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Spillover effect: From U.S. monetary policy to Brazil and Mexico's sovereign yields

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To my family,
For their unlimited support

TABLE OF CONTENTS

Introduction

The aim of this work is to discuss how changes in U.S. monetary policy affect the yield of sovereign bonds in emerging markets (EM).

This phenomenon is also known as the spillover effect, the countries that we will consider are Brazil and Mexico. Historically, Mexico is highly related to U.S. for its vicinity, their relation goes beyond their huge amount of trade; it involves also cultural, touristic and educational ties. Mexico is one of the United States' most important trading partners, is ranked third in total U.S. trade. The strong economic ties are mainly due to the North American Free Trade Agreement (NAFTA) of 1994. The trade between the two countries has increased significantly after this agreement. Through the NAFTA United States reinforced their political ties with the emerging country and Mexico attracted a significant level of Foreign Direct Investments (FDI). FDI is a fundamental part of the economic relationship between these two countries. The United States is the first source of FDI in Mexico and creates great flows of capital between the two countries. Moreover, two main factors that affect economic trends of Mexico are: manufacturing exports and oil prices. The first one is highly dependent on United States as approximately 80% of Mexico's exports are destined for the United States[1]. The second one is important because affects exports and consequently prompts the volatility of foreign exchange market.

Thus, following these facts is easy to observe that their respective financial markets are in strong connection.

"Brazil traditionally have enjoyed robust economic and political relations with United States"[2]. Mechanisms that facilitate the movement of trade and

[1] (Villareal 2017) The paper analyses the economic and trade relationship between Mexico and U.S. and also the strong cultural ties that connect the two countries.

[2] (Bureau of Western Emisphere Affairs 2017) The report explains the relation of the United States with Brazil, under the political and the economic point of view.

investments between these two countries are constantly growing, in addition Brazil is the second largest trading partner of the United States. The trade of goods and services between these two countries has more than tripled during the last decade. The category that has the greater share of export from Brazil is machinery, more specifically high-tech. Also services like telecommunication and technical services play an important role in the percentage of trade. Moreover, Brazil is the largest source from Latin America of FDI in the United States. FDI from the emerging to the advanced economy include energy like coal, gas, alternatives and renewables[3]. Furthermore, the great amount of foreign reserves of Brazil held in USD is very important for the exchange-rate volatility so it is important to see how Brazilian financial market reacts to American shocks.

Not only one channel affects spillover effect, usually this effect is determined by the interconnection of different factors like stock prices, exchange rates, oil prices and international parity condition. By the way, in our analysis we will take in consideration the long-term yields because the effect of domestic factors reflects more the economic fundamentals of the individual country[4].

Moreover, long term interest rates are a key driver in the effect of monetary policy so, in order to deeply analyse this effect, we take in consideration how the changes in 10-year U.S. treasury yields (UST-10Y) affect the Brazilian and Mexican sovereign yields of fixed–rate local currency bonds with the same maturity.

Understanding the causes of the spillovers is very important for different reasons. Firstly, after the financial crisis the presence of investors in emerging markets has increased massively heightening cross-border linkages. Secondly, changes in sovereign bond yields can affect government and borrowing costs and consequently can affect financial sector. Finally, long term U.S. treasury yields has changed significantly after the news of the tapering talk (2013) by the Fed.

In the first part of this paper we will discuss recent contributions to the literature on spillover effects in sovereign debt markets in the context of the global

[3] (Moghadan 2011) The IMF working paper maps the cross-border linkages and identifies factors that drives them.

[4] (Matheson 2015) examines how global financial condition proceeds after the recovery proceeds and the Fed normalization process.

financial crisis and some dataset about specific countries to have a general flavour of the argument. While, in the second chapter we will use an econometric model to test for the presence of spillover effects and establish some empirical evidence about the correlation between U.S. Monetary policy and Emerging Markets Economies (EMEs). More specifically we will run a "Vector Auto Regression" (VAR) model including important macroeconomics variables such as external determinants of local currency sovereign yields, including credit risk and risk appetite of investors. As a model and main reference for this study we will take Góes (2017)[5].

The main results emerging from the empirical analysis are as follows:

The spillover effect is present in both countries but is not as large as we thought before the analysis because the extensive literature about this effect suggested a higher level of interconnection between the U.S. 10-year treasury yield and 10-year sovereign bond yields of the emerging markets. In our findings the effect is lower. More specifically, Mexican yield is more responsive than Brazilian after a 100 basis points shock in the U.S. 10Y. On the other hand, Brazilian yield tends to fluctuate more than Mexican yield to changes in their respective policy rate.

Therefore, our results suggest that even if still present in both countries the spillover effect is lower than in previous years. Both emerging markets taken in consideration have strengthened their economic fundamentals and independence from United States. Giving the signal that future possible shocks in the U.S. economy will be absorbed better.

[5] (Carlos Góes 2017) analyses through a VECM the spillover effect from U.S. monetary policy to Brazil and Mexico during the Normalization period and the effect immediately after the tapering tantrum.

I. SPILLOVER EFFECT

1.1 Understanding Spilllovers

The definition of spillover effect is not unique and irreversible. One could the defines spillover effect as the international monetary movements that affect short-term and long-term interest rates and policy rates[6] or as interactions between internal and external factors which alters the economic factors via trade linkages and exchange rates[7]. The best way to define it is by saying that spillover effect is the impact that some economic decisions of one nation may have on the economies of other countries. This concept of course excludes co-movements across markets that are driven by common factors (like global shocks that affect many economies similarly).

I decided to take in consideration this specific spillover to underline the importance of the cross-border transmission channel between EMEs and advanced economy. Analysing how one of the main superpower in the world influence economic fundamentals of emerging countries is important to fully understand the size of changes undertaken by nations like the United States. After the financial crisis the importance of these "effects" has increased significantly.

"In its latest Global Financial Stability Report (GFSR), the IMF argues that the importance of spillovers, in particular those from emerging to advanced economies, has increased significantly over the last two decades"[8].

The main reason for this increasing effect is that a large fraction of macroeconomics variables of emerging countries is part of advanced economies variables affecting stock prices and yield rates. The leading role of this effect is the portfolio channel. The increasing number of outflows and inflows between advanced economies and emerging economies have increased the connection between markets. If we consider the Global Financial Stability Report (GFSR)

[6] (Hoffman 2015) which in his paper uses standard panel regressions to analyse international monetary spillovers in short-term and long-term interest rates

[7] (Klaus Weyerstrass 2006) which studies the impact of different types of spillover effect affecting the Euro area.

[8] (BNP Paribas 2016), page 2. The research paper take in consideration the increasing spillover from emerging market through the flows of portfolio debt and portfolo equity.

of the International Monetary Fund of April 2015, it is possible to see the increasing exposure to emerging markets since the first years of the new millennium. In the following figures the capital flows for emerging markets are represented in median in terms of percentage of GDP. Capital flows are divided in portfolio equity and portfolio debt. Respectively, figure 1a represents inflows for emerging markets and figure 1b outflows. Capital inflows are defined as net acquisition from foreign investors of domestic assets and capital outflows are defined as net acquisition of foreign assets by residents.

Figure 1

Median, percent of GDP

-- Portfolio Equity -- Portfolio debt

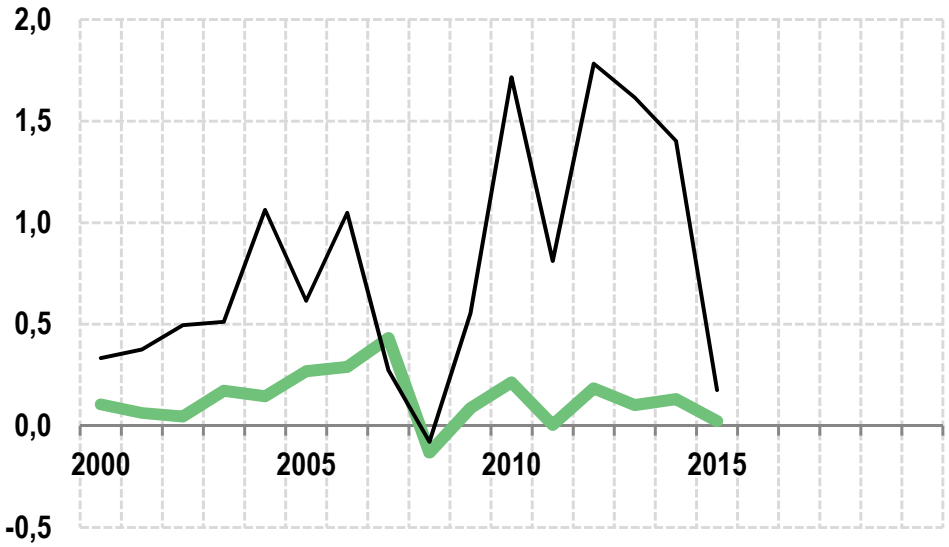


Chart 1a Sources: IMF, WEO April 2016

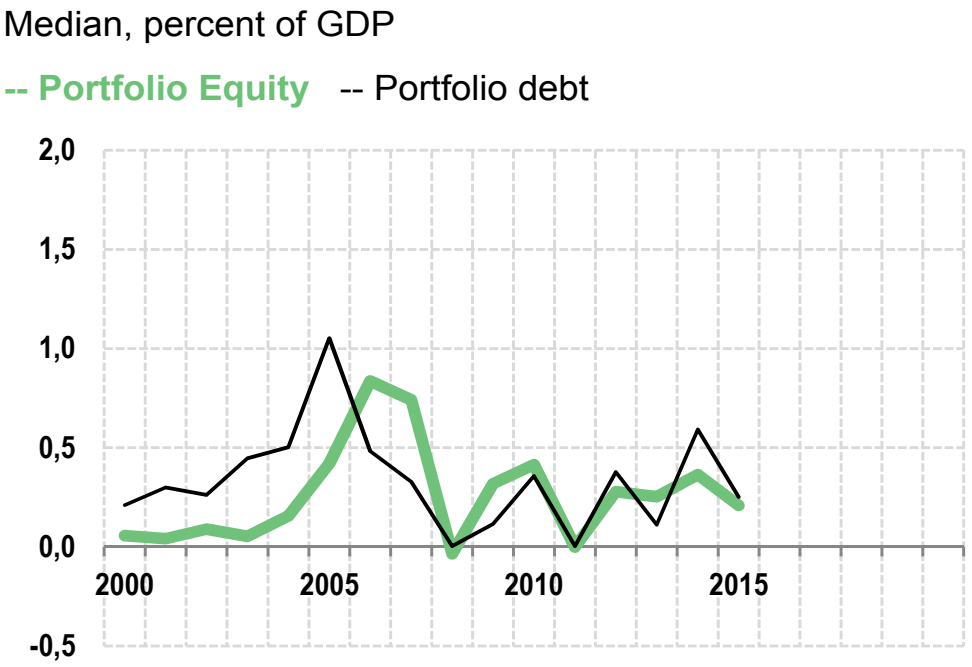


Chart 1b Sources: IMF, WEO April 2016

If we look at figure 1 we can see that inflows of portfolio debt are much larger than inflows of portfolio equity, apart during the financial crisis where the lines intersect with each other and follow quite the same trend. This is the main reason behind the decision of analysing long-term debt rather than equity instruments. On the other hand, in figure 1 it is noticeable that the level of outflows between the portfolio equity and portfolio debt increase and decrease by almost the same percentage points, except from the initial period (2000-2005) where a spread arises between the two types of portfolios. Once we had a look on this data we should evince the fact that debt instruments play a more central role than equity instruments on spillovers among financial markets, but this is not true. In fact, we can consider spillovers arising from equities as different from spillover arising from bonds. Equity markets spillovers of emerging countries are due to equity prices and exchange rates in advanced economies. They have become more and more important during the last two decades and now constitute one third of the volatility in asset returns in advanced economies. Bond markets spillover follow different trends, they tend to be driven more by global factors

as explained in the Global Financial Stability Report of 2016[9]. We will explain the importance of this factors later. Let's now have a look at the contagion channel.

