.92	0.86	-0.07	8.07	4.46	5.65
China	White's adjusted SE	0.34	0.18	0.08	0.14	0.15	0.08
China	t-ratio White	2.02	0.92	-0.07	7.78	3.88	5.9
China	Newey-West's adjusted SE	0.27	0.16	0.08	0.15	0.14	0.1
China	t-ratio NeweyWest	2.53	1.04	-0.07	7.56	4.2	4.97
Europa	Coefficient	0.39	0.19	-0.29	0.61	0.95	0.19
Europa	Standard error	0.1	0.02	0.21	0.1	0.05	0.24
Europa	t-ratio	3.71	9.72	-1.37	6	17.15	0.81
Europa	White's adjusted SE	0.09	0.01	0.2	0.09	0.06	0.25
Europa	t-ratio White	4.23	11.3	-1.43	6.54	15.27	0.77
Europa	Newey-West's adjusted SE	0.08	0.01	0.18	0.08	0.05	0.22
Europa	t-ratio NeweyWest	4.53	10.78	-1.56	7.5	17.67	0.88

Table 25 – Contemporaneous Effects of Foreign Variables on Domestic Counterparts

Country	eq	cpi	ex	cds	pr	ir	fer
South Africa	Coefficient	0.47	0.78	2.16	0.72	0.7	0.69
South Africa	Standard error	0.11	0.16	0.59	0.11	0.14	0.15
South Africa	t-ratio	4.03	4.88	3.66	6.36	4.92	4.62
South Africa	White's adjusted SE	0.09	0.19	0.59	0.1	0.13	0.13
South Africa	t-ratio White	4.83	4.11	3.65	6.63	5.3	5.33
South Africa	Newey-West's adjusted SE	0.07	0.16	0.56	0.1	0.13	0.12
South Africa	t-ratio NeweyWest	6.12	4.75	3.8	6.84	5.11	5.62
EUA	Coefficient	0.38	1.3	-0.03	0	2.49	1.29
EUA	Standard error	0.12	0.2	0.2	0	0.18	0.16
EUA	t-ratio	3.06	6.43	-0.15	0	13.38	7.93
EUA	White's adjusted SE	0.12	0.2	0.22	0	0.17	0.17
EUA	t-ratio White	3.01	6.35	-0.14	0	13.94	7.23
EUA	Newey-West's adjusted SE	0.13	0.2	0.18	0	0.16	0.18
EUA	t-ratio NeweyWest	2.86	6.42	-0.17	0	15.12	6.97

