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Essays of macroeconomic shocks, exchange rate dynamics, output reaction, and stock market return: the role of identified source and channels

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Ensaios sobre choques macroeconômicos, dinâmica da taxa de câmbio, reação do produto e retorno do mercado de ações: o papel de choques identificados e canais.

Resumo

Esse trabalho analisa o repasse cambial e seus determinantes nos países emergentes. É averiguado os impactos do repasse cambial e identificado, de acordo com a origem dos choques, o grau do do repasse cambial. É apontado que a origem dos choques desempenha um papel relevante na resposta do nível de preços. A seguir, esse trabalho também investiga como o mercado acionário brasileiro responde a choques condicionados a diferentes origens. É encontrado que choques de origem doméstica são mais relevantes para o mercado acionário brasileiro do que choques que vem do exterior. Adicionalmente, nos analisamos como a atividade econômica é afetada por depreciações cambiais por meio do canal de comércio e financeiro para diferentes grupos de países. Encontra-se uma relação positiva para o canal comercial e uma relação negativa para o canal financeiro. No entanto, países que possuem mais ativos em moeda estrangeira do que passivos, o canal financeiro opera na direção oposta, melhorando as condições financeiras domésticas, incrementando a atividade econômica. Esse resultado mostra a importância das posições em moeda estrangeira dos bancos para determinar o sinal do canal financeiro.

Palavras-chaves: BGVAR, estimação bayesiana, repasse cambial, mercado de ações, estimação em painel, canal financeiro, canal comercial.

Abstract

This work analyzes the exchange rate pass-through and its determinants in emerging countries. It examines the impact of shocks on the exchange rate pass-through and identifies the source of the shocks that determine the degree of exchange rate pass-through. We show that the source of the shocks is essential to the price level response. The study also investigates the Brazilian Stock market responses conditional on the source of the shocks. The findings suggest domestic outcomes are more relevant for the Brazilian stock market return than foreign outcomes. Additionally, we show how local currency depreciation affects economic activity through trade and financial channels in different countries. We found a positive relation for the trade channel and a negative sign for the financial channel. However, in countries with more foreign currency claims than liabilities, the financial channel operates in the opposite direction, improving domestic financial conditions and boosting economic activity. This highlights the importance of banks' foreign exchange rate position in determining the sign of the financial channel.

Key-words: BGVAR, bayesian estimation, exchange rate pass-through, stock market, panel estimation, financial channel, trade channel.

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Introduction

Many studies have been published to analyze the exchange rate pass-through. The exchange rate pass-through is defined by the magnitude of the price level reaction after exchange rate movements. In some economies, mainly emerging countries, there is a close look at the determinants of the exchange rate pass-through since they are prone to be impacted by exchange rate shocks. Those studies have covered various determinants of exchange rate pass-through, including asymmetries between exchange rate appreciations and depreciation, non-linearity, the role of anchored inflation expectation, and the economic activity performance in those events. However, only recently, the source of the shocks has been considered an essential factor in determining the degree of exchange rate pass-through. In this case, domestic variables' reactions might differ significantly depending on the source of the shocks. Those differences determine the degree of the exchange rate pass-through.

To do that, the first part of this work investigates the exchange rate pass-through conditional in the source of the shocks. Using the BGVAR methodology, we jointly model how the price level of 5 Latin American countries behave after the domestic, regional, and global shocks. We analyze the reaction of the price level after the shocks and how those shocks impact the exchange rate. This study confirms that the source of the shocks is decisive in determining the degree of exchange rate pass-through. Indeed, the result becomes essential for the policymakers. If they can identify the shocks hitting the economy, they can make better inferences about the exchange rate pass-through and properly respond to the event.

Next, We use the same methodology applied in the first part of this work to analyze how the three Brazilian stock market indexes behave after shocks identified by their origin. The aim is to identify the Brazilian stock market responses according to shocks from domestic, regional, and global sources. In summary, we have identified that the Brazilian stock market responds more to domestic shocks than foreign ones, with the demand shocks having the most persistent and strong impact. This outcome shows how domestic outcomes are more relevant for the Brazilian stock market return than foreign outcomes.

An intriguing result in this work's previous part is based on the output reaction after an exchange rate shock. In some countries, economic activity rises following a local depreciation currency, and in other countries, the output gap declines. This result might be explained by the channels through which exchange rate movements operate in those economies. Following this line, we present a study examining which channels the exchange rate impacts domestic economic activity in the third part of this work. Two main channels are investigated: the trade channel, which means the local currency appreciation and depreciation effects in the exports and imports, and the financial channel, representing possible changes in the domestic financial conditions.

