The Decomposition of the Impact of International Monetary Spillovers to Emerging Market Economies

Francisco Eduardo Luna A. Santos

Márcio G. P. Garcia

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The decomposition of the impact of international monetary spillovers to emerging market economies

Francisco Eduardo Luna A. Santos
Institute for Applied Economic Research
Macroeconomic Policy and Studies

Márcio G. P. Garcia
Pontifical Catholic University of Rio de Janeiro
Department of Economics

Abstract: Using monthly data between January 2002 and September 2017, we decompose US monetary spillovers to interest rates and foreign exchanges of four EMEs: Brazil, Chile, Colombia, and Mexico. Our estimates point to larger US monetary policy spillovers after the Global Financial Crisis (GFC) in Brazil and Colombia, while Chile presents a higher degree of monetary autonomy. In Mexico, we identify large and stable monetary spillovers in the sample period. The impact on the currency market is smaller, in general, expect in Brazil, whose currency presents a higher sensitivity to variations in US interest rates. Our findings suggest central banks adjust the response of domestic monetary policy to counterbalance spillover effects on the currency market but this is not an effective strategy.

Keywords: Emerging markets, interest rates, foreign exchange rates, international spillovers, identification.

1. Introduction

How international monetary spillovers are transmitted to financial markets in EMEs? Answering this question is important to understand how policymakers react to spillover situations and to project its impact on the economy. Our research is motivated by the ongoing discussion of whether or not monetary autonomy holds in inflation targeting (IT) regimes and by strong market reactions over news on US monetary policy decisions. As a matter of fact, central banks consider the international scenario in their decision-making process and usually desire to avoid large changes in interest rate differentials that could lead to outburst of capital flows and/or excessive currency variation. While the co-movement between domestic rates, currencies and global rates is worth noting, alone this is not an evidence of the presence of monetary spillovers since it could the result of synchronization of business cycles.

In this paper, we are particularly interested on the decomposition of international monetary spillovers as we look at the impact of US monetary spillovers on interest rates and foreign exchange markets between January 2002 and September 2017 on four EMEs: Brazil, Chile, Colombia, and Mexico. In our baseline model, we develop a multi-stage econometric approach designed to address the inherent methodological challenges posed by measuring international spillovers. We extend the analysis of Caceres, Carrière-Swallow and Gruss (2016) to incorporate exchange rates in a structural VAR setting, where identification and the decomposition of spillovers are obtained through a rules-based monetary policy framework, while exchange rate components are depicted through a portfolio model on the spirit of Blanchard et al (2016). This approach generates the following spillovers components: expectations and monetary spillover components for the determinants of spillovers on interest rates; external and domestic spillover components for the determinants of spillovers on exchange rates.

First, we split the analysis into sub-samples, defining the Global Financial Crisis as the structural break. We find that Brazil and Colombia share similar reactions to shadow rate shocks. Regarding monetary spillovers, we can note a remarkable upward shift. After GFC, a
25-bps shadow rate shock increase interest rates by 10.8 bps and 7.4 bps in Brazil and Colombia respectively, while they were negative before GFC. Those are the only countries where shadow rate shocks impact interest rates through inflation and output expectations. Concerning the impact on exchange rates, we identify a remarkable shift in the external spillover component. A 25-bps shadow rate depreciates Brazilian and Colombian currencies by 2.63% and 1.89%, respectively. Given the relative magnitude of the domestic spillover component to the exchange rate, we conclude that monetary spillovers were not powerful enough to play the “leaning against the wind” role in the exchange rate markets. All in all, we show that Brazil and Colombia present only partial monetary autonomy as we find the presence of sizeable monetary spillovers. The substantial use of FX interventions in both countries can be seen as anecdotal evidence of the failure of domestic interest rates to offset external spillovers. In Mexico, we identify large and stable monetary spillovers across sub-samples. In terms of exchange rate impact, the depreciation of the exchange rate due to a US monetary shock of 25-bps is small. After GFC, though, we find that shadow rate appreciates Mexican currency. We conclude that Chile presents a higher degree of monetary autonomy and smaller currency market volatility. We find that monetary spillovers are lower than its counterparts, and more importantly, it is stable across sub-samples. We also identify that spillover components to Chilean currency are weak.

These findings suggest that as the United States normalizes its monetary policy with the liftoff of its policy rate, emerging economies will face sizeable interest rate spillovers to domestic interest rates. However, even if central banks adjust the response of domestic monetary policy to avoid excessive fluctuation in the level of exchange rates, we find that such strategy is inefficient and could potentially induce excessive volatility in domestic expectations and jeopardize monetary policy conduct in EMEs.

We also perform time-varying estimates in order to assess the robustness of our results. In general, it confirms the conclusions of the sub-sample analysis on the dominance of the monetary spillovers and external spillover components. Besides, it identifies the tapering announcement in 2013 as an event that notably impacted spillovers components. Apart from periods of noise and jumps, the overall evolution of each component is well-behaved as the signs align with our previous results. That said, it is not right to interpret each component as if they are valid at any point in time. As we are ultimately interested in assessing the level of stability of our models, we acknowledge that responses diverge to some extent. However, we claim that this divergence is consistent with the subsampling exercise in many ways and they do serve as a guide for macroeconomic analysis and for our specific purpose of decomposing the impact of international monetary spillovers to exchange rates and interest rates.

Past empirical papers relied on specific events (the tapering announcement in 2013, in particular), while others analyzed spillovers only to interest rates (Chen, Mancini-Griffoli and Sahay (2014)) or exploited correlations between US and foreign financial markets (Aizenman, Chinn & Ito (2016)). To our knowledge, this is the first paper that offers a method to decompose spillovers in the exchange rate and interest rate markets and test its evolution dynamically. Accordingly, the novelty of the paper is to provide evidence on the changing dynamics of the impact of US monetary policy on both exchange rates and interest rates, which may have experienced a major discontinuity after GFC with the extensive use of unconventional monetary policy. Notably, spillover decomposition amplifies the understanding of central bank reaction functions and offers the means to evaluate spillovers through different channels of transmission.
The remainder of the paper is organized as follows. In Section 2, we review the literature on international monetary spillovers. Section 3 presents the models for the decomposition of interest rates and exchange rates. Section 4 briefly presents background information and preliminary analysis of the data for each country. It also gives details of the construction of the database. Then, we explore the methodology in Section 5 and discuss the results in Section 6. Finally, Section 7 contains our concluding remarks.

2. Monetary policy and international spillovers

In the beginning of the nineties, emerging market economies (EMEs) were under severe scrutiny by investors worldwide. Although the origins of the malaise could differ country by country, all of them shared the same symptom: a shortage of capital, whether it domestic or external. Pushed by the need to solve capital constraints, EMEs adopted a set of macroeconomic reforms that included but was not restricted to the openness of the capital account. Since then, they have enjoyed the many benefits of heavy capital inflows but they also have proved the bad taste of its sudden reversals. In a globalized economy with increasingly integrated markets, one cannot fully insulate the performance of the economy and, in particular, the domestic asset prices from global shocks.

Monetary shocks from advanced economies have always been considered a fundamental source of spillovers to EMEs. Under normal circumstances, an easing (tightening) of monetary policy in advanced economies seems to boost (dampen) asset prices in EMEs. However, one could argue over the magnitude and direction of such effects as the interaction with the state of the economy and the type of asset matters. Indeed, a tightening policy following an economic recovery, for instance, could produce positive spillovers. Behind this lack of consensus lies the theory that the effect of monetary policy spillovers is dependent upon the sum of three independent channels of transmission that can produce divergent outcomes (see Ammer et al (2016)). By the domestic demand channel, monetary policy tightening in the center economy decreases foreign demand in EMEs by reducing exports to the center economy. Under the flexible exchange rate regime, the exchange rate channel arises from a feature of the Mundell- Fleming model, which predicts that a tightening of monetary conditions in the center economy reduces imports from EMEs because of the depreciation of its currencies. A third channel, the risk-taking channel, refers to the effect on foreign financial conditions of the monetary tightening where portfolio balance effects induces changes in home asset prices due to higher longer term yields that drives capital flows from foreign economies to the center economy. The magnitude and the sign of the international spillover depend on the relative strength of each of above channels.

At the heart of these discussions is the impossible trinity of macroeconomic policy (Mundell (1963)) under which the adoption of a flexible exchange rate regime and financial openness would suffice\(^1\) to guarantee monetary autonomy. Aizenman, Chinn & Ito (2016) revisit the trilemma by analyzing interest rate and foreign exchange rate linkages between peripheral and center economies through a panel of about 100 countries. The results show that the exchange rate regime matters to the degree of sensitivity of emerging economies to policies of center economies. More importantly, the authors show that its interaction with domestic financial factors and financial openness can amplify international spillovers. Along similar lines, Obstfeld, Ostry and Qureshi (2017) and Caceres, Carrière-Swallow and Gruss (2016) offer evidence in support of the trilemma in multi-country analysis that separates the influence of domestic fundamentals on the evolution of domestic interest rates. The monetary trilemma,

\(^1\) The model has been applied to a small open economy, with perfect capital mobility assuming that trade balance depends only on exchange rate and income and taxes and savings increase with the latter.
however, has been challenged by Rey (2015, 2016) whose findings point out to the sensitivity of countries to the global financial cycle irrespective of the exchange rate regime. According to Rey, the existence of an international credit channel prevents countries from insulating against movements in international interest rates due to its impact on external finance premium.

With the zero lower bound (ZLB) being effective on December 2008, we have seen an increase of the degree of uncertainty surrounding the effects of international spillovers discarding the prior belief that once ZLB had been reached it would mean no monetary effects elsewhere. In fact, the set of unconventional measures that were applied after ZLB not only kept spillovers alive but in many cases may have amplified it.