1.1.1 Contagion Channel

The contagion channel is an important factor that may influence partially the spillover effect.

After the financial crisis investors have relied more on mutual funds rather than on banks. The activities of mutual funds are obscure and opaque but is known that a lot of money that they manage are invested in emerging markets because of their higher profitability. The reason behind the importance of mutual funds on spillover effect regards the position that this funds take when facing gain or losses. More specifically, when these funds incur in gain or losses funds' manager rebalance their portfolio of assets. In rebalancing these assets' portfolios across countries they can propagate shocks internationally even if countries do not have any economic or trade linkages. This is known as the portfolio channel of contagion or more simply contagion channel. Thus, a question rise spontaneously, what is the difference between contagion and spillover? The difference between contagion effect and spillover effect is semantic. The best way to define these two similar effects is by saying that spillover effect is always present in the market, in good times and in bad times. On the other hand, contagion effect even if it could be always present is more relevant during periods of crisis[10]. Therefore, rather than be one the consequence of another is more appropriate to say that one is in the other. For sure, the increasing number of advanced economies' investors in emerging markets and viceversa have feed the contagion channel, which now play a central role in the determination of the spillover effect.

[9] (International Monetary Fund 2016) furnishes on april of each year an annual report on the global financial conditions and factors which influence emerging markets

[10] (ECB November 2016) which reviews empirical literature on contagion and international spillovers and analyses the two possible sources of bias of observed variables: endogeneity and omitted variables.

1.1.2 Spread determinants

To better understand how the relative difference between the 10-year U.S. treasury yield rate and the corresponding 10-year sovereign yields rate of the two emerging markets taken in consideration works out we will have a close look to the main determinants of this spread.

The first and the most important determinant is the credit risk. Credit risk is defined as the risk that the lender faces when lending money to a borrower, more specifically is the risk that the borrower default and so is not able to give back the money plus the interest rate to the lender. Asymmetric information influences the decision of choosing between a good creditor and a bad creditor. Credit risk can be summarized in the following formulae:

$$CR = \text{Expected Loss} + \text{Unexpected Loss} \quad (1.1)$$

$$\text{Expected Loss} = PD * LGD * EAD \quad (1.2)$$

with

PD= Probability of default in a given time period

LGD= Loss given Default

EAD= Exposure at Risk

Unexpected Loss = Variance and Covariance around expected loss[11]

Moreover, various multidimensional aspects can represent credit risk which can be divided into three distinct variables: (i) liquidity and solvency risk, (ii) macroeconomic fundamentals, (iii) external shocks.

Liquidity and solvency risk variables include useful indicators to spot the governments' ability to meet their short-term obligations. Among the measures taken in consideration we have: export earnings and import expenditures, international reserve-to-GDP ratio, interest payments, level of external indebtedness, share of short-term debt and degree of trade openness. For example, usually, relatively closed economies find difficulties in generating surpluses in order to guarantee external debt repayments, so they have a low incentive to repay debts.

[11] (Basel Committee on Banking Supervision July 2005) which is a paper regarding Revised Framework on Internation Convergence of Capital Measurement and Capital Standards, which is fundamental for national rulemaking.

Macroeconomic fundamentals form the second group which analyse the long-run solvency of a country. Over the last years, solvency has been a factor of debate. Most central banks had set new solvency requirements, for example Solvency II by ECB, in order to increase the level of financial stability. If we consider sovereign debt instruments, solvency capital requirements are based on the spread risks. The spread risk is made up of two elements:

-The credit quality, which is represented by the Credit Quality Step (CQS)

-The sensitivity of the instrument, which in general is a function of the spread duration[12]

The CQS of an asset is defined as the second best rating from 3 External Credit Assessment Institutions (ECAI). The three major ECAI are Moody's, Standard & Poors, Fitch.

The spread duration represents the opposite of the derivative with respect to the spread price of the bond, divided by the (dirty) price of the bond.

Of course solvency capital requirement need to be calculated taking into account the spread of the issuer.

However, there exist some bonds which are exempt from solvency capital requirements such as: bonds issued by central banks (like ECB and Fed), bonds issued by governments in their own currency and bonds issued by certain international organizations.

For other bonds the SCR depends on the rating. AAA and AA sovereign bonds have shocks of 0. For rating below BBB, the shocks for the sovereign bonds are equal to the shocks for corporate bond with a rating of one grade more favourable. For example, BB sovereign bonds are treated as they were BBB corporate bonds.

In our case the U.S. 10-year Treasury yield is rated Aaa (Moody's), the Brazilian 10-year sovereign bond is rated Ba2 (Moody's) and the Mexican 10-year sovereign bond is rated A2 (Moody's) we can see the differences among these ratings in the following table (Table 1)

[12] (Natixis asset Management 2016) that provides a detailed description of the key elements in the calculation of Solvency Capital Requirements for debt instruments.

Table 1

Moody's		S&P		Fitch		Description	
Long-term	Short-term	Long-term	Short-term	Long-term	Short-term		
Aaa	P-1	AAA	A-1+	AAA	F1+	Prime	Investment-grade
Aa1		AA+		AA+		High grade	
Aa2		AA		AA			
Aa3		AA−		AA−			
A1		A+	A-1	A+	F1	Upper medium grade	
A2		A		A			
A3	P-2	A−	A-2	A−	F2	Lower medium grade	
Baa1		BBB+		BBB+			
Baa2	P-3	BBB	A-3	BBB	F3		
Baa3		BBB−		BBB−			
Ba1	Not prime	BB+	B	BB+	B	Speculative	Non-investment grade
Ba2		BB		BB			
Ba3		BB−		BB−			
B1		B+		B+		Highly speculative	
B2		B		B			
B3		B−		B−			
Caa1		CCC+	C	CCC	C	Substantial risks	
Caa2		CCC				Extremely speculative	
Caa3		CCC−				Default imminent with little	
Ca		CC				prospect for recovery	
		C					
C		D	/	DDD	/	In default	
/				DD			
				D			

Source: Google

The second valid proxy for the quality of management (both monetary and economic) is the inflation rate that may reflect accommodation of fiscal imbalances. The level of inflation depends upon the governments and central banks decision, usually a low and constant inflation (from 0% to 2%) is considered good for the economic growth of the country, but this may variate across different nations. Another reliable index is the real exchange rate which measures the competitiveness of trade of an economy. This is considered as an important cause of debt crises if the currency is overvalued because of capital flights and future devaluation. However, if the domestic debt is denominated in foreign currency and is devaluated fiscal problems are exacerbated.

Finally, terms of trade are also important because they change information on how external shocks affect trade and financial flows.

The most important variables in the third group of external shocks are oil prices and the degree of global liquidity. Shocks on oil prices are a threats to emerging economies, unless they are oil exporter. High oil prices affect the credit-worthiness on world growth and usually decrease the competitiveness of oil importer countries. The vulnerability of oil importer countries to higher oil prices depend on the level of oil-intensity of their economies. Usually, oil-importing emerging economies use twice the quantity of oil of an advanced economy to produce one unit of economic output[13]. This is because emerging economies are more energy-intensive and are less efficient in saving it.

Therefore, given the fact that United States is one of the major oil-exporter, U.S. monetary policies are an important fraction influencing global liquidity which affect emerging market spreads. High U.S. rate increase the cost of borrowing and also the interest rate charged on existing debt, when debt is contracted in U.S. dollar at floating interest rate.

1.1.3 Further Determinants

In order to complete our analysis of spread determinants we have to consider two more important factors in the analysis of spillovers, the risk appetite of investors and the volatility of world market portfolio. Technically, risk appetite is divided in three distinct states: risk loving, risk averse and risk neutral. The preferences are not grouped in a single function, the state in which the investors are depend upon exogenous conditions. In "good times" investors can be considered risk lovers so the demand for risky assets increases as well as the value. In "bad times" investors should be considered as risk averse, in this case the exposure to risky assets is reduced and the value decreases. However, risk neutral investors are always present in the market and they represent the part of investors which do not care about the degree of risk, they decide their investment by accounting only for expected return. The actions of investors trigger "risk on" or "risk off" periods which depend on their risk appetite.

[13] (International Energy Agency 2004). This summary provides a quick overview on the economic consequences due to position taken by oil-importer and oil-exporter countries

Moreover, re-balancing international portfolio in terms of risk and liquidity implies the transfer of risk perceptions from one country to another by investors[14]. This process, regardless of macroeconomic fundamentals, give rise to the phenomenon of contagion (see 1.1.1) which is enlarged by the fact that investors operate usually across countries and therefore a crisis in a specific country leads to higher yield spreads in the surrounding area. "The pattern and the severity of financial contagion depends on markets' sensitivities to shared macroeconomic risk factors, and on the amount of information asymmetry in each market"[15]

Another determinant seems to be the level of transparency and comprehensiveness of the balance sheets of national governments. This because the market creates an assessment of the government's ability to repay debts and this assessment relies on information disclosed by the governments themselves, so consecutively it makes sense that an appraisal of the confidence on the information available is endogenous in the yield spreads.

[14] (Conte 2009) in his paper reviews the literature concerning the determinants of the yield spreads on government bonds of the emerging markets economies.
[15] (Kodres 2002) which developed a multiple asset rational expectations model of asset prices to explain the determinants of financial market contagion.

1.2 The role of Monetary Policy

Before analysing the impact of U.S. monetary policy on spillover effect we will have a quick look at the history of United States monetary policy. Let's begin by taking in consideration the last two decades, to see how these policies had changed.