We have a common intuition that local currency depreciation positively affects economic activity through its effects on net exports. However, the financial channel might operate in the opposite direction, depressing the economic activity. In order to do that, we investigated how the trade and financial channels work in a panel of countries divided by geographic location, level of development, and a measure of domestic banks' foreign currency exposure. We find a positive relation for the trade channel meaning that the net exports will rise with the local currency depreciation and a negative sign for the financial channel. Notwithstanding the countries with more claims than liabilities in foreign currency in their bank balance sheets, the financial channel operates in the opposite sign. This means that when a local depreciation occurs, the domestic financial conditions are improved, making depreciation booming the economic activity through the financial channel. That is a new outcome in the literature and shows how the foreign exchange rate position by the banks is important to determine the sign of the financial channel of exchange rate movements.

1 Shock Dependent Exchange Rate Pass-Through - An Analysis for Latin American countries

This chapter investigates the exchange rate pass-through considering the source of the shocks that hit the economy. With a Bayesian Global VAR model, the exchange rate pass-through is analyzed for 5 Latin American countries: Brazil, Chile, Colombia, Mexico, and Peru. The model is estimated with Bayesian techniques and is identified by sign and zero restrictions. The BGVAR estimation enables us to allow spillover between countries mimicking the real conditions when the shocks hit the economies. Four domestic shocks for each Latin American country are considered: an exchange rate shock, a risk premium shock, a monetary policy shock, and a demand shock. The demand shock has the highest exchange rate pass-through for all the countries and the exchange rate shock has the lowest. Additionally, two regional shocks are considered: a regional monetary policy shock, an event in which the region raises its interest rate, and a regional risk premium shock, where the risk premium rises simultaneously. For most countries, the exchange rate pass-through coming from those regional shocks is lower than its domestic counterpart shock. Finally, we investigate two global shocks, an uncertainty shock, and a global commodities/demand shock. The uncertainty shock decreases economic activity and depreciates the exchange rate with a negative exchange rate pass-through in the middle term. The commodities/demand shock increases the economic activity and appreciates the exchange rate pass-through, having a negative or neutral exchange rate pass-through over time.

1.1 Introduction

Exchange rate pass-through is a topic that always comes into the discussion when the exchange rate volatility arises. Emerging countries face this volatile environment more periodically, and understanding its consequences is imperative for policymakers. The exchange rate pass-through (ERPT henceforth) is defined as the degree of the exchange rate movements transmitted to the domestic price level. This ERPT definition explains much of the importance of understanding how it evolves through the economy and the key factors that determine its magnitude. For example, the Central Bank should comprehend the ERPT in order to set the interest rate and avoid a wrong response of the monetary policy. The ERPT also has implications on investment and savings decisions and current account balances.

The literature presents a wide pool of methodologies to investigate the exchange rate pass-through. (CAMPA; GOLDBERG, 2005), for instance, use single equations to investigate how the exchange rate movements impact the import prices. They control for variables that might affect the degree of the pass-through and found evidence that the pass-through is less than 1 (incomplete), with macroeconomic variables such as the volatility of the exchange rate and the average inflation being important to explain the cross-country differences. With an open-economy macroeconomic model, (CHOUDRI; HAKURA, 2006) also have found strong evidence that the average inflation determines the degree of the pass-through dominating other macroeconomic variables. Using a model of firm behavior including staggered prices, (TAYLOR, 2000) emphasizes the importance of a low and stable inflation scenario for a low pass-through environment. In his model, the firms set prices for future periods taking into account the costs that may occur during these periods. In a high-inflation environment, the cost increases tend to be more persistent and the firms are more prone to adjust their prices to any cost pressure, including the exchange rate depreciation.

The volatility of the inflation rate is consensual as one of the main factors that influences the degree of ERPT. However, it seems that the monetary environment is crucial since having inflation expectations anchored is also very important. MISHKIN (2007, 2008), (MENDONçA; TIBERTO, 2017) suggest that having anchored inflation lesser the degree of the ERPT. In a panel data analysis for developing countries, (MENDONçA; TIBERTO, 2017) argues that price shocks are mitigated when the inflation expectations are anchored, particularly shocks from the exchange rate.

The business cycle position is another key variable to determine the degree of the ERPT. (CORREA; MINELLA, 2010) employing thresholds models shows us that when the economy is growing faster, the degree of the ERPT is higher. (DONAYRE; PANOVSKA, 2016), (PRZYSTUPA; WRóBEL, 2011), among others also find evidence that an economy in an expansion cycle has higher ERPT. A possible reason for this result is due to a favorable scenario to raise prices when the economy is growing faster as the people might be more willing to accept price increases. As we can see, there are some stylized facts about the variables that influence the degree of the exchange rate pass-through. Notwithstanding, a new look has recently begun to investigate the ERPT: the source of the exchange rate movements. The idea here is to extract information about the kind of shocks that are hitting the exchange rate since the other variable's responses also depend on this shock. A positive demand shock, for example, has different implications for the output and the inflation rate than a monetary policy shock. As those variables are key to determining the degree of the ERPT, their usual response provides information about what we can expect from the ERPT. This shock-dependent ERPT study was pioneered first by (SHAMBAUGH, 2008) but without a closer look at its determinants.