With this scenario in mind, a group of studies devoted its attention to the effects of US unconventional monetary policies and/or its comparison with conventional monetary policy in the domestic market. Gagnon et al. (2011) studied the effects of Large-Scale Asset Purchases (LSAPs), often referred as Quantitative Easing (QE). By means of an event study analysis, the results show that LSAPs were associated with the overall reduction of long-term interest rates by lowering term premiums rather than expectations over future short-term rates. Rogers, Scotti and Wright (2014) incorporates to this analysis the set of unconventional monetary policies implemented by the most important central banks around the world, notably Fed, Central Bank of Europe, Bank of England, and Bank of Japan. They find that unconventional monetary policies are effective in easing financial conditions for all countries. Besides, although cross-country spillovers are significant, the effect of US policies is more pronounced. Krishnamurthy and Vissing-Jørgensen (2011) also apply an event study analysis to confirm the impact of QE on the US bond markets, decomposing its effects by the channels through which it operates. Similarly, Bauer and Neely (2014) show that the international channels of transmission of monetary policy are compatible with normal times where signaling effects are larger for countries with more sensitivity to conventional policies. Moreover, portfolio balance effects move according to the degree of substitutability between international bonds.

Beyond the impact on bond markets, the literature also provides evidence on the effect of monetary spillovers on currency markets. There are well-documented empirical evidences (Faust et al (2003); Scholl and Uhlig (2008), and Bouakez and Normandin (2010)) that links declines in the federal funds rate in the pre-crisis period with the depreciation of the dollar. Glick and Leduc (2015) find that not only did unconventional monetary policies preserve its ability to influence the value of the dollar but also QE surprises had larger effects than the monetary conventional policies executed prior to GFC. Using a New Keynesian model, Akinci and Queralto (2019) show that financial frictions and dollar indebtedness amplify the effect of US monetary spillovers to exchange rate in emerging markets.

As the amount of capital flows to EMEs increased considerably over the recent period of time, so did its share of studies of international spillovers. A comparison of spillovers to financial assets between unconventional monetary policies and the pre-crisis period is offered by Chen, Mancini-Griffoli and Sahay (2014). With a sample of 21 EMEs from 2000 to 2014, the event study shows that spillover effects to capital flows and asset prices were stronger in the unconventional phase of monetary policy. With a novel measure of shocks that separates signal shocks from market shocks, they conclude that the signaling channel has a leading role in explaining spillovers.

Bowman, Londono and Sapiriza (2015) studies the effect of US unconventional monetary policy on 17 EMEs, from 2006 to 2013. Applying a heteroskedasticity approach to identify monetary shocks, the results of the event study reveals the existence of considerable spillovers
on sovereign bonds, exchange rates and on the stock markets, with sizeable heterogeneity among countries.

Recent papers narrow in the analysis on the tapering event of 2013. All of these papers find spillovers effects on EMEs at least in the very short term but there are no consensus over whether better fundamentals matter or not. Eichengreen & Gupta (2015) and Aizenman, Binici & Hutchinson (2016) find that better fundamentals and deeper financial linkages are to blame for the surge in volatility in bond and foreign exchange markets. Larger financial markets could make it easier to foreign investors to rebalance portfolios, making them more sensitive to external shocks. Conversely, Ra and Suchanek (2014), Mishra et al (2014) and others find that better macroeconomic fundamentals help dampen spillover effects.

The literature on monetary spillovers shares the common econometric challenge of properly identifying structural monetary shocks. To overcome endogeneity issues, an important strand of the literature (Faust et al (2003), Andersen et al (2007), Matheson and Stavrev (2014), Kears et al (2018), among others) relies on intraday data to recover structural shocks. Those who advocate for the use of high frequency data argue that it leads to better specified models which minimize the main sources of endogeneity: the omitted variables and simultaneity biases. However, intraday studies do not account for long term dynamics and persistence by relying on the strong assumption that information is quickly absorbed by markets that correctly price the assets.

The VAR literature, for its part, offers a wide range of possibilities for structural analysis from long-run restriction (since Blanchard and Quah (1989)) to short restrictions (Bernanke and Blinder (1992)). Concerning large scale models, Dedola, Rivolta & Stracca (2017) use a Bayesian VAR with sign restrictions to identify monetary shock in a sample of 18 advanced countries and 18 EMEs. Their findings point out to dollar appreciation in most countries following a US monetary tightening, with larger effects on EMEs but no strong connection with fundamentals were apparent. An alternative method is the identification strategy based on the heteroskedasticity of the data. This framework was used to identify the degree and direction of financial transmission between the Euro area and the United States in the bond, stocks, and exchange rate markets by Ehrmann, Fratzscher and Rigobon (2011). A similar approach has been applied by Rogers, Scotti, and Wright (2014), Glick and Leduc (2013), and Neely (2010) that find that easing U.S. monetary policy stimulates financial conditions abroad and weakens the dollar. These papers identify U.S. monetary policy shocks using the method in Wright (2012), based on a VAR identified through heteroskedasticity along the lines of Rigobon and Sack (2003).

Finally, it is important to mention multi-country studies that rely on panel approach instead of individual VAR regressions (Buitron and Vesperoni (2015), Georgiadis (2015)) to identify and measure international spillovers and the use of dynamic stochastic general equilibrium (DSGE) models (Fukuda et al (2013)).

3. **Determination of interest rates and exchange rates in a small open economy**

We now outline a framework to help us understand the effect of spillovers on EMEs. For that purpose, we propose a simple model which serves as a tool to identify the main components of monetary spillovers. In Section 3.1, we depict the determinants of the short-term interest rate for countries in which IT is the monetary system. In Section 3.2, we describe the model of determination of exchange rates with an eye to decompose the effect of changes in global interest rates, in particular of the US federal funds.
3.1. Model for interest rates under an inflation target regime

In IT regimes, there is a pre-established goal for inflation, which must hold for a given horizon. This goal is announced publicly and the central bank acts to ensure that the effective inflation is in line with it. Central bank actions are usually based on the control of just one instrument, which is the short-term interest rate. Under this monetary system, central bankers generally use rules as a guide to interest rate decisions where the connection between the interest rates to the evolution of price and output is of central significance.

Although rules are not intended to serve as a unique guide, they play a central role in understanding the economic logic behind interest rate decisions. First, it is a systematic and simple way of communication decisions as monetary rules are usually linear functions of a few economic variables in the economy. Simple rules are able to transmit this idea and they can provide guidance as to how central bank responds to key economic shocks and about the level of deviation from its objective\(^2\). For instance, the principles of conduct of monetary policy suggest that when inflation is running above its target, central banks should apply a restrictive monetary policy by raising interest rates to slow demand and reduce inflation expectations.

The prescription of a standard Mundell-Fleming model is to let the currency fluctuate to adjust for international monetary policy shocks in order to preserve monetary autonomy. To the extent that it is desirable to provide flexibility for central banks to smoothly absorb shocks, inflation targets in EMEs generally have confidence bands in which inflation can fluctuate in the short run as a means for dealing with exchange rate pass-through in particular. A critical question is if those bands are enough to accommodate shocks or monetary authorities prefer to overreact to international monetary policy shocks.

In this sense, we assume that a forward looking Taylor rule best describes interest rate decisions where inflation and output expectations are its main drivers, with a prevalence of the former \((\gamma_1 > \gamma_2)\) as shown in equation (1) below. To the conventional Taylor-rule, we add a monetary spillover term \(ms(i^*)\) that reflects the response of interest rates to international monetary spillovers that cannot be explained by inflation and output gaps, as follows:

\[
i = \bar{a} + \gamma_1(E_\pi - \bar{\pi}) + \gamma_2(E_Y - \bar{Y}) + ms(i^*) + \varepsilon \tag{1}
\]

Where \(i\) is the interest rate set by the central bank, \(E_\pi\) and \(E_Y\) are inflation and output expectations respectively, \(\bar{\pi}\) is the target inflation and \(\bar{Y}\) is the long-run output. \(\gamma_1\) and \(\gamma_2\) are the coefficients of the response of the interest rate to variation in inflation and output gaps. Finally, \(ms(i^*)\) is an autonomous term that accounts for monetary spillovers and \(\varepsilon\) is an error term.

Since we are only interested in shocks related to international monetary spillovers, we ideally seek to simplify \(i\) in (1). The idea is to rule out unimportant effects and highlight the evolution of \(i\) owed to \(i^*\). Then, we isolate a term \(exp(i^*)\) in (1), which represents the variation in expectations due to variations of \(i^*\). Additionally, we keep the monetary spillover component \(ms(i^*)\) and assign terms that do not respond to external factors to the constant term \(\bar{i}\) so that we can rewrite (1) as:

\[
i = \bar{i} + exp(i^*) + ms(i^*) + \varepsilon \tag{2}
\]

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\(^2\) See, for instance, the Monetary Policy Report from the FED, released in February 2018, which analyzes US monetary policy through the lens of different types of monetary rules.
If we first difference (2), we get:

$$\Delta i(\ast) = \Delta \text{exp}(i^\ast) + \Delta m\text{s}(i^\ast)$$  \hspace{1cm} (3)

Where $\Delta$ express the absolute first difference between the current and the past values.

With this model in mind, we look for evidence that interest rate decisions in Brazil, Chile, Colombia, and Mexico can be explained by movements in $i^\ast$. More importantly, we aim to analyze the reaction of the autonomous term ($m\text{s}(i^\ast)$) to changes in US monetary policy, in which case could provide evidence in support of a lack of monetary policy autonomy in these countries. Section 5 will describe the methodology steps that we take to answer these questions.

3.2. A portfolio model for exchange rate determination

For purposes of tractability, we construct a stylized exchange rate model that keeps the spirit of the Mundell-Fleming framework while communicating with the determination of interest rates depicted in Section 3.1. We build on the portfolio model of Blanchard et al (2016) by adding the interaction of exchange rates with domestic interest rates, while at the same time we simplify by making bonds as the only asset, except for money.

For simplicity, the local economy has only a bond market whose rate of return is equal to the short rate ($i$) that the central bank sets for monetary policy, which follows (1). Under a flexible exchange rate regime with imperfect capital mobility, domestic investors can buy both domestic and external bonds whose rate of return is the international rate ($i^\ast$), which can be different than the domestic interest rate ($i$). In our framework, external investors can buy domestic bonds as well and we define $e$ as the nominal exchange rate, and $E_e$ its expectation in the next period.