Before the financial crisis of 2008/2009 investors and markets were used to deal with conventional monetary policies. The aim of monetary policy was the inflation targeting. In other words, the achievement of a low and stable inflation through conventional instruments in order to guarantee a constant economic growth. "The instrument was a short-term interest rate at which the central bank provided funds to banks or the interbank market and the impact of this official rate on market rates and the wider economy"[16]. Within this framework, a wide variety of macroeconomic signals were used to set interest rate, the setting of the interest rate by Fed during the period before the financial crisis could be approximated with the Taylor's rule. Hereby, the classic formula:

$$i\text{-}i^* = \theta_\pi(\pi - \pi^*) + \theta_q(q - q^*) \qquad (1.3)$$

Where $i\text{-}i^*$ is the deviation of short term interest rate to a baseline path, the θ are two constant parameters, one related to inflation and one to output. $\pi - \pi^*$ is the difference between actual level of inflation and inflation target and $q\text{-}q^*$ is the output gap. Taylor adopted the "real-output-plus-inflation" variant so the baseline nominal interest rate (i^*) is equal to the equilibrium real interest rate (r^*) plus inflation (π). Setting the inflation target (π^*) and the equilibrium real interest rate (r^*) equal to two and the two parameters (θ_π, θ_q) equal to one-half we obtain the classic Taylor's rule:

$$i = 2 + \pi + \frac{1}{2}(\pi - 2) + \frac{1}{2}(q - q^*) \qquad (1.4)$$

[16] (Joyce 2012) considers the implication of theoretical models for the impact of QE and other unconventional monetary policies followed by different central banks in the wake of the financial crises.

As Orphanides noted, this parameterization appeared to fit Federal Reserve behaviour remarkably well over the past years[17].

This rule is a forecasting model suggesting how the interest rate should be managed when different levels of employment and quantities of output occur. If conventional monetary policy is effectively used inflation will be at its efficient level. However even if this kind of policy allows to control and stabilize inflation it cannot prevent asset market bubbles. Nowadays, after long periods of analysis it still seems impossible to prevent bubbles with monetary policy, by the way after the crisis of 2008/2009 central banks have a much greater focus on the financial stability in addition to targeting inflation. This was improved by the strengthening of capital adequacy and liquidity rules through Basel III. The main reason behind the inefficiency of conventional monetary policy after the crisis is the zero lower bound. More specifically, if we had applied the classic Taylor's rule formula (1.2) after 2008 we would had obtained a negative nominal interest rate. Surely this is not feasible, given the fact that investors can always hold non-interesting bearing cash, market interest rates are effectively bounded to zero. Once the interest rate is set at or close to zero other forms of monetary policy need to be considered.

This is the turning point at which conventional monetary policy was integrated with unconventional monetary policy.

After the global financial crisis major advanced economies gave up conventional instruments and adopted unconventional monetary policy tools to help improve the weak economy and restore calm in financial markets. Unconventional monetary policy can take many forms, one of this for example is negative interest rate which were tested for the first time by the Danish central bank. Nevertheless, we will focus on US monetary policy.

The more common form of unconventional monetary policy is the expansion of central banks' balance sheets through asset purchase programmes. One famous operation is the "credit easing" in which the Fed expanded its balance sheet by purchasing securities and providing liquidity and confidence in the market. The other important form of policy is known as "operation twist", in this case the

[17] (Orphanides 2002) makes an historical examination that investigates the usefulness of the Taylor rule framework for decribing the policy rate debate.

balance sheet of CB is unaffected because the selling of short-term government bonds is cancelled out by the purchase of long-term bonds, but the central bank tries to influence non-standard interest rate.

In the period after the collapse of Lehman Brothers, September 2008, Federal Reserve started its asset purchase program (QE1). In the first period the Fed focused its attention on the extension of liquidity operations to support banks and markets and on purchasing large-scale assets (LSAP) like GSE debt, agency debt, mortgage backed securities (MBS) and treasury securities. In 2010 Fed launched the second asset purchase program for $600 billions (QE2) which was concentrated mainly on US Treasury securities [18]. After that in 2011 it started a different type of program known as "Operation Twist". Despite the different strategy US did not reach a full recovery yet. Therefore, Fed planned a new asset purchase program (QE 3) which started in 2012. After 6 years of asset purchasing in October 2014 the Fed put an end to Quantitative Easing, which helped the US to come out from the crisis of 2009 creating solid job position and lowering unemployment. After the long period of QE Federal Reserve focused mainly on the unemployment rate, the target inflation rate and the level of interest rates[19]. "The stated objective of quantitative easing is to reduce long-term interest rates in order to spur economic activity"[20]. There is significant evidence that long-term interest rates are affected by QE policies. For example, Gagnon et al. (2010) that presented an event study of QE1 that documents large reductions of interest rates associated with positive QE announcements.

1.3 The impact on Emerging Markets

All this movement in financial markets had some important consequences. As the period of unconventional monetary policy continued, emerging markets' policymakers begun to raise concerns. The asset purchase programmes in

[18] (Fratzscher, Lo Duca e Straub 2013) which anlayses the measures undertaken by the Federal Reserve during the unconventional monetary policy period and their impact on spillovers.

[19] (Jarrow 2014) paper estimates the impact of the Fed QE during the period 2008-2011 on the U.S. term structure of interest rates.

[20] (Krihnamurthy 2011)

advanced economies caused a large capital inflow in emerging economies, especially into debt instrument like bonds, soliciting spillover effect.

To investigate the effect of monetary policy decision by CB is essential to analyse two components: the surprise (or unexpected) factor and the informational content.

The first one can tell us if the decisions are perfectly anticipated by the market or not. If for example the Fed announce an increase in the interest rate of 1% and the market was expecting an interest rate increase higher than 1% then the asset prices should increase. On the other hand, if the market perfectly anticipates the decision asset prices remain unchanged because they were adjusted before the moment of the transmission of information regarding the policy. The second dimension is also important. Strategy decision of monetary policy can provide important information about future intentions of the Central Bank. This is also called the signal component. For example, through a communication the Fed can provide data on the availability of bonds to private investors or simply the risk of inflation (or deflation). Therefore, both components are of fundamental matter and can be observed in bond prices immediately after the policy decision[21]. In theory, surprises related to the signal component should affect short-term bonds and surprises related to the market component should affect long-term bonds.

Finally, the impact on emerging markets is measured calculating changes in asset prices and capital flows in response to monetary policy surprises by the Fed.

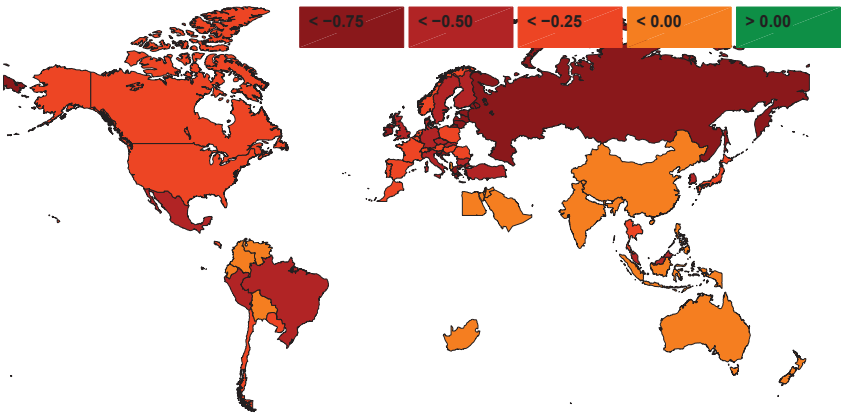
In general, analysing the past years we can observe that spillover effect was grater when announcements surprised markets with future information on policy rates. Surely, also the economic situation of the individual country plays a central role in determining the spillover effect. Countries with strong fundamentals like GDP growth, low inflation and small shares of local debt held by foreigners significantly dampened spillover effect, especially during the "unconventional" period. Let's analyse more deeply the effect of U.S. monetary policy.

Federal Reserve decision on U.S. monetary policies produces sizable outcome on spillover effect. That's why is important to have an overview of the main effect of monetary policy on spillovers. The effect of U.S. monetary policy can be larger in external countries like Brazil and Mexico than in U.S. itself. These

[21] (Jiaqian Chen 2015) which article explains the spillovers effect for emerging markets by the Fed through the flows of capital.

effects depend on different factors like trade openness, level of financial integration and exchange rate regime. For example, non-advanced economies with fixed rate regime tend to face larger spillover. It is possible to figure out the impact of U.S. monetary policy on different countries (figure 2). The figure has been taken from an ECB Working paper by Georgios Georgiadis. In his analysis Georgiadis take in consideration the reaction of 61 countries to U.S. monetary policy. More specifically, the figure displays the trough spillovers to real GDP to a 100 basis points contractionary monetary policy shock in the US[22]

Figure 2



Source: ECB Working Papers

The magnitude of the reaction is explained in the figure by different colours. It is remarkable the reaction of the two countries that we are considering.

Both Brazil and Mexico suffered a higher impact of the spillover with respect to the domestic country during the sample period (1999-2009).

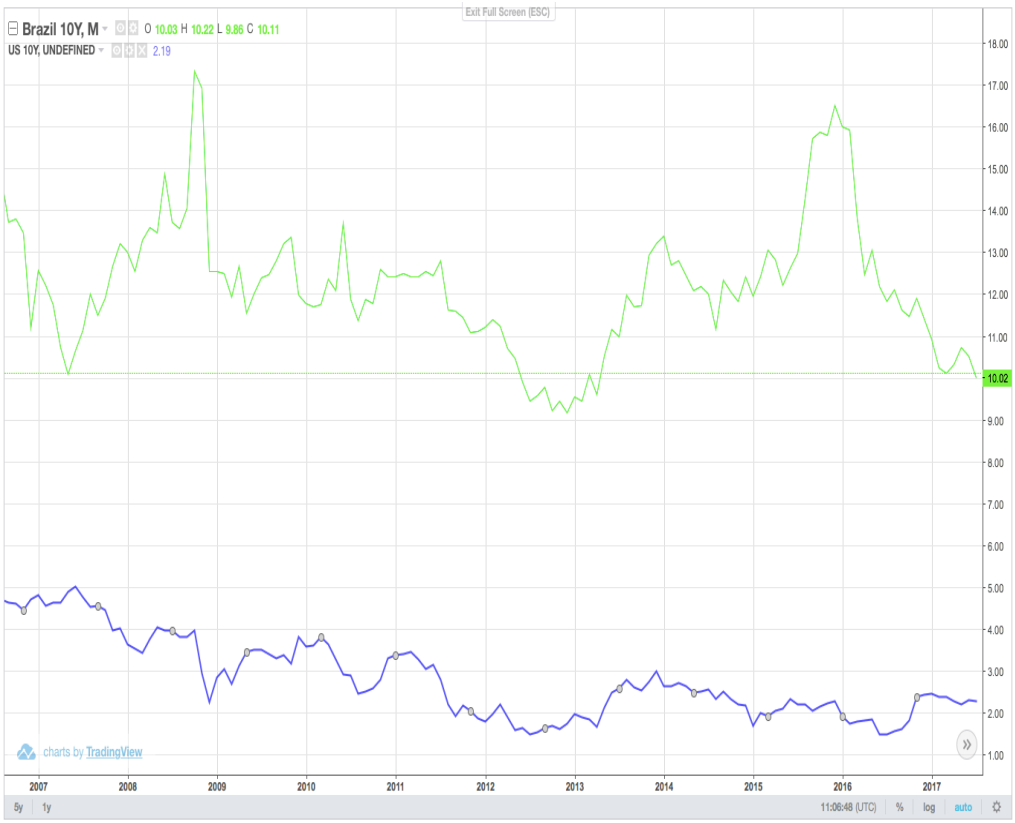
[22] (Georgiadis September 2015). This ECB paper asses the global spillovers from identified US moetary plicy shocks in a Global VAR model.