Figure 26 – US 1se Negative Shock to UMP indicator - CDS

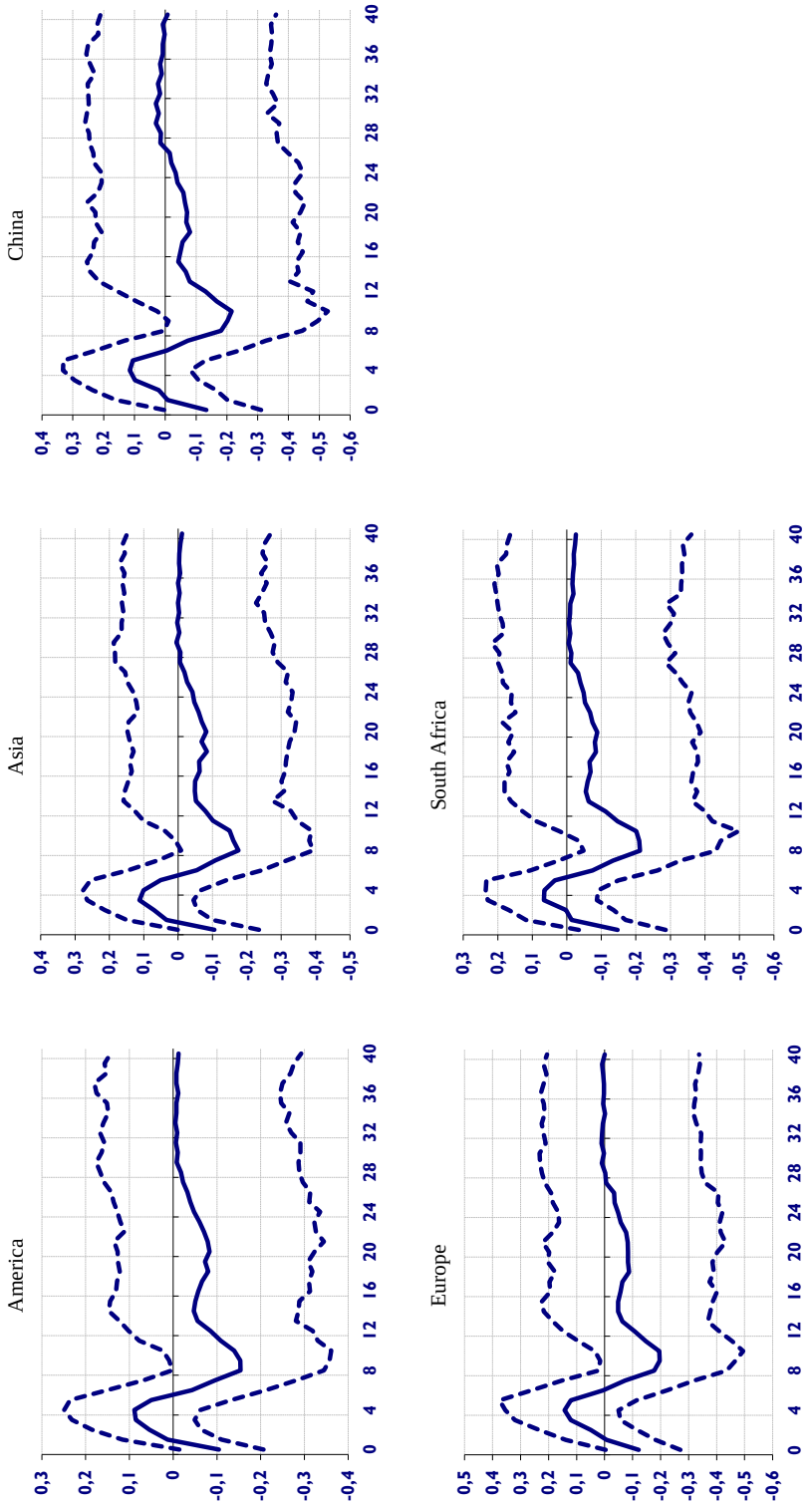


Figure 27 – US 1se Negative Shock