Domestic wealth ($W$) is distributed among the available assets in the economy for domestic investors: $M$ for money, $B_D$ for domestic bonds owned by domestic investors, and $\frac{B_D^*}{e}$ for external bonds owned by domestic investors.

$$W = M + B_D + \frac{B_D^*}{e}$$  \hspace{1cm} (3)

While shifts in wealth are determined by the payoff of the investments in (3), the demand for each asset determines its distribution. To start with, demand for money ($M$) depends linearly on the prime interest rate $i$:

$$M = (\alpha_0 - \alpha_1 \cdot i)$$  \hspace{1cm} (2)

Since equilibrium in the money market does not depend on output, we do not need an explicit IS curve, that is, output is exogenous in our model. Like Mundell-Fleming, money supply is exogenous and under the control of the central bank.

The demand for bonds owned by domestic investors ($B_D, \frac{B_D^*}{e}$) is proportional to the domestic net wealth ($W - M$) and plays a central role in determining portfolio allocation. Also, the

\footnote{In our definition of exchanges rates, we follow the convention in which increases in $e$ or $E_e$ mean appreciation of the exchange rate.}
parameters \((\beta_1, \beta_2)\) refer to the sensitivity of each demand to the domestic and international interest rates. Note that assuming \((\beta_1 \neq \beta_2)\), we depart from the usual hypothesis that the demand respond only to interest rate differentials, adding flexibility to its interpretation.

\[
B_D = \left( a + \beta_1(1 + i) + \beta_2 \left(1 + i^*\frac{e}{E_e}\right) \right)(W - M) \tag{4}
\]

\[
\frac{B_D}{e} = \left( b + \beta_1(1 + i) + \beta_2 \left(1 + i^*\frac{e}{E_e}\right) \right)(W - M) \tag{5}
\]

With regards to the demand of domestic bonds from external investors \((B_F)\), it also responds to shocks in each interest rate. We capture the difference between domestic and external investors by adding a parameter \(r\) in the equation for foreign investors, which according to Blanchard et al (2016) is the source of capital flows. Parameter \(r\) can also be viewed in equation (6) to account for country risk. In the interest rate parity condition, country risk is a measure of the degree of capital mobility and can be defined as the covered interest rate parity differential (see Didier and Garcia (2003), for instance). As long as country risk cannot be hedged through diversification, it is a systematic risk that must be accounted for.

\[
B_F = \left( c + \beta_3(1 + i) + \beta_4 \left(1 + i^*\frac{e}{E_e}(1 + r)\right) \right)(W^* - M^*) \tag{6}
\]

Where \(W^*\) and \(M^*\) are global wealth and money demand, respectively, and the set \((\beta_3, \beta_4)\) refers to the sensitivity of external investors' demand to each interest rate.

Our focus on this Section is to depict spillovers components of exchange rates. In this sense, we are aware that interventions, for instance, qualify as a spillover component since it may be triggered by international rate variations and at the same time it may affect exchange rate through the portfolio balance channel. However, intervention policies vary considerably in the sample and may be as infrequent (in Chile, for instance) to the point of making its explicit decomposition uneven and intractable. With that note of cautious\(^4\), we only allow central banks to trade domestic bonds. Let \(B_{BC}\) represent central bank domestic bonds. If the initial conditions for wealth, money, and bonds are \([W, \bar{M}, W^*, \bar{M}^*, \bar{B}_D, \bar{B}_F, \bar{B}_D^*, \bar{B}_F^*, \bar{B}_{BC}]\), then:

\[
M - B_{BC} = \bar{M} - \bar{B}_{BC} \tag{7}
\]

Assuming the supply of domestic bonds is fixed, equilibrium requires that the domestic bond market clears.

\[
B_D + B_F + B_{BC} = \bar{B}_D + \bar{B}_F + \bar{B}_{BC} \tag{8}
\]

Following Blanchard et al (2016), we rule out size effects by assuming that net wealth is equal in both countries, that is: \(W^* - M^* = W - M\). As we know by Walras Law that we have to clear just one market in order to obtain equilibrium for both of them, we choose to balance the capital account, or \(\Delta B_F = \Delta \frac{B_D}{e}\):

\(\text{In Section 5, we control exchange rates for central bank interventions.}\)
\[
\left( c + \beta_3 (1 + i) + \beta_4 \left(1 + i^*\right) \frac{e}{E_e}, (1 + r) \right) \right) \left( W^* - M^* \right) - \overline{B_F} = \\
\left( b + \beta_1 (1 + i) + \beta_2 \left(1 + i^*\right) \frac{e}{E_e} \right) \left( W - M \right) - \frac{\overline{B_D}}{e} 
\]

(9)

Clearing constants and equaling net wealth in (9), we can simplify expression (9) as follows:

\[
(\beta_3 - \beta_1)(1 + i) = (\beta_2 - \beta_4) \left(1 + i^*\right) \frac{e}{E_e}, (1 + r) 
\]

(10)

Without loss of generality, we make \( E_e = 1 \). Then, we simplify expression (10) to:

\[
(\beta_3 - \beta_1)(1 + i) = (\beta_2 - \beta_4)[(1 + i^*)e, (1 + r)] 
\]

(11)

Log-linearizing, we can express the variation in exchange rate due to \( i^* \) in the sum of four terms, we obtain:

\[
\Delta_i e = \Delta i^* + \Delta r + \Delta \beta_{i^*} + \Delta \beta_i + \Delta i 
\]

(12)

Where \( \Delta_i \) express percent variation and \( \Delta \) express the first absolute difference. Besides, \( \Delta \beta_{i^*} \) is the change in the sensitivity of the demand for bonds attributed to \( i^* \) and \( \Delta \beta_i \) is the change in the sensitivity attributed to \( i \).

To obtain a final expression for spillover components to international interest rates, we need to compute the evolution of each of the above components that is caused by \( i^* \). Thus, if we make \( i = i(i^*) \) and \( r = r(i^*) \), (12) can be rewritten as:

\[
\Delta_i e(i^*) = \left( \Delta i^* + \Delta r(i^*) + \Delta \beta_{i^*}(i^*) + \Delta \beta_i(i^*) + \Delta i(i^*) \right) 
\]

(13)

In order to simplify notation and provide a tractable analysis of spillovers, we split exchange rate variation \( \Delta_i e(i^*) \) in two terms. The first term corresponds to the external spillover of the international interest rate that is represented by the sum \( \Delta i^* + \Delta r(i^*) + \Delta \beta_{i^*}(i^*) \). The second term is the change in the exchange rate due to the domestic interest rate through its spillover component \( \Delta \beta_i(i^*) + \Delta i(i^*) \). Note that we add a factor that accounts for the variation in the sensitivity to each type of interest rate. Since \( \Delta exp(i^*) \) is originated by common factors in the domestic and global economies, we assume that this factor does not affect the exchange rate. Summing up, we are able to write exchange rate variation caused by \( i^* \) in two components: a external spillover \( de(i^*) \) and a domestic spillover \( ds(i^*) \):

\[
\Delta_i e(i^*) = \left( \Delta s(i^*) + \Delta d s(i^*) \right) 
\]

(15)

3.3. Components of monetary spillovers to domestic interest rates and exchange rate

With the background offered in Sections 3.1 and 3.2, we can organize the impact of international monetary spillovers into its different components, which we refer in the remainder of the paper.
We start with the impact of spillovers to domestic interest rates by defining its first component as the change in domestic interest rates due to changes in expectations. Note that, in equation (1), changes in inflation and output expectations potentially trigger domestic interest rate changes. Thus, the expectations component, summarized by function $\Delta exp(i^*)$, aggregate the variation of domestic interest rates related to changes in inflation and output expectations caused by changes in US monetary policy. A negative value of this component implies that international rate hikes (drops) reduces (increases) inflation and/or output expectations causing a(n) reduction (increase) in domestic interest rates. Since the response of monetary policy to expectations is forward-looking, exchange rate pass-through is accounted for.

Similarly, we define the monetary spillover ($\Delta ms(i^*)$) component as the direct impact of international monetary shocks beyond what would be expected by economic linkages (Hofmann and Takáts (2015)), which express the idea of international monetary spillovers that are not explained by changes in domestic expectations. On the one hand, fear of floating could induce central bankers to overreact to changes in international rates in order to avoid excessive currency fluctuation. This behavior was widespread among EMEs in the late 1990s (see Reinhart and Calvo (2002)), after several financial crisis hit emerging markets worldwide. On the other hand, the subsequent rise in international reserves may have provided a cushion against negative developments in the external scenario. All in all, small $\Delta ms(i^*)$ figures would suggest the presence of mature and credible monetary frameworks in the selected countries. It also serves as an indicator of the degree of monetary autonomy.

As we turn our attention to spillovers to the exchange rate, we identify two sources of variation that bears many resemblances with interest rate parity (IRP) models which assign variation in exchange rate to domestic and international interest rates. Thus, the effect on exchange rates has a direct spillover of international interest rate summarized in the external spillover component $\Delta es(i^*)$. In addition to the direct effect of international interest rates, this component gathers from risk premiums imposed by external investors on the demand for domestic bonds and changes in the sensitivity of demand for bonds to $i^*$. The second component (domestic spillover) refers to the indirect effect of international monetary policy on the exchange rate through domestic interest rates, with the addition of a term to account for the changes in bond sensitivity to $i$.