1.4 Yield rate comparison among countries

As we have seen how U.S monetary policy can affect EMEs let's now go for a more detailed view on the actual yield of the countries. In the following graph we can underline movements and co-movements between the two emerging countries taken in consideration, Brazil and Mexico, and USA.

1.4.1 Brazil vs. USA

Figure 3



Source: Trading Economics

In figure 3 above we can see with the green line the Brazilian 10-year government bond (GEBR10Y) and with the blue line the general American 10-year government bond (USGG10YR).

If we begin by looking at the trends from 2007 it is possible to see that in the first period the yield rates follow quite different paths. The U.S. rate has a considerably lower volatility, the yield oscillates within 80 basis points from 2007 to the third trimester of 2008. On the other hand, the Brazilian rate has initially a decline reaching almost 10% (same level of the rate nowadays) and

then a steady increase which overtakes the wall of 14%. Thus, the volatility is strictly higher in the emerging economy which has a range of around 400 basis points.

September the 15th 2008, Lehman brothers declares bankruptcy. One of the biggest investment bank of the world collapse and the money market is shocked. Fed was able to contain the crisis through several actions like the "Money Market Investor Facility" and the "Commercial Paper Funding Facility"[23]. It's noticeable that the yield rate went down only from 4.00% to 2.25%. The brazil bond reacted in the opposite way in the immediate future and the interest rate jumped its maximum peak of the last decade reaching 17.30% in October, after that it followed the U.S. rate declining to 12.60% by the end of the year.

After the Lehman Brothers bankruptcy Fed decided to begin a period of UMP to ensure financial stability and to restore investors' appetite, as said in the previous section, through an asset purchase program. During all this period which goes from the early 2009 to September 2013 the yields rate of the two countries taken in consideration followed similar patterns. Brazilian bonds conserved the characteristic of having a higher volatility with respect to American bonds but despite of this fact the yields share a sort of co-movement.

In May 2013 the Chairman of the U.S. Federal Reserve Ben Bernanke introduced the hypothesis of a reduction in the asset purchase program, the famous "tapering talk". This event "triggered a sudden change in market expectations on the timing and pace of unwinding the quantitative easing (QE)"[24]. As result the 10-year U.S. treasury bond yield rose to 2.7% by the end of June and to 3 percent in early 2014.

Over the same period the impact on 10-year Brazil treasury bond yields was even larger with an increase of around 213 basis points compared to the 108 of the U.S. yield rate.

Another important moment that must be analysed is the raise of the interest rate by Fed in December 2015. As it is observable from the graph in the periods immediately before and after the Fed announcement regarding the rise in interest rate by 0.25% the Brazilian yield was extremely volatile. The rate reached a peak

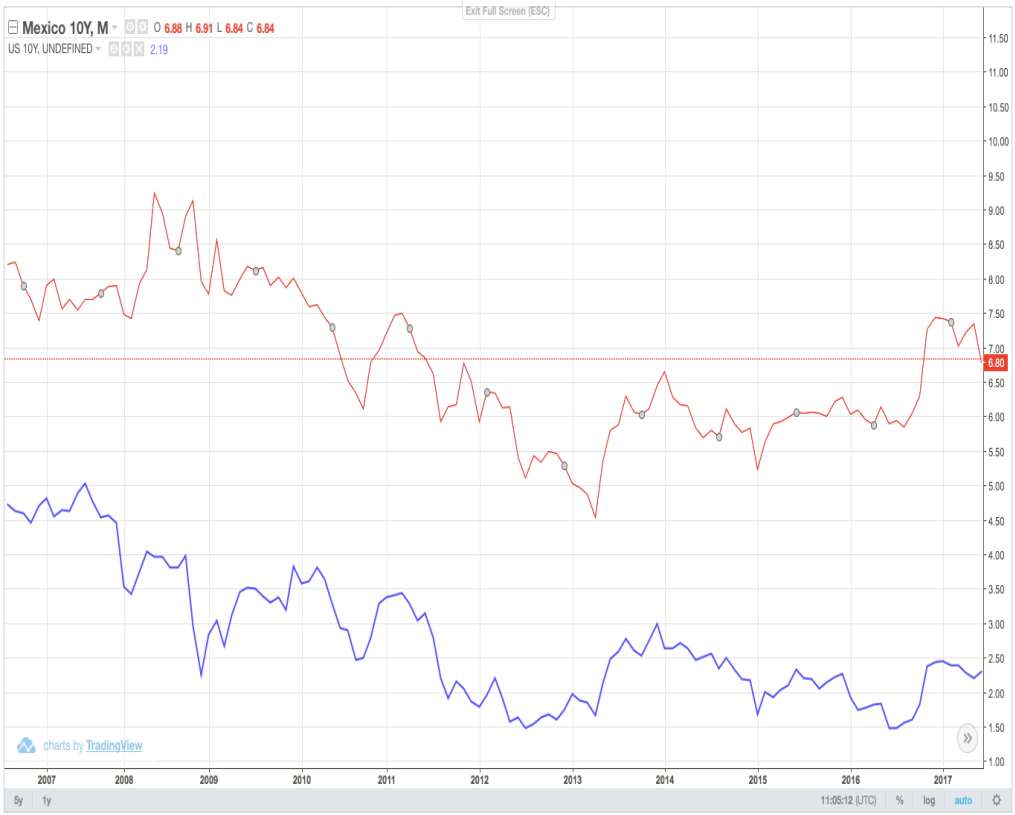
[23](Ball 2016) paper analyses the reaction of the Federal Reserve to the failure of Lehman Brothers in 2008

[24] (Carlos Góes 2017) is the paper taken as main reference explained in precendent notes.

of 16.50% after a 4 percent increase in 6 months and then fell deeply by 400 basis points after few months. After that announcement the rate of Brazil government bonds continued to decrease until the level at which it is nowadays and the American rate maintained its level of low volatility.

1.4.2 Mexico vs. USA

Figure 4



Source: Trending Economics[25]

In figure 4 we further proceed the analysis of the yield rates through the trends of the second country taken in consideration. With the blue line we identify the 10-year U.S. government bond (USGG10YR) as in the previous paragraph. With the red line we identify the 10-year Mexican government bond (GMXN10YR). It's observable the fact that the two lines follow very similar patterns for all the sample period (2007-2017), by the way we can figure out some important differences in the yields. The first remarkable point is during the year 2008/2009.

[25] Whenever a 10-year bond yield was missing, they have replaced missing values with the 9-year bond yield. As yield curves tend to have a log-function shape, the spread between 10-year and 9-year bonds is not too wide.

We can see the two main increases in the yield rate that occurred during the year are a lot bigger in the red line than in the blue line. The fluctuation of the Mexican 10-year government bond yield forms an accentuated "U" in the graph. On the other hand, the increases in the U.S. 10-year government bond yield it' s almost invisible.

A weird thing of the Mexican bond is that even if the increases during this year involved an elevated number of basis points, the decrease immediately after the bankruptcy of Lehman Brothers on September the 15th 2008 was not so steep and volatile.

After the financial crisis and the close out of Lehman the U.S. Federal Reserve started a period of Unconventional Monetary Policy. During all this period of almost 4 years the yield rates of the two countries followed practically the same route. This is given by the fact that Mexico is at the boundary of United States, so the vicinity of the two countries influences a lot the flows of goods and services between them.

The level of trade is estimated to be at around 579.7 billions of dollars in 2017. Thus, it seems automatic that the economy of the emerging market (Mexico) is pegged to the one of the advanced economy (USA).

A noticeable difference arises in the period of the taper tantrum. More specifically between May and September 2013 both the yield rate increased, but the increase of Mexican yield was significantly higher than the American one. The 10-year local currency Mexican bond had jumped by 180 basis points since May, compared with an increase of 108 basis points in the U.S. 10-year rate. This confirm what analysed in the previous paragraph, i.e. that emerging markets economies are more volatile than United States economy. After the period of the "tapering talk" the Mexican yield rate maintained its co-movement with the American yield except from 2/3 months after the Trump election in which the rates took slightly different direction.

II. EMPIRICAL ANALYSIS

2.1 Model Description

In this second section of the thesis we will go through a "Vector Auto Regressive" (VAR) model to find some empirical evidence from the analysis of the data, but before going into details of our regression we will have a look at the working paper considered as a reference for this work. The paper took as a model written by a research group of the International Monetary Fund analyses the transmission of changes in the U.S. monetary policy to local-currency sovereign bond yields of Brazil and Mexico during the 2010-2013 period. The IMF paper focuses on the movements of the yields immediately after the announcement of the tapering talk. Their study suggested that "emerging markets need to contend with potential spillovers from shifts in monetary policy expectations in the U.S., which often lead to higher government bond interest rates and bouts of volatility"[26]. More specifically, Gòes et al. (2017) paper study the impact of changes in the 10-year U.S Treasury yields (UST-10Y) on the Brazilian and Mexican sovereign yields of fixed-rate local currency bonds of comparable maturity. Through a Vector Error Correction Model (VECM) the IMF paper found that an increase in 100 basis points in U.S. long-term yields was followed by a rise of about 200 basis points in the long-term Brazilian rate after 6 months, and a 150 basis points increase in the case of Mexican rate over the same time frame. Moreover, they checked whether macroeconomic fundamentals were affected by U.S. Treasury yields interacting actively with spillover effect and amplifying it. The author concluded by saying that in addition they found some strong evidence in both countries of a long-run equilibrium relationship between the endogenous variables. We will make a comparison between the results of our work and this paper excluding the results arising from the VECM given the fact that in our analysis we only run a VAR model.

[26] (Carlos Góes 2017)

2.2 Data and Model Specification

DATA DESCRIPTION

Usually, models of long-term interest rates decompose the long-term yield into two main components. The first one is the risk premium[27], the second one is a component that via the lifetime of the security reflects the expected path of the short-term interest rates. But given the fact that we analyse countries which are globally integrated we have to extend this model controlling for global factors.

To construct a reliable econometric model, I selected different variables. I based the selection of these variables on the existing literature of the topic like Moore et al. (2013) who measured the impact of large scale purchase of assets by Fed on local yields through event study, Miyajima et al. (2012) whom analyse the importance of domestic and external factors in dictating the dynamics of the EM local-currency bond yields and finally on Gòes et al. (2017) which I took as a main reference.