to UMP indicator - CPI

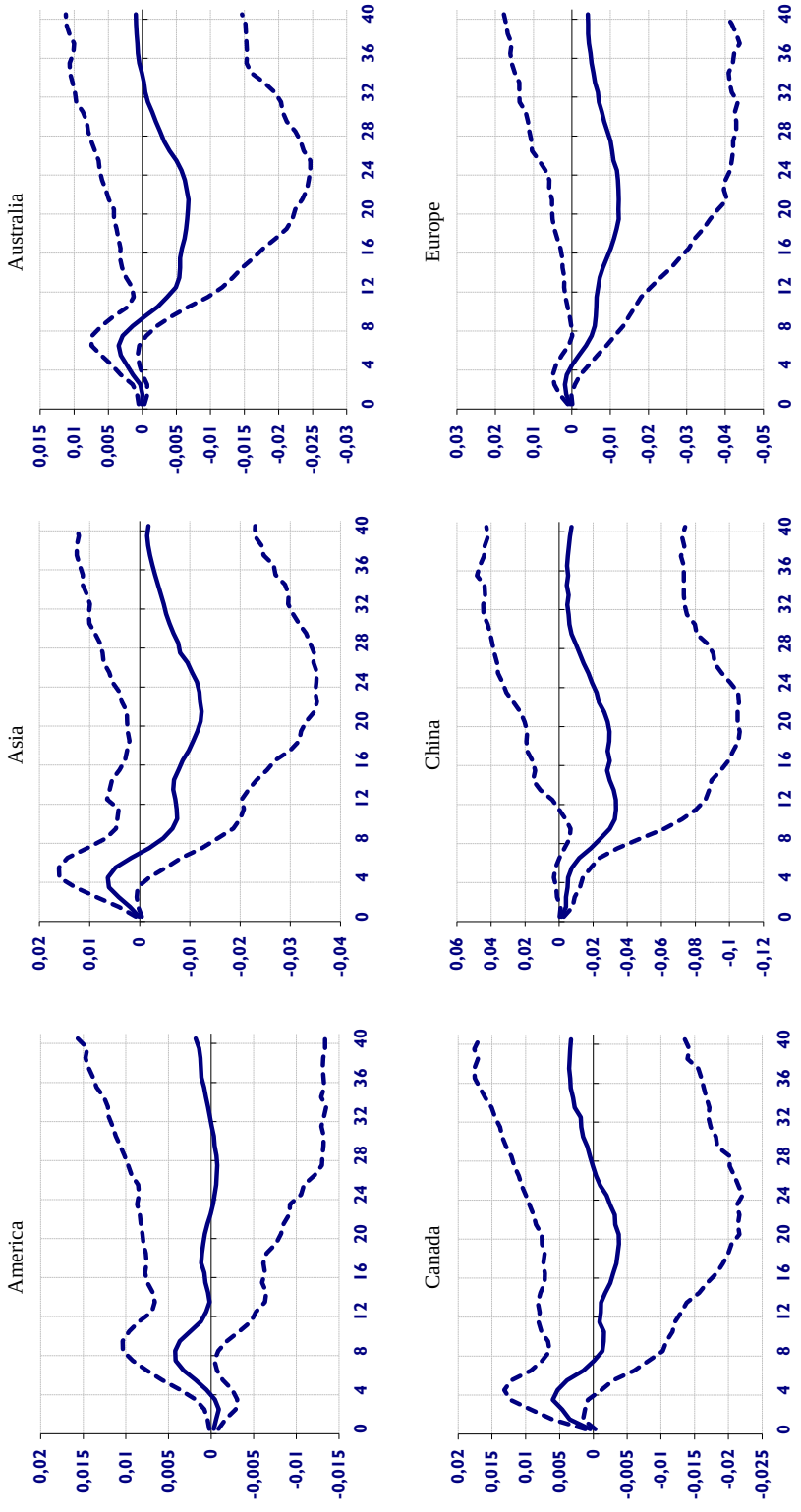


Figure 28 – US 1se Negative Shock to UMP indicator - Equity