Based on a general open economy framework, (FORBES; HJORTSOE; NENOVA, 2018) provides intuition about how the exchange rate movements translate to the domestic prices, taking into consideration what kind of shock hit the economy. (FORBES; HJORTSOE; NENOVA, 2018) highlight the relevance of identifying the source of the shock since the reaction of the output, the monetary policy, and the persistence of the exchange rate movement can better explain the magnitude of the ERPT. Using a VAR with sign restrictions for the United Kingdom, they found out that the domestic demand shock has the lowest degree of ERPT and the monetary policy the highest one. This finding for the domestic demand shock reflects the idea that after an exchange rate appreciation, the importers face a strong demand and have less incentive to reduce prices. But it is worth mentioning that his result for the demand shock considers an exchange rate appreciation and his finding may not remain with a depreciation event.

There is a growing literature in this area of shock-dependent ERPT in recent years. Studies for specific countries or groups of countries have emerged as (COMUNALE; KUNOVAC, 2017) do for euro area members, (CORBO, 2018) for Sweden, (AN; WYNNE; ZHANG, 2020) for Japan. It is interesting to note that all of those studies employ the VAR with sign restriction approach since this methodology facilitates the identification of the source of the shock. In this line, (HA; STOCKER; YILMAZKUDAY, 2020) is the only one who applies a FAVAR model to analyze the shock-dependent ERPT for forty-seven countries. Following this idea to include more countries, (FORBES; HJORTSOE; NENOVA, 2020) presents a more complete study covering a pool of countries and also finds that the demand and the monetary policy shock have the lowest and highest degree of pass-through respectively. However, those chapters that consider more than one country do not link the countries with each other, and analyze the shock-dependent ERPT individually.

This chapter contributes to the literature by applying a methodology to differentiate the shock by its origins divided into domestic, regional, and global events to analyze the ERPT. We apply the Global VAR (GVAR) approach that is built up to analyze the shocks spillover between countries, considering the relationship between them. In this sense, the Global VAR (GVAR) representation allows us to use the VAR either for a single country or for a group of countries and makes it possible to identify the shock by country and region. Hence we can pick up a complete picture of the shock with a Global model in a way that has not been done before since the literature usually deals with individual country models or big aggregate models as FAVAR. We apply our methodology to a set of 5 Latin American countries - Brazil, Chile, Colombia, Mexico, and Peru. These groups of countries make a good case study since all countries, besides their geographical location, share several macroeconomic similarities with floating exchange rate regimes within an inflation-targeting regime, and are significant trade partners.

The chapter is organized as follows: the econometric methodology and the data sample are shown in the next section. The third section presents the identification strategy followed in the fourth section by the estimation results including the Impulse Response Functions and a measure of the ERPT found. Finally, it concludes in the 5th section.

1.2 Econometric methodology and data sample

We will use the Bayesian Global Structural Vector Auto-regression (BGSVAR) methodology to estimate the exchange rate pass-through. The BGSVAR methodology is the VAR estimated for a group of countries (or entities) allowing spillover between them with Bayesian techniques identified by sign and zero restrictions[1]. To better understand, this methodology will be explained in parts: first showing its basic structure, the Global VAR (GVAR) approach, then the Bayesian inference applied to estimate it, and finally, the inclusion of the structural identification strategy.

- BGSVAR: specification.

The GVAR methodology was developed by (PESARAN; SCHUERMANN; WEINER, 2004) and has been created to evaluate shock spillover between countries. Theoretically, this kind of analysis could be done by VARs, however, due to the quick loss of degree of freedom as more variables are included, the VAR might be unfeasible to make this inference. As such, (PESARAN; SCHUERMANN; WEINER, 2004) proposed a way to estimate VARs, including spillover effect and at the same time deal, somewhat, with the loss of degrees of freedom characteristic.