In our model we run two VAR regression, one for each country. The variables that are both used in the regressions are:

- VIX (***v)***: The market Volatility Index (VIX) of the Chicago Board Option Exchange for bidding ask quotes of options that have the S&P 500 index as underlying, which is a valid proxy for global risk aversion;
- USGG 10YR ***(u)***: which is the generic time series for yields of U.S. Treasury bonds with maturity of 10 years. This proxy conceptually includes the world real interest rate, expected U.S. inflation, a term premium and provide the benchmark for different fixed-income instruments from corporate to mortgages.

The individual variables for each country are:

- CDS Spread ***(c)***: the spread measured in basis points of the 10-year Credit Default Swap USD contract for emerging country, which measures investors perception of country risk. This turns out to be a good proxy for the absolute

[27] The risk premium of a bond can be composed in different factors, including a term premium, a credit risk premium a currency risk, a premium for preferred habitat, and the supply of long-term bonds in the market. These may reflect variations in market liquidity, regulatory incentives and the received credit-worthiness of the sovereign.

risk of investing in that specific country;

- Local 10Y ***(l)***: Local currency yields for sovereign bonds with residual maturity of 10 years expressed in percentage;
- Policy Rate ***(p)***: Annualized short-term policy rate set by the individual central bank for overnight interbank loan. This rate provides measures for term premium inflation differential;
- Implied Volatility of Exchange Rate ***(i)***: Implied volatility of one month ahead foreign exchange option. It is a good proxy in order to capture the short-term currency risk premium.

Most of the data are available on daily frequency, but given the fact that our sample size (May 2009- May 2017) is quite large I opted for the analysis of monthly data. This in order to avoid computational errors. Moreover, monthly frequency allowed me to eliminate the gaps created by missing daily data of some variables like the 10-years Brazilian government yield and the corresponding Mexican government yield of same maturity.
Constructing a continuous time series for local currency bonds is not so easy because bonds have fixed maturity date. Having a fixed maturity, means that the days are decreasing over time. Our variable ***(l)*** is the rate for bonds with periodic payments until maturity, so in order to construct a good time series we need to account the yields of different bonds with different maturity during our sample size.

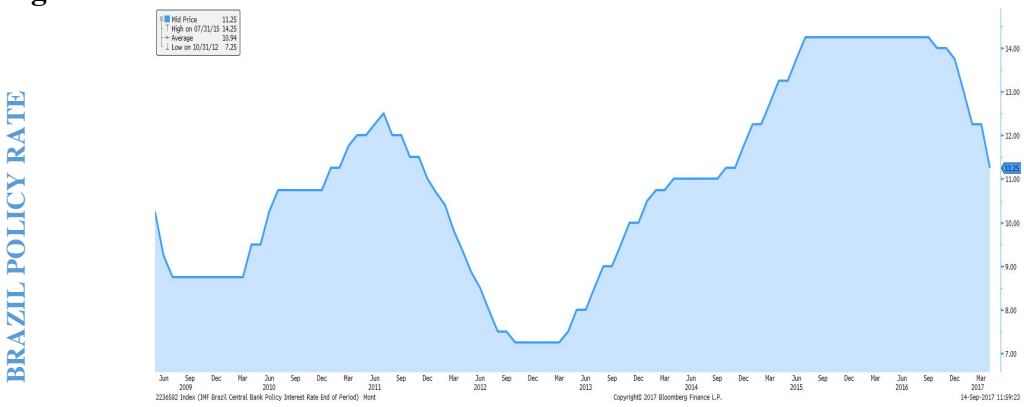
The simplest and best way to construct consistence data for our regressions is to use the Bloomberg's generic 10-year bond yield time series for a given country. Bloomberg automatically switches between different underlying securities and reports the yield to maturity of the outstanding bond whose length to maturity is closest to 10 years. This method works quite well for highly liquid markets like the one of United States and the one of Mexico because there will always be an underlying security with approximately 10 years until maturity.
However, is not the same thing for Brazil as the country has a less liquid market in terms of local-currency sovereign yield. Thus, the 10-years sovereign yield relies on approximations in absence of specific nodes in the sovereign yield curve. In particular, in absence of data we use the 9-year sovereign bond yields

to construct the time series. Considering the fact that as the yield curve tend to have a long-term shape, the spread between the 10-year and the 9- year bonds is not too relevant. All others data on specific variables were easily found in the Bloomberg platform.

We will now go through the Bloomberg' s time series to have a more detailed view of the factors used in the regression.

Brazil: Domestic Time Series

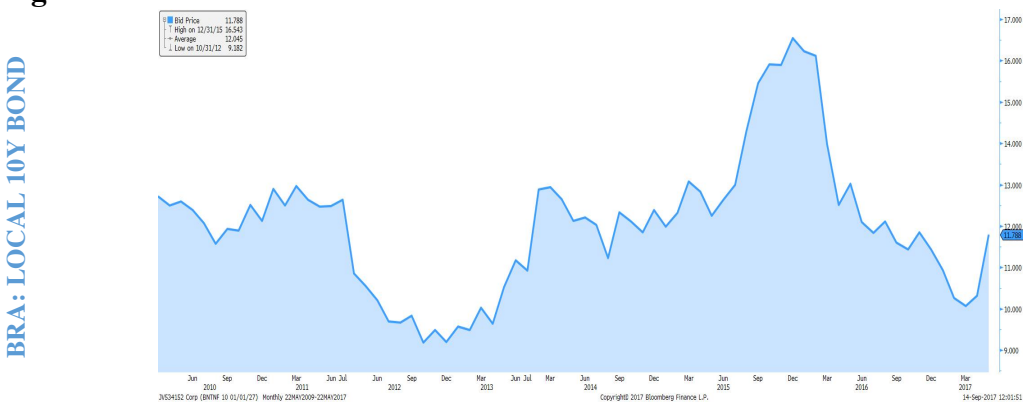
Figure 5



Source: Bloomberg

As we can see from figure 5 the brazil policy rate is stable from May 2009 to May 2010. After this period of stability, the rate increases up to 12% until September 2011 and then decrease vertically down to 2.5 percent in December 2012. In march of the following year the brazil policy rate begins a constant increase reaching a peak of 14% in June 2015. After being stable for 16 month the rate was subject to two consecutive decreases in the last trimester of 2016 and in the first trimester of 2017 which led the rate to 11.25 percent.

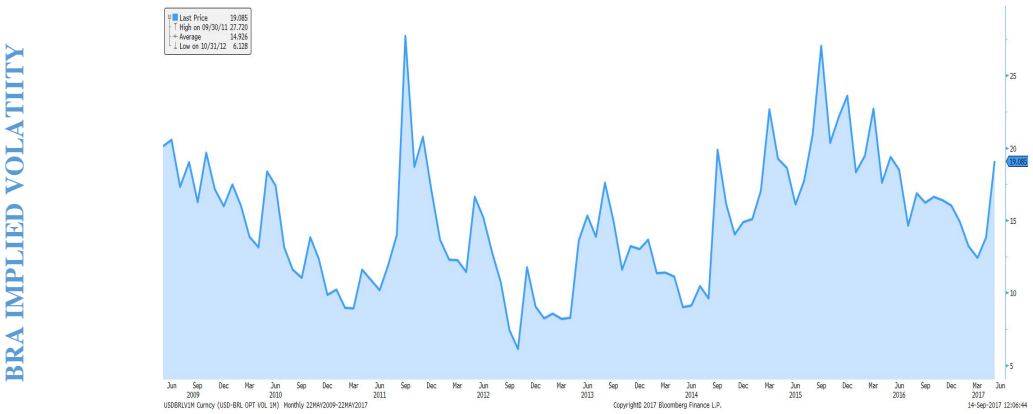
Figure 6



Source: Bloomberg

The Brazilian 10-year generic government yield in figure 6 started a period of fluctuation in June 2009 of around 70-80 basis points until July 2011, month in which the rate decreased significantly down to 9.5%. In March 2013 the yield rose by 2.5 percentage points and fluctuates for almost 24 months. After this period of fluctuation, the rate rose sharply to a peak of 16.5% in March 2016, followed by a straight decline to 11.7% in December of the same year which is the same rate of the last month surveyed.

Figure 7

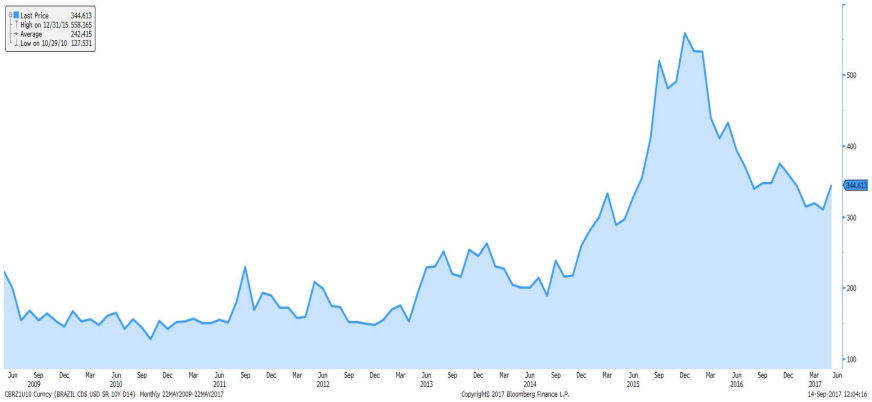


Source: Bloomberg

It' s noticeable that Brazil 1 month implied volatility of exchange rate with USD illustrated in figure 7 begun a period of decreasing fluctuation from June 2009 to March 2011. Passing from 20 percentage points to less than 10%. In June 2011 the volatility rate bumped by almost 15 percentage points reaching an historic peak of 27%. After this period two consecutives decreases brought the rate at his lowest level in September 2012 at 6.5 percentage points. In the second semester of 2013 the rate gained at least 8 percentage points. Starting from January 2014 the 1 implied volatility of exchange rate was subject to a period of up and down which ended in June 2016 with a rate of 13.5 percent. For the following year the rate went down and then surprisingly rose up, closing in June 2017 at a little bit more than 19 percent.

Figure 8

BRA CDS SPREAD



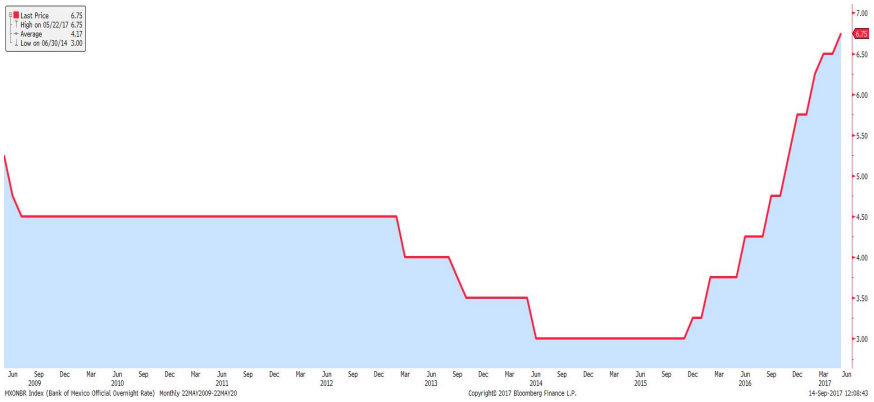
Source: Bloomberg

The Brazilian Credit Default Swap Spread rate (figure 8) seems the less volatile but if we closely look at the Y axis we can notice that the numbers among spaces are very large so a small change in this rate are equivalent to big fluctuations, in terms of percentage points, in rates of other figures. It' is remarkable that after an initial decrease the CDS spread fluctuated by an average of 25 percentage points from July 2009 until July 2011. After this period followed a similar period characterized by larger fluctuations, on average of 100 basis points, which ended in September 2014. From early December the rate was subject to two consecutives steady increase which reached an historical peak in December 2015 at 562 percent. Afterwards the spread decreased constantly, reaching in June 2017 a level of 344%.