How can we reconcile the interpretation of the components with the portfolio model? As equations (4)-(6) show, the effect on bond inflows following a positive monetary spillover shock $i^*$ depends on the combined reaction of the exchange rate and of the domestic interest rate. Everything else constant, if there is no domestic monetary impact ($\Delta i(i^*) = 0$), net bond inflows decline drives the exchange market into currency depreciation, which offsets the initial impact and allows markets to clear. If, instead, the domestic monetary impact is higher than the international shock ($\Delta i(i^*) > \Delta i^*$), bond inflows tend to increase relatively to bond outflows. Note, however, that the increase in bond inflows is amplified by the shrinking effect of domestic interest rates on money demand, which increases the distribution of wealth towards bonds. The net effect on currencies, that is, whether or not the exchange rate depreciates or appreciates, depends also on the intensity of the risk effect ($r$) that may correlate with movements in interest rates and impact net bond inflows, let alone potential changes in bond sensitivity to interest rate changes that we do not decompose.

To wrap up, our model is suitable to understand the effect of a change in global interest rates to domestic interest rates and the exchange rate of a small open economy into its main components. Despite the lack of micro-foundations and dynamic, it pays off in simplicity and organization, as summarized in the identification scheme below.
In Section 5, our task is to propose a method to correctly identify the effect of US monetary spillovers on each of the aforementioned components of interest rates and exchange rates. Next, we present background information on monetary policy on Latin America as well as preliminary analysis and summary statistics of the database for each country.

4. Background and data

As shown in Figure 2, the 2013 taper tantrum, which defines the beginning of the normalization talks in US, generated the kind of volatile effects on Brazil, Chile, Colombia and Mexico that usually concerns monetary authorities as regards to the potential collateral effect on important domestic variables such as inflation and growth. We can see large spikes in interest rates and foreign exchange figures in all countries, many of them superior to 5% in just one month. Subsequently, the taper talk also led to a reversal of capital flows, which led some countries like Brazil to engage in heavy interventions in their foreign exchange markets.

Taking this short period of time alone, Chile was the least affected country and Mexico, the most. One can argue that this is an expected result in view of the strong ties of Mexican
economy to the American economy and the task of this study is to take apart the common factors that link the EMEs to the US and provide longer term estimates of monetary spillovers free from commonalities. However, taking into account the importance of the markets involved and the amount of volatility generated, one cannot ignore the fact that monetary spillovers are worth the attention the literature has devoted recently.

The decision to choose Brazil, Chile, Colombia, and Mexico is grounded on the fact that they have been deeply impacted by recent normalization talks and by shifts in the international monetary policy framework. The geographical criterion also helps provide a more uniform analysis and a less heterogeneous sample as the four Latin American countries share similar economic backgrounds. As this paper will only sideline the discussion of whether or not the aforementioned trilemma of monetary policy holds, we choose countries with IT regimes, flexible exchange rates and considerable financial openness.

It is also important to note that the economic ties that generally link EMEs to the US did not result in a coordination of consumer inflation figures. After the initial deflationary shock, Figure 3 shows that inflation quickly rebounded in synchronization in 2010 and 2011. Afterwards, there is a disruption in the joint movement as the four EMEs followed different inflation paths while the US struggled with consumer inflation below its target. Consequently, none of the four EMEs central banks had to deal with ZLB and they were able to keep prime interest rates as the main monetary policy instrument.

**Figure 3: Consumer inflation in Brazil, Chile, Colombia, and Mexico between 2008 and 2016, in percent a year**

Source: Central Banks of Brazil, Chile, Colombia, and Mexico.

We collect monthly data between January 2002 and September 2017, or 189 months. The only exception is Chile whose sample period starts on June 2003 due to limitations on data availability. By choosing 2002 as the starting point, our aim is to avoid the noisy initial period surrounding the implementation of IT regimes. In all cases, inflation rates were well above normal level and each country decided to apply the regime to allow for less costly inflation convergence. Brazil, Colombia and Mexico implemented it in 1999, and only Chile has a long established experience since 1990. Except from Brazil, formal IT implementation followed an evolutionary approach as the central bank gradually put in place all the control mechanisms.
To characterize the optimal policy reaction function for a forward-looking central bank in a small open economy, we collect monthly data for consumer inflation and GDP growth expectations for the four countries in the study. However, as we want expectations for the following 12 months, each country data imposes its own challenges. Central Bank of Brazil, for instance, collects inflation expectations 12 months ahead on a daily basis as part of an electronic survey with private banks. The same survey reports fixed-point forecasts for GDP growth. We take end-of-month values for both expectations to synchronize with domestic interest rates data. The central banks of Chile, Colombia and Mexico have similar systems of inflation surveys and report inflation expectations 12 months ahead on a monthly basis. Concerning output expectations, fixed-point forecasts for GDP growth are available monthly in Chile and Mexico, and quarterly in Colombia.

We conduct our study following the common practice (Dovern, Fritsche and Slacalek (2012) and Caceres, Carrière-Swallow and Gruss (2016)) of using a linear combination of output fixed-point forecasts for the current and following calendar years to construct output forecasts over the following 12 months. In the case of Colombia, prior to this transformation, we apply a linear interpolation to obtain monthly data from quarterly data.

With regards to EMEs’ interest rates, we collect monthly 360-day interest rates provided by each central bank either in the form of interest rate swaps (Brazil and Chile) or on certified bond securities (Colombia and Mexico). The choice of this horizon is appropriate given that our aim is to gauge the effect of normalization on expectations on future short term interest rates rather than risk premium fluctuations. We also collect the monthly percent change of the nominal spot exchange rate, which is provided by each central bank.

It is also important to highlight that we assume that the most important source of international monetary shocks to EMEs is originated in the US and such role has not diminished after the Global Financial Crisis (GFC) . Concerning US interest rates, we use two interest rate variables. In our reference scenario, we apply a measure proposed by Wu & Xia (2016), the shadow rate, which effectively accounts for the impact of monetary policy at ZLB.

Table 1 shows that, except for Colombia, mean inflation dropped by just a few percentage points after GFC. The real effect of GFC is noticeable on GDP figures which suggest a large contraction of the four economies in tandem with the worldwide slowdown that took place in that period. Taken together, those movements explain the considerable drop in interest rates as IT central banks may trigger an expansionary stance of monetary policy to balance downward inflation pressures with sluggish economic output.

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5 Which is called “Boletim Focus”.

6 Expectations series are usually persistent and exhibit low levels of volatility. They do not generate many swings that other methods of interpolations could wrongly imply.

7 Despite being the epicenter of GFC, the position of the Federal Reserve in a globalized economy has not diminished as flight to safety international transactions reinforced the role of the US as a safe haven for investors (see, for example, Prasad (2014) and Abbate et al (2016)). We acknowledge that other central banks may have important roles in the monetary system, but the effects of its shocks on EMEs will be measured only indirectly, as long as the US interest rate market is also affected.
### Table 1: Summary statistics for interest rates, foreign exchange and expectations for Brazil, Chile, Colombia, and Mexico before and after GFC

#### Interest rates
(monthly mean value in percent per year; standard deviations in brackets)

<table>
<thead>
<tr>
<th></th>
<th>Brazil Before GFC</th>
<th>Brazil After GFC</th>
<th>Chile Before GFC</th>
<th>Chile After GFC</th>
<th>Colombia Before GFC</th>
<th>Colombia After GFC</th>
<th>Mexico Before GFC</th>
<th>Mexico After GFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>360-day</td>
<td>17.4 (5.1)</td>
<td>11.0 (2.2)</td>
<td>5.1 (1.7)</td>
<td>4.5 (1.6)</td>
<td>8.4 (1.2)</td>
<td>6.0 (1.6)</td>
<td>8.0 (1.0)</td>
<td>4.8 (1.3)</td>
</tr>
</tbody>
</table>

#### Exchange rates
(monthly mean variation value in percent; standard deviations in brackets)

<table>
<thead>
<tr>
<th></th>
<th>Brazil Before GFC</th>
<th>Brazil After GFC</th>
<th>Chile Before GFC</th>
<th>Chile After GFC</th>
<th>Colombia Before GFC</th>
<th>Colombia After GFC</th>
<th>Mexico Before GFC</th>
<th>Mexico After GFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot exchange rate</td>
<td>0.06 (6.1)</td>
<td>0.60 (4.7)</td>
<td>-0.44 (2.9)</td>
<td>0.12 (3.1)</td>
<td>0.12 (3.5)</td>
<td>0.37 (3.9)</td>
<td>-0.38 (2.7)</td>
<td>-0.27 (3.7)</td>
</tr>
</tbody>
</table>

#### Expectations
(mean value over each sample)

<table>
<thead>
<tr>
<th></th>
<th>Brazil Before GFC</th>
<th>Brazil After GFC</th>
<th>Chile Before GFC</th>
<th>Chile After GFC</th>
<th>Colombia Before GFC</th>
<th>Colombia After GFC</th>
<th>Mexico Before GFC</th>
<th>Mexico After GFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer inflation</td>
<td>5.48</td>
<td>5.45</td>
<td>3.14</td>
<td>3.08</td>
<td>5.57</td>
<td>3.87</td>
<td>3.93</td>
<td>3.83</td>
</tr>
<tr>
<td>Output</td>
<td>3.54</td>
<td>2.70</td>
<td>4.94</td>
<td>3.08</td>
<td>5.57</td>
<td>4.02</td>
<td>3.22</td>
<td>2.60</td>
</tr>
</tbody>
</table>


Another important insight is the fact that foreign exchange markets mean volatility and mean do not provide any striking evidence to support the outcry against expansionary monetary policy in US, except in Mexico. Moreover, the fact that monetary policy in EMEs is not constrained by the zero lower bound provides more flexibility to central banks to react to economic slowdown.

### 5. Methodology

As we have seen in Section 2, each of the econometric methods to overcome endogeneity issues has its own advantages and caveats. This is especially true when we are dealing with the relationship between financial variables that may respond simultaneously to shocks in different countries and markets. In a highly integrated international financial environment, it is hard to argue that shocks to US interest rates will not affect foreign interest rates and exchange rates in the same month. In multi-country analysis, the issue of standardization and availability of data is also present and must be taken into consideration.