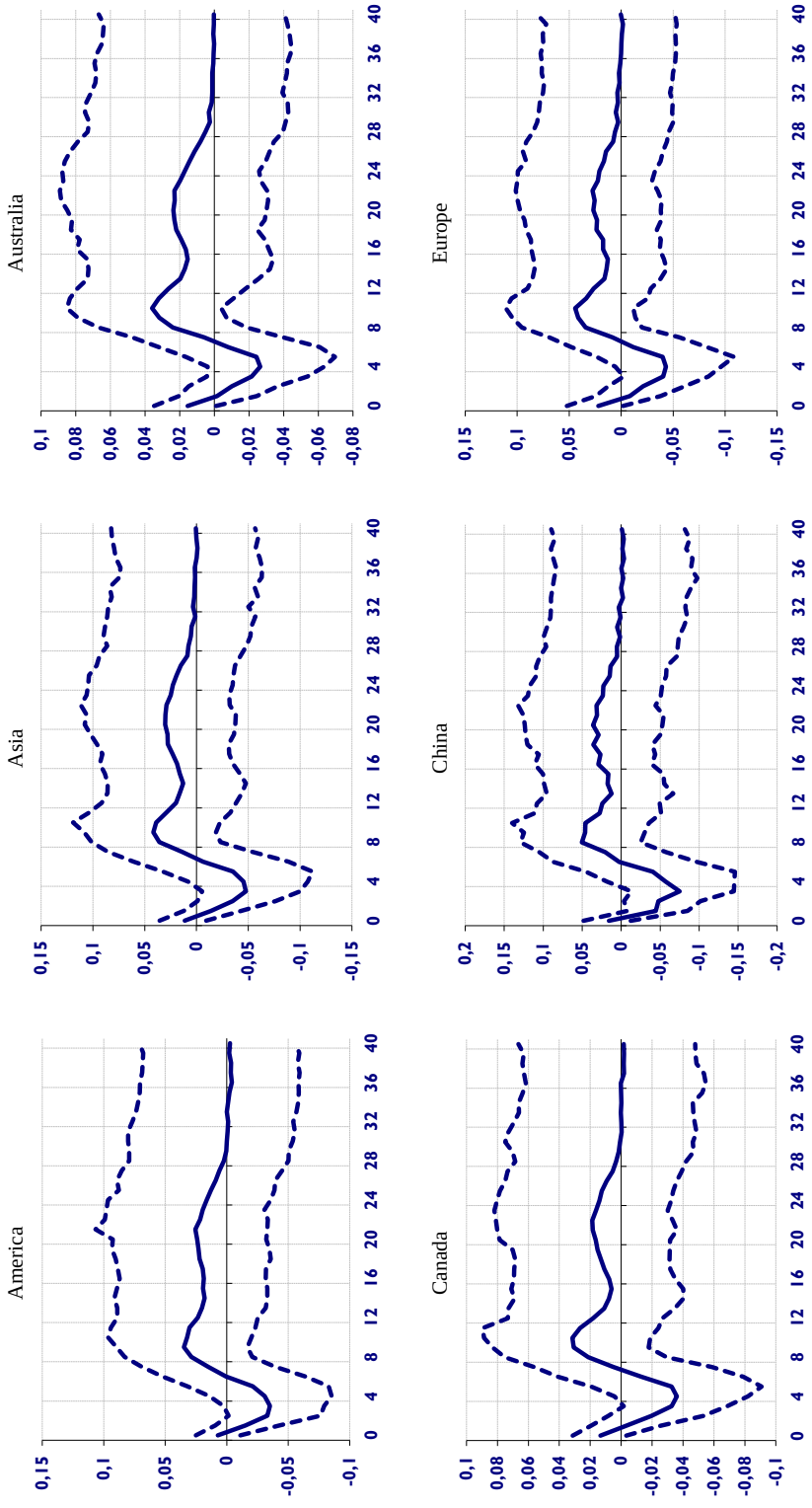


Figure 29 – US 1se Negative Shock to UMP indicator - Foreign Reserves

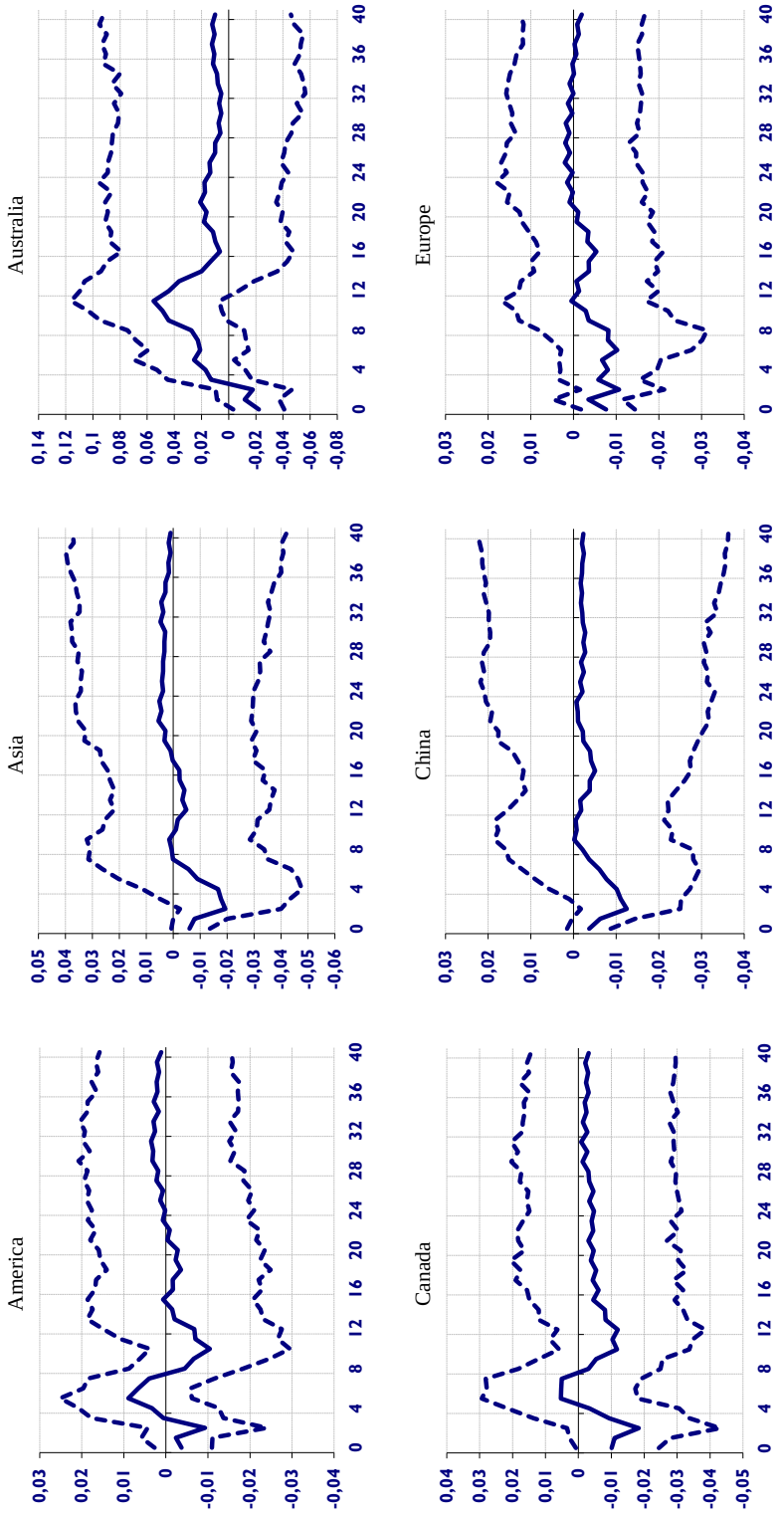