Mexico: Domestic Time Series

Figure 9

MEXICO POLICY RATE

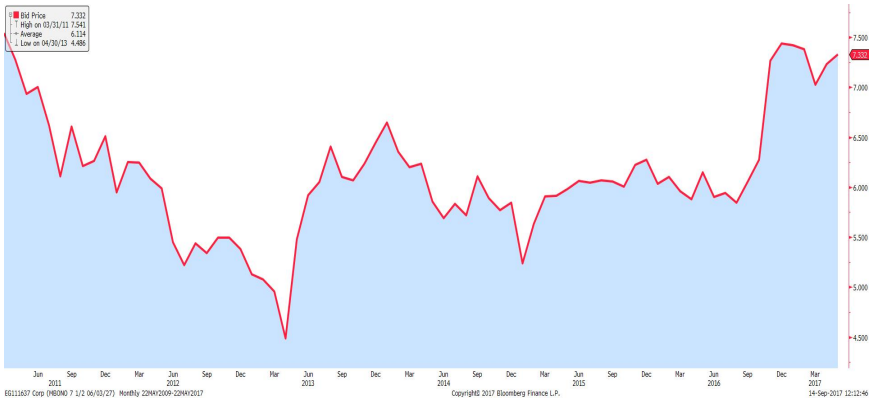


Source: Bloomberg

As we can see in figure 9 the Mexican policy rate has a particular trend. After a small decrease in June 2009 the rate remained unchanged for a long period. More precisely, the rate was fixed at 4.5% from September 2009 to March 2013. Starting from this period the rate was subject to three declines of same weight leading the rate at 3 percent in June 2014. The policy rate remained stacked at this percentage for 18 months. In December 2015 begun a period of constant increase which led the rate to 6.75% in June 2017.

Figure 10

MXN: LOCAL 10Y BOND

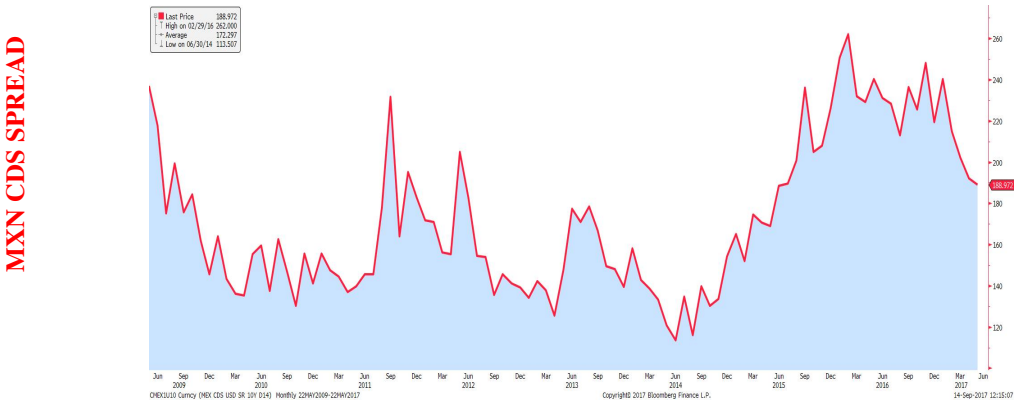


Source: Bloomberg

In figure 10 above is illustrated the trend of the Mexican 10-year government bond. Bloomberg have missing data for this index, so the graph start from the beginning of 2011 instead of starting from May 2009. However, we completed the time series in our excel table where monthly data were used to run the

regression with data from other sources like Ycharts and trendingeconomics[28]. By initializing our analyses in March 2011 we can figure out that the Mexican yield had a period of decreasing up and down until April 2013, where the yield reached 4.5 percentage points after two significant decreases. In May 2013 the rate rose sharply by 200 basis points and then fluctuated by maximum 1 percentage point until August 2016. From that moment the rate was subject to a vertical increase and closed at the end of March 2017 at 7.33%

Figure 11

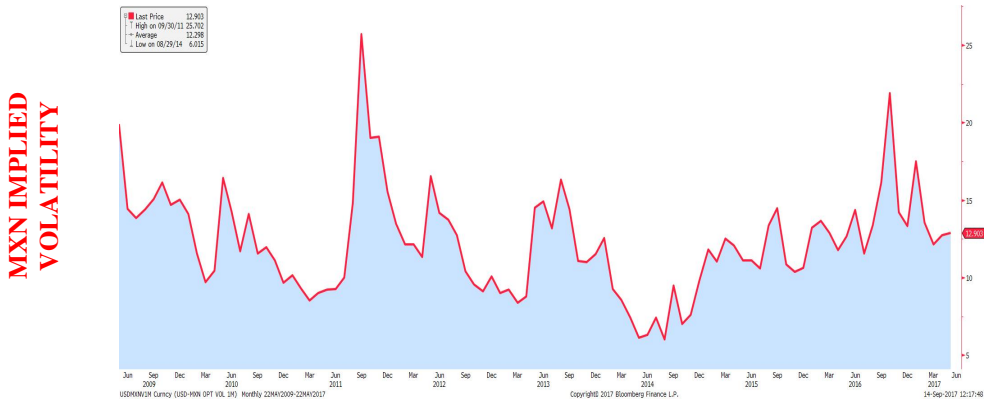


Source: Bloomberg

By simple looking at the Mexican Credit Default Swap with USD in figure 11 it's remarkable how much the index is volatile. Beginning in May 2009 at around 240% the index was subject to a decrease lasting 25 months which led the rate to 147 percentage points. After that period the rate between June 2011 and June 2012 had to positive peak, one at 225% and the other at 212%. After an important decrease during the second semester of 2012 the index re-bumped to 185 percent. Onwards the rate reached its historical low in June 2014 at around 108 percentage points. From that moment the index followed a general increase made of ups and downs. In January 2016 reached its maximum peak at 262 percent and closed at 190 percent in May 2009.

[28] Data were adjusted manually in the excel table to avoid holes which would have led to miscalculations and errors during our regression run in Rstudio, without this operation the regression would have been busted.

Figure 12

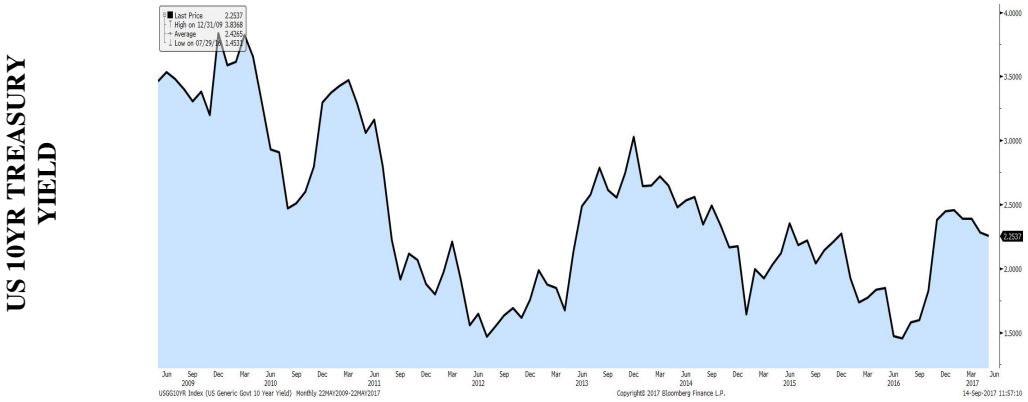


Source: Bloomberg

In figure 12 the Mexican Implied Volatility of 1 month Exchange Rate with USD is represented. The index started in May 2009 with two similar decreases in 9 months. After the second decrease in February 2010 the rate was characterized by ups and downs reaching 8% in March 2011. In September 2011 the rate jumped dramatically to its historical high at 25 percentage points. Afterwards it followed two periods of decrease alternated to two periods of increase which led the rate to the identical percentage of 16.5 first in June 2012 and then in August 2013. In the following period the rate was subject to a decrease reaching 5.7% in July 2014. Finally, for the remaining two years and a three fourths the rate increase constantly, closing at 12.9% in May 2017

Global Time Series

Figure 13



Source: Bloomberg

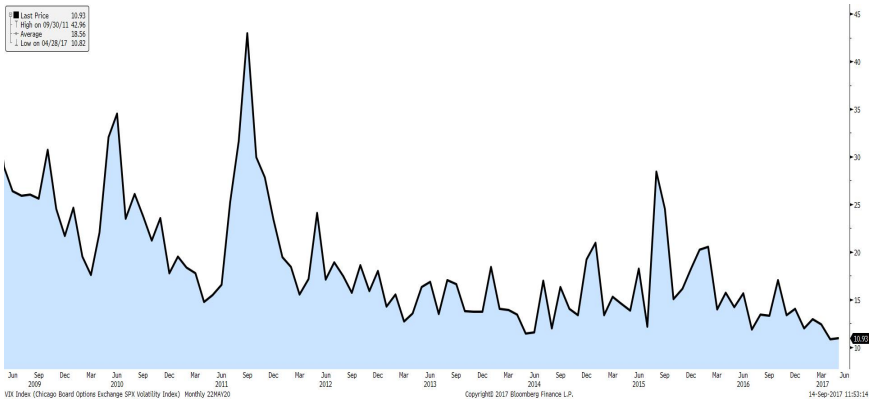
In figure 13 and figure 14 we can see the different trends of the global time series.

In the first figure is illustrated the U.S generic 10-year government bond rate[29]. It' s remarkable how the level of the yield is high in the period immediately after the beginning of the financial crises. Beginning with a rate of 3.5% in May 2009, after two peaks in December of the same year and March 2010 the yield decreased dramatically, reaching 2.5 percentage points in September 2010. After that low, the rate rose again in March 2011 and decreased substantially, by at least 170 basis points in September 2012, touching 1.5%. During the whole 2013 the rate grew constantly up to 3 percent in January 2014. From that moment onwards the rate decreased at a slow pace with two points of negative peak, the first in February 2015 and the second in July 2016 when the historic low was reached at 1.47 percentage points. Between September 2016 and May 2017 the yield increased by 88 basis points closing at 2.25%. f

[29] We used the generic time series furnished by bloomberg because it is the best way to account yield with decreasing time to maturity. This function automatically plots underlying securities with maturity closest to 10-year.