In that respect, we opt for small size VAR models to measure each spillover components of monetary policy normalization in US on the foreign exchange and interest rate markets in Brazil, Chile, Colombia, and Mexico. The identification strategy follows the idea of Caceres, Carrière-Swallow and Gruss (2016) where identification is obtained through the sequencing of VAR models with recursive identification, a multi-stage approach. This is also the appropriate choice insofar as it adheres to the objectives of the paper by providing flexibility to depict spillover components.
The first layer of the aforementioned sequencing econometric approach is the domestic monetary decisions. As shown in equation (1), IT central bank reaction functions are well described by forward looking Taylor rules, whose main decision-making factors are inflation and output expectations. For each country, we perform a recursive VAR in first differences such that the Choleski ordering runs from consumer inflation expectations to output expectations and interest rates, as shown below. In this framework, expectations are assumed to be predetermined with regards to interest rates and interest rates shocks can affect expectations only through its lagged effect.

\[
\begin{pmatrix}
\Delta i \\
\Delta E_{\pi} \\
\Delta E_Y
\end{pmatrix}_t = \alpha + A(L) \begin{pmatrix}
\Delta i \\
\Delta E_{\pi} \\
\Delta E_Y
\end{pmatrix}_t + B \begin{pmatrix}
\varepsilon_i \\
\varepsilon_{\pi} \\
\varepsilon_Y
\end{pmatrix}_t
\]

(16)

Where \( i \) is the domestic interest rate, variables \( E_{\pi} \) and \( E_Y \) are consumer inflation and output expectations, respectively. \( B \) is an upper triangular matrix.

In order compute the expectations component, we must measure the sensitivity of expectations to changes in US interest rates. Taking the residuals \( (\varepsilon_{\pi}, \varepsilon_Y) \) from (16), we propose a country-by-country regression of each expectation on US interest rates. Implicit in this proposal, expressed in equation (16), is the assumption that there is no lagged effect as expectations fully absorb the US interest rate shock in the first period.

\[
\begin{align*}
\varepsilon_{\pi t} &= \alpha + \beta \varepsilon_{\pi t-1} + \beta_{\pi}^{'} \Delta i^* t + \mu_{\pi t} \\
\varepsilon_{Y t} &= \alpha + \beta \varepsilon_{Y t-1} + \beta_{Y}^{'} \Delta i^* t + \mu_{Y t}
\end{align*}
\]

(17)

Where \( i^* \) is a measure for US interest rates; variables \( \varepsilon_{\pi t} \) and \( \varepsilon_{Y t} \) are consumer inflation and output expectation residuals from (15), respectively.

To recover the expectations component, which is summarized by \( \Delta exp(i^*) \), we need to recover the long-run impact multipliers of each expectation to the domestic rate from (16). The expectation component, thus, is the combination of each long-run impact multiplier \( \left( \sum_{i=0}^{\infty} \Phi_{i \to E(\pi)} \right) \left( \sum_{i=0}^{\infty} \Phi_{i \to E(Y)} \right) \) and \( [\beta_{\pi}^{'} \beta_{Y}^{'}] \) as given by:

\[
\Delta exp(i^*) = \left[ \beta_{\pi}^{'} \beta_{Y}^{'} \right] \left[ \Delta i^{*} \Phi_{i \to E(\pi)} \right]
\]

(18)

To summarize, one can view the computation of \( \Delta exp(i^*) \) as a two-step procedure where we take the change in expectations explained by \( i^* \) and, then, infer what will be its expected impact on domestic monetary policy decisions.

For the computation of the remaining components, we must relate interest rates (domestic and international) and the foreign exchange rate. The issue is that there is a potential source of endogeneity as global shocks may impact financial variables simultaneously. If we take a closer look at (1), we note that the channel through which domestic and international interest rates can be endogenously determined is the expectations channel.

As a matter of fact, the domestic interest rate residuals \( \varepsilon_i \), from the first layer in (15), is a measure of interest rates freed from expectations. Thus, we add a second layer, which comprises a recursive VAR that relates US interest rates \( (i^*) \), domestic interest rates \( (i) \), and exchange rates \( (e) \). However, instead of using the domestic rate directly, we substitute it for
the residuals \( \epsilon_i \). The ordering is naturally as going from \( i^* \) to \( \epsilon_i \) to \( e \). We assume that the exogeneity of \( \Delta i^* \) is uncontroversial and spillovers are originated in US and then transmitted to EMES. In the spirits of monetary models of exchange rate determination (Dornbusch (1976), for instance), we argue that the residual interest rate \( \epsilon_i \) impacts \( e \) through interest rate differentials, which can shift capital movements and influence exchange rate values contemporaneously. Foreign exchange markets could still impact interest rates with a lag. The model in first differences is described as follows:

\[
\begin{pmatrix}
\Delta i^*
\epsilon_i
\Delta e
\end{pmatrix}_t = \alpha + A(L) \begin{pmatrix}
\Delta i^*
\epsilon_i
\Delta e
\end{pmatrix}_t + B \begin{pmatrix}
w_i^*
w_{\epsilon i}
w_e
\end{pmatrix}_t
\]

(19)

Where \( B \) is again an upper triangular matrix.

From (19), we can describe the monetary spillover \( \Delta m s(i^*) \) component in terms of the impact multiplier of a given shock \( \Delta i^* \) to the interest rate \( \epsilon_i \):

\[
\Delta m s(i^*) = \Delta i^* \times \sum_{t=0}^{\infty} \phi(t)_{\epsilon_i - i^*}
\]

(20)

With this approach, we are also able to compute exchange rate spillover components. As we control for the domestic interest rate \( \epsilon_i \) in model (19), note that the accumulated long-run impact multiplier of a shadow rate shock \( \Delta i^* \) to the exchange rate \( e \) \( \left( \sum_{t=0}^{\infty} \phi(t)_{e - \epsilon_i} \right) \) is the external spillover component \( \Delta e s(i^*) \):

\[
\Delta e s(i^*) = \Delta i^* \times \sum_{t=0}^{\infty} \phi(t)_{e - \epsilon_i}
\]

(21)

We calculate the domestic spillover \( \Delta d s(i^*) \) component in two steps. First, we measure the impact multiplier of a given shock \( \Delta i^* \) to the interest rate \( \Delta \epsilon_i \). Then, we use this information to compute the effect of domestic interest rates to the exchange rate \( e \), as follows:

\[
\Delta d s(i^*) = \Delta m s(i^*) \times \sum_{t=0}^{\infty} \phi(t)_{e - \epsilon_i}
\]

(22)

6. Results

This Section shows the results of the spillover components derived above, and then discuss how the components vary by country and samples. First, we closely examine in Section 6.1 the evolution of spillover components by splitting the analysis into sub-samples, defining the Global Financial Crisis as the structural break. In Section 6.2, we proceed by showing time-varying properties of the model. Our aim is to analyze how impulse response functions evolve with a time-varying Structural VAR approach (of Primiceri (2005)) and we also compute spillover components in a rolling window basis.

6.1. Sub-sample analysis

The stability of the coefficients is a valid concern in view of what has changed in terms of monetary policy settings recently. The most obvious turning point, but not necessarily the only one, is October 2008 at the pinnacle of GFC when unconventional measures have been taken to avoid a recession deepening. As increasing turmoil in financial markets generated abnormal returns nearby GFC, an arbitrary sample split would unequivocally interfere in the comparison of the results. Bearing that in mind, we exclude the period surrounding GFC from the sub-sample analysis, from January 2008 to June 2009. In this Section, thus, we split our analysis in
two different periods: 1) Before GFC (B-GFC), between January 2002 and December 2007; except for Chile, which is between June 2003 to December 2007; 2) After GFC (A-GFC): between July 2009 and September 2017. We ensure stationarity of the VAR components by first differencing (interest rates, inflation and output expectations) and log differencing exchange rates.

We begin with the analysis of model (16), which is the three–variable Taylor-rule VAR identified by Choleski decomposition. As AIC and SBC tests show short lag lengths for all countries, we standardize it to 1 lag in this sub-sample exercise. Our aim is to understand the causal relationship between expectations and interest rates. Before proceeding, note that our measure of domestic interest rates capture the increase in short-term interest rates expected by the market over the period of one year.

Impulse responses of inflation expectations shocks to each domestic interest rate are depicted in Figure 4, together with 95% confidence bands. We consider an inflation expectation shock that corresponds to a 10 bps increase in inflation. First, it is important to highlight that all countries follow the elementary prescription of IT regimes by responding to positive variations in inflation expectations with an increase in interest rates. In fact, if we compute the 12-month accumulated response of domestic interest rates to inflation expectation shocks, they are always positive. Although such commonality holds in general terms, the length and significance of the responses vary noticeably. We find a gradual and significant response from Chile, as it persists up to 4 months after the shock. Besides, responses are stable across samples. In Brazil, interest rate responses are short-lived and significant only contemporaneously. Contrary to Chile, however, it is more pronounced before GFC than afterwards. In Colombia and Mexico, though, the impact on interest rates to changes is weak and non-significant in both periods, albeit positive.

Figure 4: Impulse response function of domestic medium interest rates to inflation expectations
Reported coefficients are expressed in bps for a 10 bps shock in inflation (π) and output (y) expectations

---

As IT countries focus on inflation, we do not show the graph for impulse response from output expectations, although accumulated impulse coefficients are available in Table 3.
Regarding output expectations, differences in monetary responses are also substantial from a policy standpoint. We can see that responses are also positive given that increases (decreases) in output expectations generally increases (decreases) interest rates. In this regard, we observe that Colombia increases its response to output expectations after GFC. By contrast, we do not observe any reaction to output expectations at all in Chile and Mexico as if each central bank only focused on inflation. Brazil is an outlier as it is the only country with a negative reaction to output expectations after GFC. In fact, the drawback of model (16), as of any linear model, is that it works better in more stable environments.