Figure 30 – US 1se Negative Shock to UMP indicator - Exchange Rate

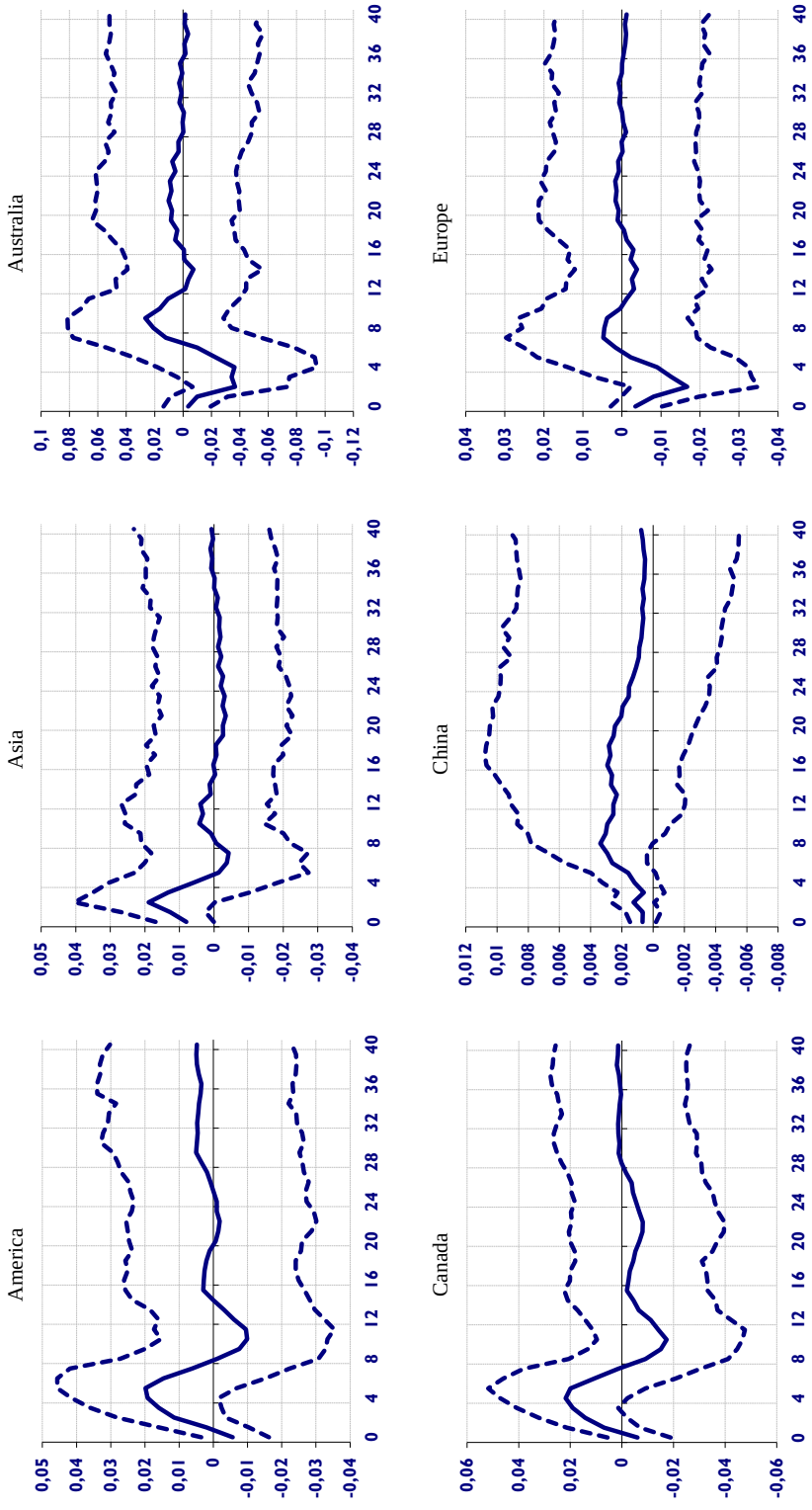