Figure 14

VIX



Source: Bloomberg

Above in figure.. it is possible to see the Volatility Index of the Chicago Board of Trade. This Index is constructed by including the implied volatility of a wide range of index options from S&P 500. This index is forward looking because implies market's expectation of 30-day volatility and is considered as a global index of volatility. As we can see from the figure it's remarkable the number of ups and downs in this index which with difficulties follow a constant rate. It's noticeable in the first period hoe the rate decreased firstly in December 2009 from 30% to 22.5% and secondly in March 2010 from 25 to 17.5 percentage points. The rate then increased again in June 2010 and fell down to 15% in March 2011. In June of the same year the index jumped sharply, reaching its maximum peak at 43 percent in September 2011. It then decreased significantly for the end of the year. From June 2012 to June 2015 the index fluctuated around a constant mean of around 15 percentage points, without large changes. In September 2015 the rate doubled passing from 15 to 30 percent and then decreased again in from March 2016, closing in May 2017 at 10.9 percentage points.

MODEL SPECIFICATION

In our analysis we estimate a Vector Auto Regression (VAR) model, taking the first difference of all the endogenous variables in order to confirm their stationary properties. The model is specified in the equation (2) below:

$$\Delta Y_t = \sum_{i=1}^{p} A_i \Delta Y_{t-1} + C + \in_t \qquad (2)$$

where $Y_t \equiv [\boldsymbol{v, u, l, p, c, i}\,]'$ is a *m*-dimensional vector of endogenous variables. A is a *(m* x *m)* matrix of coefficients determining the dynamics of endogenous variables; C is a vector of constants; $\in$ is a vector of error terms.

In order to better understand the results of the VAR model we calculate the Impulse Response Functions (IRFs) of the endogenous variables. Accumulating IRFs permit us to clearly view the impact of the variables among them.

Before looking at the Impulse Response Functions to evince some baseline results we have to do some estimation of the data to check if they fit our model.

2.3 Pre-estimation Tests

Stationarity of Data

The stationarity of data is fundamental for a time series analysis like the Vector Auto Regressive model. A stochastic process y_t is said to be *stationary* if it has time –invariant first and second moments. In other words, it has to satisfy this two conditions:

I. $E(y_t) = \mu_y$ for all $t \in$ T and

II. $E[(y_t - \mu_y)(y_{t-h} - \mu_y)] = \gamma_h$ for all $t \in$ T and all integers *h* such that *t-h* $\in$ T.

The first condition means that all members of a stationary stochastic process have the same constant mean. Thus, the time series generated by this stochastic process must fluctuate around a constant mean. The second condition ensures

that the variances, for example for h=0 the variance $\sigma^2 = E[(y_t - \mu_y)^2] = \gamma_h$ does not depend on t, are time invariant. Moreover, the covariances $E[(y_t - \mu_y)(y_{t-h} - \mu_y)] = \gamma_h$ do not depend on t, but just on the distance in time h of the two members of the process[30].

The first step to see if the data fit in the regression is to test the p-values of the Augmented Dickey- Fuller (ADF). The ADF test the null hypothesis of a unit root in a time series sample against the stationarity of the process. The results are reported in the following table (2).

Table 2.

Augmented Dickey-Fuller Unit Root Tests

	p-values	
	Brazil	**Mexico**
VIX	0.03**	
U.S. 10Y	0.20	
Policy Rate	0.47	0.04**
Implied Volatility	0.56	0.10*
Local 10Y	0.24	0.34
CDS	0.62	0.95

Null Hypothesis: variable has a unit root

Significant at 10% (*); 5%(**); 1% (***) levels

Source: R calculations

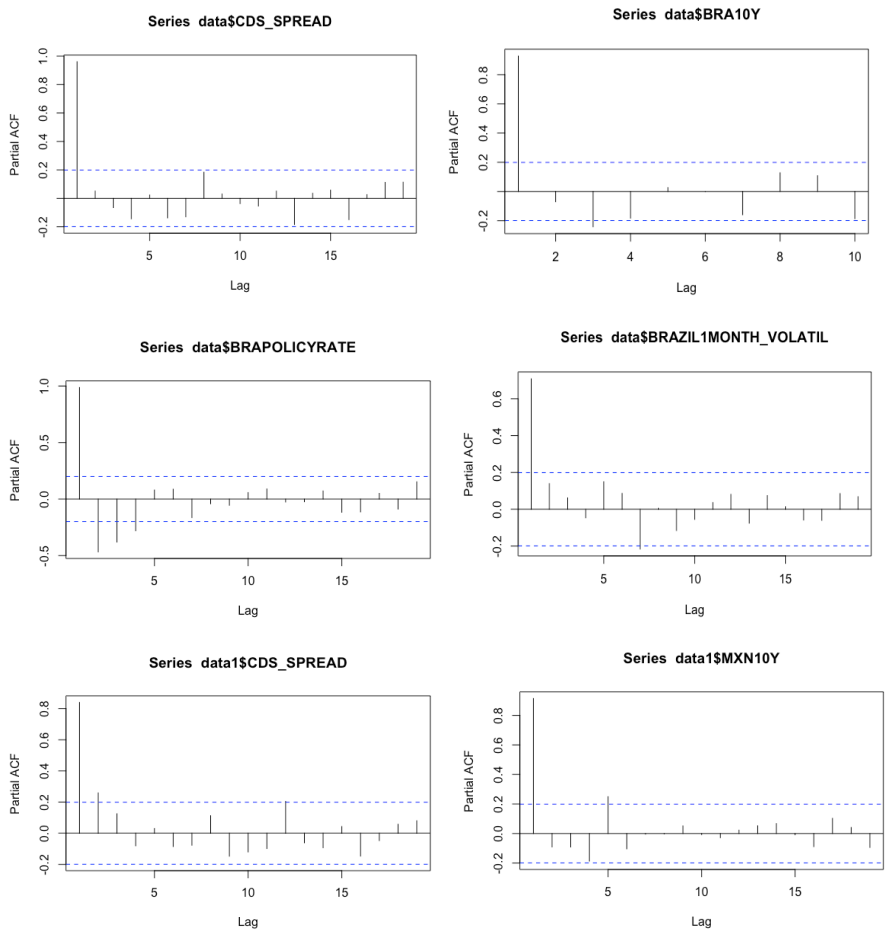
Augmented Dickey-Fuller Unit Root Test (Dickey & Fuller, 1979) rejected the

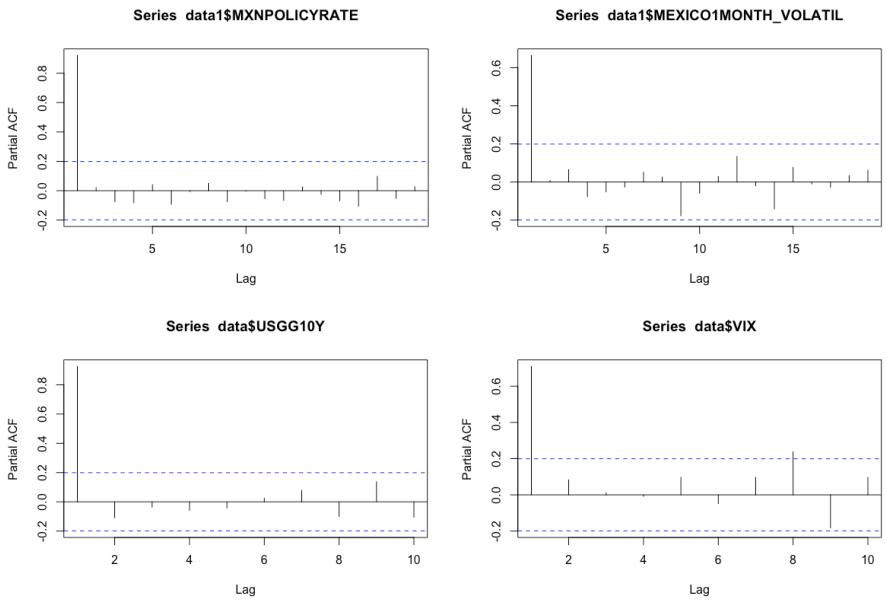
[30] (Helmut Lütkepohl 2004) is the main book taken as a reference for the econometric part. In which all the tests about the data and information about the VAR are discussed.

null hypothesis of a unit root for the VIX (***v***) in the 99 percent confidence interval. For the Policy Rate (***p***) the ADF test rejected the null hypothesis at the 5% level only for Mexico. Moreover, for the Implied Volatility of Exchange Rate (***i***) the null hypothesis is rejected at border line results for Mexico whether it is not rejected for Brazil. The tests for all other variables do not reject the null hypothesis of unit root in the 90 percent confidence interval.

It is not always easy to see from ADF test if it is reasonable to assume stationarity of time series. Therefore, it is useful to consider some statistics related to time series. One possibility is to look at partial autocorrelation of time series. The partial autocorrelation between y_t and y_{t-h} is the conditional autocorrelation given $y_{t-1}, \ldots, y_{t-h+1}$, that is, the autocorrelation conditional on the in-between values of time series. By looking at PACFs (figure 15) we can establish the lag of our autoregressions.

Figure 15





Source: R calculations

It is remarkable that almost all variables have a strong autocorrelation in lag 1, which is typical of time series data, apart from Brazil Policy Rate (***p***) and Mexican spread for CDS (***c***) which present some lags out of confidence interval. The analysis of partial autocorrelation functions suggests us that all the variables should be considered as *stationary*. Moreover, it is also noticeable from figure 5 that one lag should best fit in our regression.

One more way to see how many lags we should use in our regression is through the AIC test. Akaike's Information Criterion or more easily AIC is an index used in econometrics to choose among competing models. The index takes into account both the number of parameters that have to be estimated in order to achieve a particular degree of fitness and the statistical goodness, by imposing a sort of penalty if the number of parameters increases. Lower value of the index indicates the preferred model, the one with fewer parameters which should best fit the data[31]. The results of the test are always negative, so by looking at simple numbers we will have an idea about the right number of lags that will best fit the regression. Table 3 confirm what suggested by the PACFs.

[31] (B. S. Everitt 2010) Is the book considered as a bible for the elaboration of data and theorem regarding the statistics and econometrics models.

Table 3.

Aikake's Information Criterion

	values	
Number of lags	**Brazil**	**Mexico**
One	-1184.45	-1262.14
Two	-1158.40	-1220.26
Three	-1105.64	-1174.95
Four	-1072.58	-1165.98

Source: R calculations

The number of lags suggested by both PACFs and AIC is one. Therefore, we use one lag in our VAR model.