In Table 3, we report estimates of the sensitivity of domestic expectations to US interest rates shocks. A first natural test for the empirical relevance of the expectations components is to analyze the statistical significance of the sensitivity coefficients for each sub-sample and country. In fact, neither Chile nor Mexico survives this test as all $\beta$ coefficients are either not significant or negligible, when significant. Accordingly, we conclude that expectations in both countries are not affected by monetary policy in US. On the basis of the results in Table 3, the effect of US monetary policy in Brazil and Colombia is also very limited through the expectations channel. In Brazil, a 25 bp increase in US shadow rates decreases Brazil GDP expectation by 5.9 bps and an identical shock reduces inflation expectation in Colombia by 6.0 bps before GFC. All remaining coefficients are non-significant.

As we analyze point coefficients, note that the impact of US monetary policy across sub-sample has shifted in a meaningful way. Indeed, a positive US monetary shock increased GDP expectation before GFC, while the reverse is true after GFC. This is not surprising as we turn back to Ammer et al (2016) that shows that monetary policy spillovers to output are dependent upon the sum of independent channels of transmission. Hypothetically, an increase in US monetary policy rates raises foreign GDP through the exchange rate channel, but it lowers foreign GDP through the financial and domestic demand channels. Judging by the negative sign of the relationship after GFC, the latter channels of transmission outshines the former. Let alone the side effect of exchange rate pass-through to inflation, which may require monetary policy tightening, further reducing economic growth. All things considered, it may ultimately vary according to domestic fundamentals. As opposing and idiosyncratic dimensions play important roles in this discussion, it is difficult to unequivocally determine the sign of the net impact on expectations. In this paper, we opt for a documentary approach on the basis of our empirical results.

Anyway, taking GFC as the turning point for the business cycle, the coefficients for both inflation and output expectations are far from stable in these countries since the relative magnitude of spillover transmission channels may vary across different states of the economy. It is also important to add that if we add commodity prices as a control variable to regression (16), we reach similar conclusions.

Table 3: Sensitivity of domestic expectations to US shadow rates
Reported coefficients are expressed in basis points (bps) for a 25-bps shock in US shadow rate. Levels of significance are reported as follows: 1% (*); 5% (**); 10% (**).

<table>
<thead>
<tr>
<th>Country</th>
<th>$\beta_{\pi,i}^{*}$</th>
<th>$\beta_{y,i}^{*}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B-GFC</td>
<td>A-GFC</td>
</tr>
<tr>
<td>Brazil</td>
<td>4.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Chile</td>
<td>-0.2</td>
<td>-0.7</td>
</tr>
<tr>
<td>Colombia</td>
<td>-6.0***</td>
<td>-4.8</td>
</tr>
<tr>
<td>Mexico</td>
<td>2.2</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Note: Significance codes: ‘***’ 0.001; ‘**’ 0.01; ‘*’ 0.05; ‘.’ 0.1
Now, we turn to the analysis of the second layer (model (19)), which consists of a second VAR model with Choleski decomposition that relates interest rates (domestic and US), alongside with the exchange rate. Figure 4 displays one fundamental output of the second layer, which is the impulse response function of domestic medium interest rates to a 25-bps US shadow rate shock. In general, our results for the first period (before GFC) are consistent with the study of Caceres, Carrière-Swallow and Gruss (2016) in that they point out to an overall high degree of monetary autonomy. The response is also generally non-significant and short-lived. As opposed to Edwards (2015), we do not identify significant spillovers in Chile and Colombia before GFC.

The advent of GFC caused an upward shift of the immediate responses to movements in US rates, which became eventually significant and positive. In Brazil, the upward shift is noticeable as the contemporaneous impact is negative before GFC and alternates to a positive and significant response after GFC, both being significant. Monetary policy in Colombia follows the same pattern, although interest rate reaction occurs with a lag. In Chile, the change is more subtle as there is a positive and significant contemporaneous coefficient both before and after GFC, in the first lag and contemporaneously respectively. Finally, despite the fact that monetary policy autonomy in Mexico is positive in both periods, note that the response is non-significant and there is no apparent shift across sub-samples. In view of the results above, it is reasonable to conclude that GFC is a turning point in terms of the effect of US monetary policy on domestic interest rates.

Figure 5: Impulse response function of domestic medium interest rates to US shadow rate shocks
Reported coefficients are expressed in bps for a 25-bps US shadow rate shock

Note:1: variable “it” is short for domestic interest rate.

9 As a reminder, even a negative impact does not mean that the interest rate will increase or decrease as it only means that it will increase or decrease relatively to what is implied by output and inflation expectations.
Note 2: B-GFC and A-GFC refer to the sample periods Before GFC and After GFC, respectively.

Turning to the response of exchange rates to a 25-bps shadow rate shock, our results in Figure 6 show that after GFC all currencies depreciates in nominal terms, except for Mexico. In Brazil and Colombia, it is positive and significant in thorough at least one period after GFC. Collectively, the results show that GFC is also a turning point not only for interest rates but also for exchange rates as the impulse response functions show little sign of external spillovers before GFC.

What is unique in Mexican currency vis-a-vis its Latin American counterparts? It is the combination of two desired trading properties: its low carry and high liquidity. According to the Triennial Central Bank Survey (2016), Mexican peso (MXN) is the second most-widely traded emerging-market currency in the world, after the renminbi. The low carry cost makes MXN an attractive instrument to hedge against losses in other EMEs peso and MXN is often seen as a proxy to express risk views of the region.

Figure 6: Impulse response function of foreign exchange rates to US shadow rate shocks
Reported coefficients are expressed in bps for a 25-bps US shadow rate shock

No other country in the sample shows the kind of balance between liquidity and carry that MXN enjoys. The side effects of this condition reflects in the reaction of Mexican central bank to spillovers, including the pace and intensity of foreign exchange interventions, as we will discuss shortly. Of course, the literature shows that EMEs’ propensity to financial turbulences depends on a number of variables, not limited to those related to macroeconomic fundamentals. As discussed in Section 2, Eichengreen and Gupta (2015) have shown that size and liquidity of financial markets matters for the size of external shocks to currency markets through its effect on the ability of investors to rebalance portfolios depends on those variables. All things considered, it is reasonable to find that foreign exchange responses are heterogeneous.
Turning to our last building block of model (19), the response of exchange rates to a 25-bps domestic medium interest rates shock is commented on Figure 7 below. We would expect that exchange rates would appreciate in response to interest rate increases. That is the overall assessment of the period before GFC, where we can find negative and occasionally significant responses in Chile, Colombia, and Mexico. However, as we move to the period after GFC, there is an upward shift in the response, especially in Brazil and Mexico. Even in Colombia, the response was negative and significant before GFC and non-significant afterwards.

Figure 7: Impulse response function of foreign exchange values to domestic medium interest rates shocks
Reported coefficients are expressed in bps for a 25-bps US shadow rate shock

Note:1: variable “FX” is short for foreign exchange.
Note 2: B-GFC and A-GFC refer to the sample periods Before GFC and After GFC, respectively.

Thus, the overall picture is that the sampling period matters for the analysis of spillovers to interest rates and foreign exchange markets. According to Taylor (2013), monetary policies in advanced countries deviated from the standard rules after GFC forcing other central banks to deviate from their own optimal policies, amplifying spillovers. The literature provides examples of results that are broadly in line with this study. In a sample that includes Chile, Colombia, and Mexico, Albagli et al (2018) also find that US monetary spillovers to fixed income markets in EMEs are larger after GFC. Curcuru et al (2018) obtain similar results for Brazil and Mexico. On the other hand, Takáts and Vela (2015) find smaller spillovers after GFC, which is consistent with the smaller proportion of central bankers claiming to follow advanced countries monetary policies according to BIS questionnaires. Chen, Mancini-Griffoli, and Sahay (2014) attribute larger spillovers after GFC to the instruments used in the unconventional phase of monetary policy while Curcuru et al (2018) conclude that the impact in Brazil and Mexico are greater due to an increased sensitivity to expected changes in interest rates rather than term premium variations.

With the results discussed above, we are able to recover structural parameters regarding the impact of US interest rates on financial variables of EMEs. However, we are still unable to compare spillovers between countries by pointing out which was the most or least affected or which component of the portfolio balance model plays a bigger role. We exercise this
comparison between countries by identifying the four spillover components for each country as depicted in Table 6, which follows the methodology described in Section 5. At this point, we use point impulse coefficients to aggregate the components to better address the practical use of our spillover indicators, except for the expectation component where we use the significance of the sensitivity indicators in equation (17).

Table 6: Components of spillovers for each sample and country and aggregate effects on interest rates and exchange rates
Reported components are expressed in bps for a 25-bps shock in shadow rates.
To match the definition of $\Delta i^{(e)}$, negative components imply depreciation and positive coefficients mean appreciation.
The aggregate interest rate component ($\Delta i^{(e)}$) as well as the expectation ($\Delta exp^{(e)}$) and monetary spillover ($\Delta ms^{(e)}$) components are expressed in bps as the absolute percent change for a 25-bps shock in shadow rates.
The aggregate exchange rate component ($\Delta e^{(e)}$) as well as the external spillover ($\Delta es^{(e)}$) and domestic spillovers ($\Delta ds^{(e)}$) components are expressed in percentage points for a 25-bps shock in shadow rates.

<table>
<thead>
<tr>
<th></th>
<th>Before GFC</th>
<th>After GFC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta exp$</td>
<td>$\Delta ms$</td>
</tr>
<tr>
<td>Brazil</td>
<td>0</td>
<td>-14.10</td>
</tr>
<tr>
<td></td>
<td>$\Delta e$</td>
<td>4.58</td>
</tr>
<tr>
<td>Chile</td>
<td>0</td>
<td>4.58</td>
</tr>
<tr>
<td></td>
<td>$\Delta e$</td>
<td>4.58</td>
</tr>
<tr>
<td>Colombia</td>
<td>0</td>
<td>-24.39</td>
</tr>
<tr>
<td></td>
<td>$\Delta e$</td>
<td>-24.39</td>
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<tr>
<td>Mexico</td>
<td>0</td>
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We opt to segment the analysis according to commonalities between countries. In that respect, we begin the analysis with Brazil and Colombia that remarkably share very similar reactions in all components. First, as far as the expectations component is concerned, it is significant only in Brazil and Colombia. Despite the fact that the impact is very subtle, the impact of shadow rate shocks on expectation increases in the transition between the period before GFC and afterwards. Regarding the monetary spillover component, we highlight that monetary spillovers were negative before GFC, which means that there is a reduction in domestic interest rates of 14.1 bps and 22.6 bps following a 25-bps US shadow rate shock.