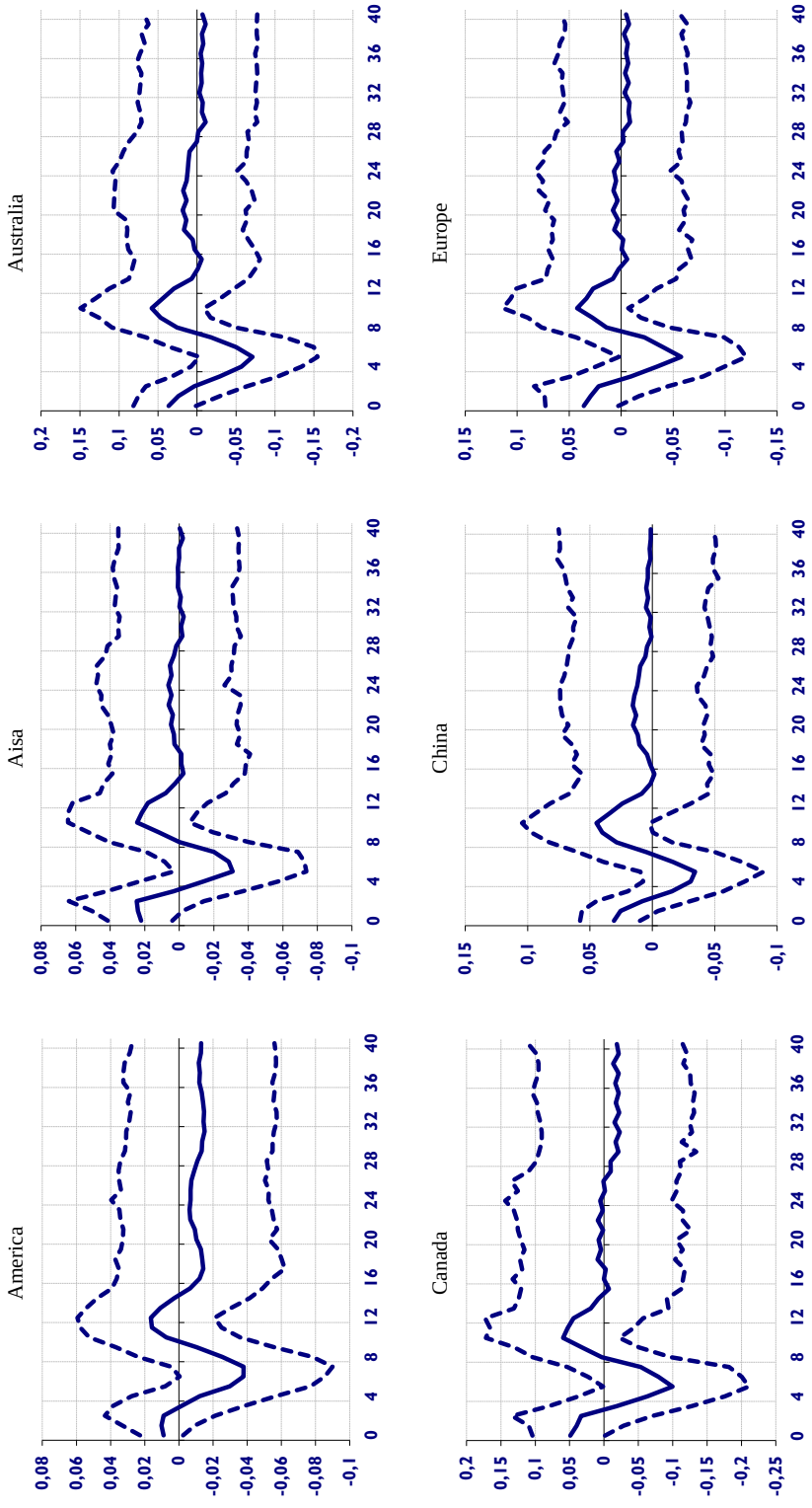


Figure 31 – US 1se Negative Shock to UMP indicator - 10 Years Treasury Yields



Appendices