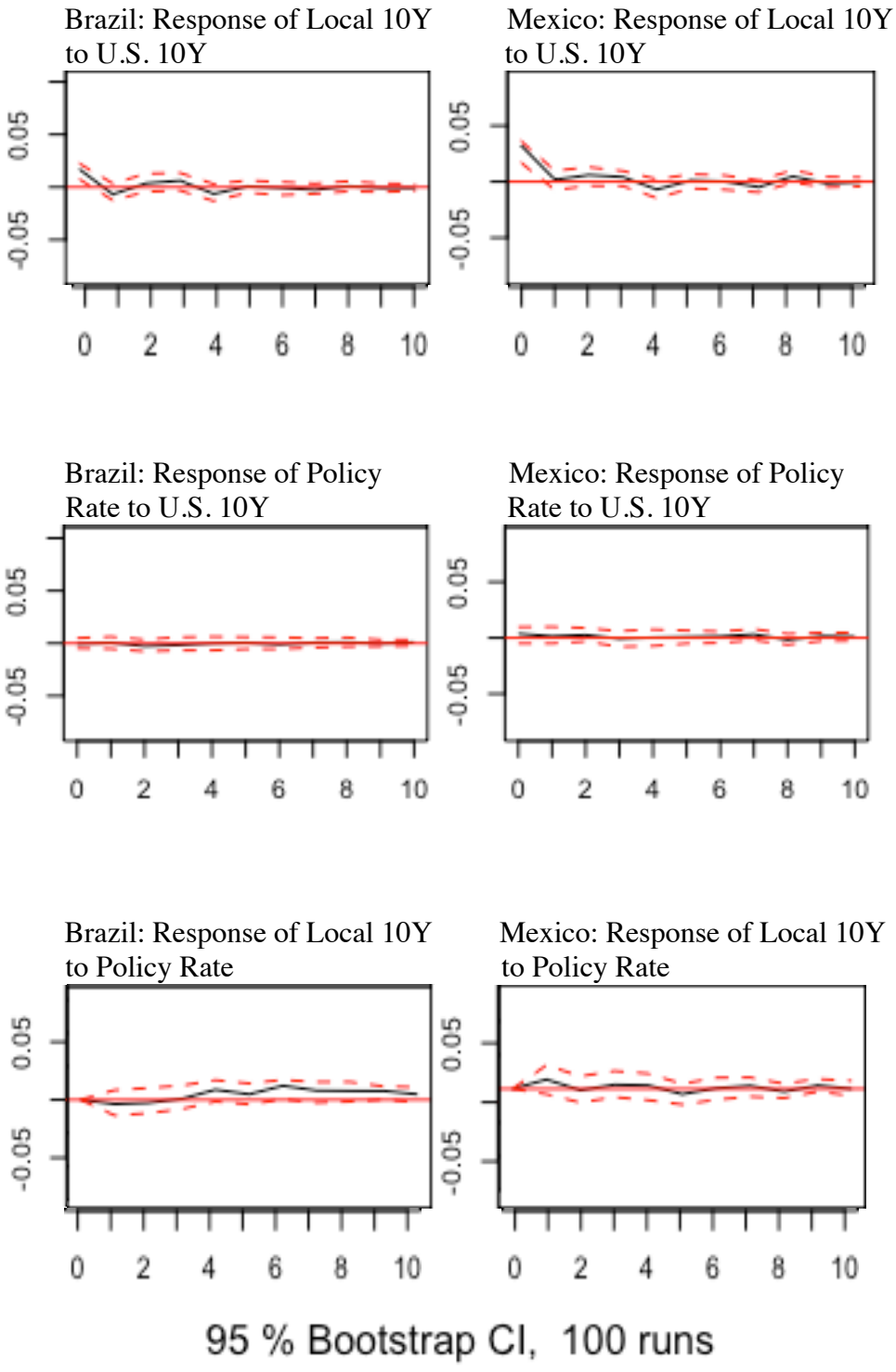
2.4 VAR Estimation

As said at the beginning of the chapter our empirical analysis is based on a Vector Auto Regressive (VAR) model. After having specified the model and calculated our pre-estimation tests for the fitness of data we analyse the results of the regressions. The best way to analyse these results is by looking at the impulse response functions (IRFs) of the VAR model (figure 6).
We focused particularly on the following IRFs: (a) the response of local currency 10-year sovereign bond yields to changes to the U.S. 10-year bond yields; (b) the response of the policy rate of the two emerging market to changes in the U.S. 10-year bond yields; and (c) the response of local currency 10-year sovereign bond yields to changes in the policy rate of the respective country. The boot-strapping method has been applied and the cumulative responses were based to identical shocks of 100 basis-points. The shaded lines represent the 95% confidence intervals of the relative variables.

It is possible to see how the countries reacted to these shocks in similar manners. The impact that we were expecting was for sure higher than the actual impact that the model predicts. But let's go more in detail. The impact of the Brazilian 10-year sovereign yield is estimated to be around 25 basis points (0.025%) immediately after a 100 basis points shock in the U.S. 10-year bond. Between the first and fourth month the impact is then significantly lower and tend to go to zero after the fifth month. If we look at the corresponding IRF of the Mexican yield we can see that the impact is significantly higher immediately after the initial shocks, it is around 45 basis points. Differently from Brazilian sovereign yield, it tends to oscillates more around zero in the following periods and tend completely to zero after 8 months.

By looking at the Brazilian and Mexican policy rate responses to the 100 basis points shock is easy to figure out that the reaction for both countries is practically zero. This means that the two policy rate do not react to the changes in the U.S. 10-year bond yield.

Figure 16



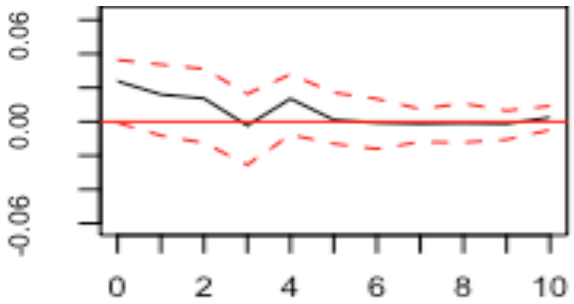
Source: R calculations

Furthermore, if we continue our analysis from the last to graphs of figure 16 we can have a look at the impact on the local 10-year sovereign yield with respect to changes in the local policy rate. The impact in Brazil is initially negative, but very small until the third period when the response function starts to have a positive shape. In the fourth month the response is about 15 basis points whether after 6 months is around 20 basis points. The impact of the shock is quite different in Mexico where it takes a positive shape of 10 basis points in the first period and then tend to decrease and fluctuate by few basis points in the following months.

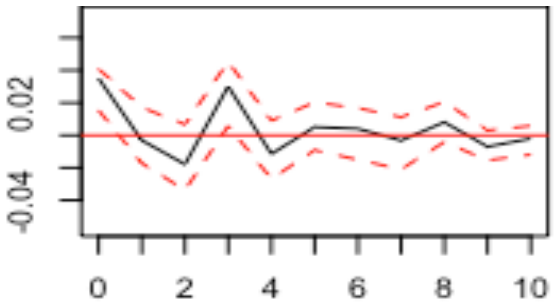
The entire VAR model is affected by the initial shock of the 10-year U.S. Treasury yield, this means that the impulse response functions reflect also the interactions among all other variables and not only the effect of the U.S. Treasury yield change. For example, a rise in Treasury yields could signal a broad tightening in global financial conditions and consequently an increase in the sovereign CDS spreads in EM. That's exactly what IRFs below (figure 17) suggest us.

Figure 17

Brazil: Response of CDS Spread to U.S. 10Y



Mexico: Response of CDS Spread to U.S. 10Y



95 % Bootstrap CI, 100 runs Source: R calculations

Impulse response functions of figure 16 arise from our VAR model in which, the impact of a 100 basis shock to U.S. 10-year Treasury yield is measured, in this case, on the 10-year Spread of Credit Default Swap measured in USD.

In Brazil's case it is noticeable how the CDS Spread is affected by a rise of 35 basis points immediately after the shock then it tends to zero until the third month and jump up to 20 basis points shift in the fourth month. After that it tends to zero for the following periods.

On the other hand, if we look at Mexico response of CDS Spread we can see that the immediate impact of the shock results in an increase of around 40 basis points, followed by a negative impact down to minus 15 basis points. In the third period the impact returns in positive shape reaching 30 basis points and then oscillates around zero for the remaining periods.

Conclusions

In this paper we examine how changes in U.S. monetary policy affected the two sovereign bond yields of Mexico and Brazil. Our analysis focused on the 10-year U.S. Treasury Yield, that is considered as the more representative factor of the Fed monetary policy, and the corresponding sovereign bond yields of same maturity of the two EM considered.

Using Vector Auto Regression model we found that Mexican yield was more sensitive than the Brazilian one to the identical shock of 100 basis points in the U.S Treasury Yield. Our econometric results also suggested that both Brazilian and Mexican Policy rate were indifferent to the same shock. Local 10-year sovereign yields showed little responsiveness to the changes in the countries relative Policy Rate. However, in this case Brazil local 10-year sovereign yield was more sensitive than the respective Mexican local yield of same maturity.
Moreover, we also took in consideration the impact of CDS Spread to a 100 basis points increase in U.S. 10-year Treasury Yields. This choice was made to demonstrate the importance of all factors in determining spillovers effect. In this case we found that both spread reacted in similar manners to the initial shocks.

If we make a comparison between our results and the results of the paper taken as a model Gòes (2017) we can easily evince the main differences between the two Vector Auto Regression models. Impulse Response Functions of the IMF paper showed a different reaction of local 10-year government bond yield to shocks in U.S. 10-year treasury yields and local policy rates. The impact was much larger and the predictions of the model overshot actual rates. Thus, the results of the paper suggested a high level of spillover among these countries. On the other hand, our results arising from the IRFs showed a lower impact on the local 10-year government bond and local policy rate of Brazil and Mexico which were subject to identical shocks of 100 basis points used in the paper. Therefore, our results suggested the presence of the spillover effect but in a significantly lower proportion with respect to the paper taken as a model.
The striking difference between the results is due to two reasons, the sample size of our regression and the omission of a variable. The VAR model run by the IMF

considers a small period, the period immediately after the announcement of the taper tantrum, plotting in the regression daily data of similar factors. Our model considers a much larger period (2009-2017) with monthly data so the difference is substantial. Moreover, we decided to exclude one variable from our regression because we could not access it, given the fact that the variable was a specific index elaborated by J.P. Morgan and our Bloomberg terminal does not have the authorization to access those data.

To conclude we can say that our expectation on reactions of the emerging markets were strictly higher than the results obtained. This model with a large and updated sample period suggested us that the spillover effects are still present in the markets but their own effects are due to a group of factors which are in strong connection with each other and interact among themselves. Probably, after the financial crisis and the period of QE by Fed emerging markets like Mexico and Brazil have strengthened their macro and financial fundamentals, building solid criteria to face off periods of financial instability. Therefore, the specific spillover effect taken in consideration has decreased significantly during the last years suggesting more "independence" from United States for both Brazil and Mexico.

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