Recall that monetary spillovers are absent from changes in domestic GDP and inflation expectations so that it is entirely explained by international economic developments. Intuitively, thus, monetary spillovers can be negative if increases in US interest rates are related to strong international economic prospects that lead to overall reduction in global risk (summarized by $\Delta r^{(e)}$, the risk components that is part of the external spillover component). As a matter of fact, credit ratings in both countries had a declining trend in the first subsample, which led both countries to the investment-grade category later on. In fact, Ammer et al (2016) show that spillovers can be either positive or negative depending on which transmission channel prevails. Moreover, the assessment whether a monetary policy is tightening or accommodative depends on the judgement of its policy reaction function. In fact,
global monetary policy\textsuperscript{10} has been below levels implied by Taylor rule in the beginning of the 2000s suggesting accommodation even when interest rates were rising in the US. Lastly, shadow rate shocks did not affect exchange rate components by representative amounts before GFC.

After GFC, however, we can see a remarkable upward shift in levels in all components in Brazil and Colombia. Monetary spillovers are now positive as 25-bps shadow rate shocks increase interest rates by 10.8 bps and 7.4 bps, in Brazil and Colombia respectively. Actually, Unconventional Monetary Policy (UMP) headed shadow rate movements for most part of the period after GFC. The increase in global liquidity that followed UMP eased financial constraints in EMEs in general. Identical channel of transmission can explain the remarkable shift in the external spillover component of exchange rates as global liquidity increases caused by UMP appreciate the exchange rate, while the reverse is true when liquidity wanes. A 25-bps shadow rate depreciates Brazilian and Colombian currencies by 2.63% and 1.89%, respectively. Judging by the relative magnitude of domestic spillover components in both countries, monetary spillovers were not powerful enough to play the “leaning against the wind” role in the exchange rate markets.

To conclude this part of the analysis, we show that Brazil and Colombia present only partial monetary autonomy as we find the presence of sizeable monetary spillovers. Also, the existence of large external spillovers to the exchange rate in the presence of monetary spillovers is a sign of the failure of domestic interest rates to rein in exchange rate movements. Thus, the heavy use of FX interventions in both countries can be seen as a complementary economic policy strategy. By the way, Colombian Central Bank provides mechanisms for discretionary and rule-based\textsuperscript{11} interventions in the spot and derivatives markets. More recently, the preference has shifted towards pre-announced interventions, with predetermined volume. Since 2015, interventions are triggered when the nominal exchange rate exceeded a specific threshold. In Brazil, the program of FX interventions proposed by the Brazilian Central Bank of Brazil (BCB) in the aftermath of the taper tantrum of May 2013 is unique in terms of magnitude and extent. Previously, although BCB has always intervened in the FX market in a systematic way, it did so by means of irregular and unexpected interventions. On August 22, 2013, BCB announced daily sales of USD 500 million worth of traditional swap contracts and USD 1 billion on repurchase agreements on Fridays. The program has been extended until March 2015.

Mexico establishes a middle ground in the analysis of spillover components. First, note that monetary spillovers cannot be ignored as we find there is an increase in the range of 6-7 bps in domestic interest rates due to a 25-bps shadow rate shock. Contrary to Brazil and Colombia, though, $\Delta m_{s}$ is stable across sub-samples. In terms of exchange rate impact, the depreciation of the exchange rate due to a US monetary shock of 25-bps is negligible before GFC and, again, the external spillover component is the predominant driving force. After GFC, we find a negative external impact that is compatible with the shape of the impulse response function in Figure 5. As already noted, we speculate that our finding that currency appreciates when shadow rate shocks are positive owes to the unique position of Mexican peso in the international market (relatively to our sample) coupled with its deep economic linkages with the US. Finally, it is worth mentioning that Mexican Central Bank offered pre-programmed

\textsuperscript{10} See, for instance, “Taylor rules and monetary policy: a global “Great Deviation?””, BIS Quarterly Review, September 2012, by Boris Hofmann and Bilyana Bogdanova.

\textsuperscript{11} From December 2001 to February 2012, the rule was triggered 231 times, highly concentrated in the period of 2006-2008. Average sales were higher than average purchases of dollars but purchases were conducted more frequently.
interventions in two different periods after GFC: from March through September 2009, amounting to USD 10.3 billion, and from March through November 2015, totaling USD 20.7 billion. Such strategy adds to our conclusion that the inefficacy of monetary spillovers as a means to avoid currency overshooting.

We conclude that Chile, our last country in the sample, presents a higher degree of monetary autonomy and smaller currency market volatility. We find that monetary spillovers are lower than its counterparts, and more importantly, it is stable across sub-samples. The legacy of a well-designed IT framework, together with strong macroeconomic fundamentals, may explain its apparent monetary insulation. We also identify that Chilean currency is the least affect by shadow rate movements as it depreciates 0.29% when subject to 25-bps shadow rate shock. Ideally, countries with higher output prospects and stronger fundamentals are favored against feeble domestic conditions in terms of capital flows. As the degree of capital mobility can shape the reaction of currency markets to risk variations, it could induce different reactions between countries. Such stability is reflected in its exchange rate policy as interventions in Chile are essentially sporadic even after GFC. It occurred during exceptional episodes of uncertainty and volatility as we identify only four short-lived intervention episodes: 2001, 2002, 2008, and 2011, all of them unannounced and short-lived.

These findings suggest that as the United States normalizes its monetary policy with the liftoff of its policy rate, emerging economies will face sizeable interest rate spillovers to domestic interest rates. However, even if central banks adjust the response of domestic monetary policy to avoid excessive fluctuation in the level of exchange rates, we find that such strategy is inefficient and could potentially induce excessive volatility in domestic expectations and jeopardize monetary policy conduct in EMES. The intended but underachieved consequence of central bank overreaction is offsetting currency depreciation, which not only confirms the presence of a fear of floating behavior but also it is a symptom of monetary dependence to some degree.

In terms of our portfolio model, as we usually find that the domestic monetary impact is lower than the international shock ($\Delta i^d < \Delta i^e$), bond outflows explains currency depreciation that follows external shocks. For the sake of argument, if we check the correlation between bond inflows$^{12}$ and US shadow rate variation we find that correlations$^{13}$ are in fact negative (between -0.2 and -0.3). Remember, though, that we augment the range of possible responses of the exchange rate in the model that demand sensitivities to interest rates are free parameters.

To conclude, our purpose is to isolate the pure effect of US monetary spillovers. In that respect, our findings point to a structural break in US monetary spillovers after GFC. It is important to highlight, though, that this paper does not account for all international spillovers to EMES. Aside from pure US monetary spillovers, spillovers from the Chinese economy or commodities prices, to take a few, also affected the emerging market economies in our sample. Let alone the domestic challenges face by some countries like Brazil, which is running fiscal deficits for five years in a row, or the economic measures in Colombia to overcome the persistent economic slowdown since 2015. Such factors also played important roles in the evolution of domestic interest rates and currencies throughout this period.

$^{12}$ Balance of payments accounts reports all external investments in a bundle, which includes riskier assets.

$^{13}$ We do not possess monthly data on inflows from Colombia.
6.2. Time varying analysis

Treating system instability through subsampling is an efficient and simple way to handle it, although it is not free from criticism. Its main drawback is that subsampling requires as many subsamples as the number of potential structural breaks. Besides, even though the choice of the sample break is not entirely arbitrary, it inevitably carries an amount of subjectivity. Accordingly, this section aims to understand the degree of changes in the response of both recursive VARs (models (15) and (18)) in order to conclude whether or not our subsampling procedure is valid. In this respect, we apply two different approaches: a time-varying Structural VAR with Stochastic Volatility (TVP-SVAR-SV) and rolling window (RW) estimates.

The time-varying structural VAR approach is based on the work Primiceri (2005), for which we only provide a general description. Consider the general form of a time-varying VAR of order 1 with stochastic volatility, which is meant to capture heteroscedasticity of the shocks and nonlinearities in the contemporaneous relations:

\[
y_t = C_t + B_t y_{t-1} + A_t^{-1} \Sigma_t \epsilon_t
\]  

where \(y_t\) is an \(n\)-random vector of observed endogenous variables; \(C_t\) is a \(n\)-vector of time-varying intercepts; \(B_t\) is a matrix of time-varying coefficients; \(A_t\) is a lower triangular matrix with ones on the main diagonal and time-varying coefficients below it; \(\Sigma_t\) is a diagonal matrix of time-varying standard deviations; \(\epsilon_t\) an \(n\)-dimensional white noise process with variance equal to the identity matrix.

All time-varying coefficients evolve as random walks, except for diagonal elements of \(\Sigma_t\), which behave as geometric random walks. The innovations in the model are jointly normally distributed, with mean equal to zero and its covariance matrix follows a block diagonal structure as described in Primiceri (2005).

Bayesian inference on model (23) amounts to updating prior beliefs about the VAR parameters that are seen as stochastic variables and it is the most suitable method to estimate this class of model. Consequently, Bayesian methods are used to simulate posterior distribution of the unknown objects of the model (\(\Sigma_t, B_t, A_t\), and the covariance matrix of the innovations) by Gibbs sampling. Time variation in the coefficients (\(B_t, A_t\)) accounts for changes in the propagation mechanism (response) and time variation in the covariance matrix accounts for changes in the size of the shocks (impulse). All things considered, data will determine the main source of time variation of the linear structure.

The first 24 observations are used to calibrate model (23), whose initial states of the unknown coefficients are set according to Primiceri (2005). The initial mean of the unknown coefficients are set to be its respective OLS estimates period and standard deviations are multiples of the OLS counterparts. Time-varying amplitude relies on arbitrary parameters applied to the covariance structure of the innovations. In order to avoid implausible behavior of time varying coefficients, we again follow Primiceri (2005) and the related literature in its definition.

Figure 8 shows the value of the monetary spillover component in each month \(t\). First of all, we clearly observe a pattern of rising effect in all countries, except in Chile and Mexico. In Brazil and Colombia, monetary spillovers are negative before GFC and positive after GFC, which corroborates our previous results. It is also clear that October 2008 is a turning point for Brazil and Colombia, which validates our exclusion of the period surrounding the epicenter of GFC. While we confirm that GFC is the most important event in the sample period, we acknowledge
that we observe additional jumps in the response, which owes to the degree of discretion of central bank reaction to international spillovers. In this respect, we note periods of instability in our estimates as we identify upward trends between 2013 and 2016, probably due to tapering news and the beginning of US monetary policy normalization.

Narrowing down the analysis, we can see that Chile is the only country in which the behavior of interest rates is notably stable. As we can see in Figure 8, our previous finding that monetary spillovers in Mexico are stable hides the fact that there are at least three periods of least three distinguishable cycles of monetary reaction: in 2005, 2008-2009 and 2013-2016.

Figure 8: Monetary spillover component to interest rates, in each month (TVP-SVAR-SV)
Reported coefficients are expressed in bps for a 25-bps US shadow rate shock
The vertical line is set to October 2008.

As another illustration of time-varying properties of the model, we opt to zoom in on the behavior of our model along the sample period as we show impulse response functions that track the main building blocks of our components’ decomposition in four different months: two observations have been arbitrarily chosen to represent the period before GFC and other two observations for the period after GFC.

In Figure 9, we present impulse response function of domestic medium interest rates to inflation expectations shocks. It is also worth noting that response is positive for every country, which holds well with the subsampling exercise and the stylized fact that interest rate decisions are positively correlated to inflation expectations. There is just one negative contemporaneous coefficient in Mexico in June 2012 that stands out, but there is well-established pattern of reaction, with varying degrees of intensity. In Brazil, Chile, and Mexico we may group the first pair of months (January/2006 and January/2007) as the one with the greater response and the second pair (June/2012 and January/2016) with less intense response. In Colombia, the evidence is more mixed as the greater reaction occurs in January/2016 that pertains to the period after GFC. Another common feature is that responses converge to zero after four months.
Figure 9: Impulse response functions of domestic medium interest rates to inflation expectations shocks in January 2006, January 2007, June 2012 and January 2016 (TVP-SVAR-SV).

Reported coefficients are expressed in bps one standard deviation inflation expectation shock.


Regarding the response of exchange rates to US shadow rate shocks, we find that contemporaneous coefficients are positive in mostly positive, or that the initial response of exchange rates is to depreciate due to an increase in shadow rates. As we look at the response at subsequent horizons, we find that after the initial overshooting there is a correction process that leads to a total appreciation response in Mexico, and a total depreciation in Brazil, Chile and Colombia, again corroborating our previous findings.

Figure 10: Impulse response functions of exchange rates to US shadow rate shocks in January 2006, January 2007, June 2012 and January 2016 (TVP-SVAR-SV).

Reported coefficients are expressed in bps for one standard deviation US shadow rate shock.


Figure 11 measures the direct effect of interest rates to exchanges rates. To make it clear, recall that the domestic spillover component only consider the effect of interest rates that is
owed to changes in shadow rate changes ($r^*$). Thus, it is not directly comparable to domestic spillover because the response depends on the sign of monetary spillovers.

The usual assumption that exchange rates appreciate when interest rates rise is only found in Brazil (before GFC) and Colombia. The change in the sign of the impulse response suggests an exchange rate overshooting that reaches equilibrium after 4 months. In Chile and Colombia, domestic interest rate hikes depreciates each currency. Also, we cannot ignore the fact that responses can be quite different even when they belong to the same sub-sample. Chile and Colombia provides good examples of this assertion.

Figure 11: Impulse response functions of exchange rates to domestic medium interest rates in January 2006, January 2007, June 2012 and January 2016 (TVP-SVAR-SV). Reported coefficients are expressed in bps for one standard deviation US shadow rate shock.

As a final robustness check, we compute the dynamic evolution through a rolling window application of our models that consists of a window size of 60 observations. A rolling window exercise adds to the effort of opening the black box of the reaction as we break up spillover components overtime using different methods. As we analyze it, we are looking for persistent trends and opt to overlook short term fluctuations.

Regarding the monetary spillover component, we present its evolution in Figure 12. With that in mind, in Brazil and Colombia, it steadily increases after GFC again matching our previous results. In Mexico, the increase is triggered in a later moment with the beginning of US monetary normalization talks in 2013 that generates jumps in spillovers followed by stabilization in a higher level. In Chile, our data sample before GFC is too small to be conclusive, but we can note a positive trend after 2014.
When we analyze external spillovers, we also identify an uprising trend in Brazil and Colombia. The rolling window analysis shows that the negative external spillover component that we find at the sub-sample analysis of Mexico is limited to the last three years of the sample. In Chile, apart from short-term fluctuation, this component is rather stable.

Regarding domestic spillovers in Figure 14, the main is that there is a positive trend in all curves after 2013, which indicates that tapering news had an important and persistent impact on the evolution of exchange rates and interest rates in all countries.
With the information at our disposal, we can assert that the tapering announcement matters for spillovers in a persistent way and qualify as a potential structural break in the data, beyond GFC. Also, apart from periods of noise and jumps, the overall evolution of each component is well-behaved as the signs align with our previous results.

That said, it is not right to interpret each component as if they are valid at any point in time. As we are ultimately interested in assessing the level of stability of our models, we acknowledge that responses diverge to some extent. However, we claim that this divergence is consistent with the subsampling exercise in many ways. But they do serve as a guide for macroeconomic analysis and for our specific purpose of decomposing the impact of international monetary spillovers to exchange rates and interest rates.

7. Conclusion

Following the Global Financial Crisis (GFC), shifts in the stance of monetary policy have always renewed interest in measuring monetary spillovers. But this time is different insofar as the combination of unconventional and conventional monetary policies set up a new framework of monetary policy with potential changes in its spillover effects. With that in mind, this paper analyzes the effect of US monetary policy shocks on interest rates and exchange rates of four EMEs: Brazil, Chile, Colombia, and Mexico between January 2002 and September 2017. The point is that the radical changes in terms of monetary policy settings in the recent period may have affected the response of EMEs financial markets to international monetary spillovers.

The main contribution to the related literature lies in the effort to decompose international monetary spillovers to interest rates and exchange rates in EMEs. To our knowledge, this is the first paper that offers a method to decompose spillovers in both markets and test its evolution dynamically, through sub-sample and time-varying estimates. The foundation of our identification method is the estimation of two small size VAR models that capture the interaction between domestic and international interest rates with the exchange rate. It follows the idea of Caceres, Carrière-Swallow and Gruss (2016) where identification is obtained through the sequencing of VAR models with recursive identification, a multi-stage approach. Exchange rate components are depicted through a portfolio model on the spirit of Blanchard et al (2016). This approach generates the following spillovers components: expectations and monetary spillover components for the determinants of spillover on interest rates; external and domestic spillover components for the determinants of spillover on exchange rates.
In the sub-sample analysis, we find that Brazil and Colombia share similar reactions to shadow rate shocks. Regarding monetary spillovers, we can note a remarkable upward shift and those hose are the only countries where shadow rate shocks impact interest rates through inflation and output expectations. Concerning the impact on exchange rates, we identify a remarkable shift in the external spillover component, while domestic spillover component to the exchange rate were small. We conclude that monetary spillovers were not powerful enough to play the “leaning against the wind” role in the exchange rate markets. All in all, we show that Brazil and Colombia present only partial monetary autonomy as we find the presence of sizeable monetary spillovers. In Mexico, we identify large and stable monetary spillovers across sub-samples. In terms of exchange rate impact, the depreciation of the exchange rate due to a US monetary shock of 25-bps is small. After GFC, though, we find that shadow rate hikes appreciate Mexican currency. We conclude that Chile presents a higher degree of monetary autonomy and smaller currency market volatility. We show that Chilean monetary spillovers are lower than those its counterparts, and more importantly, they are stable across sub-samples. We also identify that spillover components to Chilean currency are weak. We attribute spillover moves in the transition between sub-samples to the implementation of Unconventional Monetary Policy (UMP) and macroeconomic fundamentals can explain different reactions between countries.

While it is obvious to take October 2008 as the primary turning point in the sub-sample analysis, we perform a time-varying estimates that identify that tapering news impact spillover components and qualify as a potential second structural break in the data. We also perform time-varying estimates in order to assess the robustness of our results. In general, it confirms the conclusions of the sub-sample analysis on the dominance of the monetary spillovers and external spillover components. Apart from periods of noise and jumps, the overall evolution of each component is well-behaved as the signs align with our previous results. That said, spillover components serve as a guide for macroeconomic analysis and for our specific purpose of decomposing the impact of international monetary spillovers to exchange rates and interest rates.

These findings suggest that in fact central banks in the four countries of the sample adjust the response of domestic monetary policy to counterbalance the spillover effect on the currency market. The rationale behind this reaction is to limit currency pass-through that could jeopardize its monetary policy conduct. Actually, Herwartz and Roestel (2017) offer evidence on the relationship between currency stability and monetary autonomy, suggesting that this tradeoff would be favored and more palatable to central bankers with the reduction of the degree of financial openness.

To conclude, we highlight that, although the spillover components identified in the study represent a major portion of the total spillovers, our paper does not deal with second order effects of international monetary spillovers. By second order effects, we mean the lagged impact on different markets, other than the ones we study, that can ultimately interfere in the domestic monetary process and the exchange rate. Since the impact on those markets can take time to mature, it is not temporally related to the evolution of international rates. The methodology, with some additions like, for instance, the control of macroeconomic announcements, could benefit from the use of higher frequency data, which would relieve the lag length constrain.

8. References