Let us consider that there are $i + 1$ countries with x endogenous variables. Each of those countries is estimated with its own factors (the x endogenous variables) and also with the weak exogenous variables x^* representing the external variables from the country i. For presentation purposes let's assume the following GVAR model with lag 1 for the country i:

$$x_{it} = a_{i0} + a_{i1t}t + \phi_i x_{it-1} + \Lambda_{i0} x^*_{it} + +\Lambda_{i1} x^*_{it-1} + \epsilon_{it} \tag{1.1}$$

where: a_{i0} and $a_{i1t}t$ are the constant and deterministic time trend of the VAR model for the country i, x is a vector $(k_i \times 1)$ of endogenous variables, x^* is a vector $(k^*_i \times 1)$ of foreign (weak exogenous) variables, ϵ_{it} is a $(k_i \times 1)$ vector of idiosyncratic shocks and ϕ_i is a matrix $(k_i \times k_i)$ of lagged endogenous coefficient.

The idiosyncratic shock can be decomposed in a time-varying variance-covariance matrix $\Sigma_{it} = V_i S_{it} V_i'$ with V being a lower triangular matrix of dimension $k_i \times k_i$ with

[1] Actually, in the literature the BGSVAR is called as BGVAR without the term S. However, we inserted this term to highlight the identification strategy possibility.

elements $v_{ij,n} = (j = 2, ..., k_i; n = 1, ..., j-1)$ and S being a diagonal matrix given by: $S_{it} = diag(\epsilon^{s_{i1,t}}, ..., \epsilon^{s_{ik,t}})$. The Λ_{i0} and Λ_{i1} are matrices $(k_i \times k_i^*)$ of contemporaneous and lagged coefficients of the foreign variables. Note that if $\Lambda_{i0} = \Lambda_{i1} = 0$, equation (1.1) defines a VAR(1), but if we allow the presence of foreign variables, Λ_{i0} and $\Lambda_{i1} \neq 0$, we turn to have a VARX(1,1) with the foreign variables entering in the model contemporaneously and lagged.

The weak exogenous variables are defined in the GVAR model as:

$$x_{it}^* = \sum_{j \neq i}^{N} \omega_{ij} x_{jt} \tag{1.2}$$

where ω_{ij} is a link matrix that is formed by the weighted trade flows or any other economic variables that represent the bilateral connection between the countries. It is worth noting that this bilateral linkage ω_{ij} is exogenous (and fixed) and the weak exogenous variables x_t^* is a function of x_t, allowing to be determined endogenously within the global system. Additionally, we must have $\sum_{j=0}^{N} \omega_{ij} = 1$.

The estimation strategy of the GVAR comprehends two stages: first, it estimates the VARs for the individual countries, assuming that the residuals ϵ_{it} is uncorrelated between the countries. Second, combine the individual VARs with the weak exogenous variables to obtain a Global representation of the model. To achieve a Global representation of the VARs, define z_t as:

$$z_{it} = \begin{bmatrix} x_{it} \\ x_{it}^* \end{bmatrix} \tag{1.3}$$

If we restate the model (1.1) with left-hand size contemporaneous terms, we have:

$$A_i z_{it} = a_{i0} + a_{1t} t + B_i z_{it-1} + \epsilon_{it} \tag{1.4}$$

with $A_i = (I_k, -\Lambda_{i0})$ and $B_i = (\phi_i, -\Lambda_{i1})$. Recalling (1.2) it is possible to re-write the equation (1.4) using a W link matrix:

$$A_i W_i x_{it} = a_{i0} + a_{1t} t + B_i W_i x_{it-1} + \epsilon_{it} \tag{1.5}$$

which $A_i W_i$ and $B_i W_i$ are both $(k_i \times k)$ dimensional matrices. Stacking these matrices for all countries in the model leads to:

$$G x_t = a_{i0} + a_{1t} t + H x_{t-1} + \epsilon_t \tag{1.6}$$

where $a_{i0} = [(a_{00})', ..., (a_{N0})']$, $a_1 = [(a_{01})', ..., (a_{N1})']$, $G = [(A_0W_0)', ..., (A_NW_N)']$, $H = [(B_0W_0)', ..., (B_NW_N)']$ and $\epsilon_t = [\epsilon'_{0,t}, ..., \epsilon'_{N,t}]$. Remind that we have assumed the nonzero contemporaneous shocks correlation between countries, hence $\epsilon_t = [\epsilon'_{0,t}, ..., \epsilon'_{N,t}]$ $\sim \mathcal{N}(0, \Sigma_\epsilon)$ with Σ_ϵ denoting a block diagonal matrix. As G is a full rank matrix and hence non-singular, we can multiply (1.6) from the left by G^{-1} yielding:

$$\begin{aligned} x_t &= G^{-1}a_{i0} + G^{-1}a_{1t}t + G^{-1}Hx_{t-1} + G^{-1}\epsilon_t \\ &= b_0 + b_1t + Fx_{t-1} + e_t, e_t \sim \mathcal{N}(0, \Sigma_e) \end{aligned} \tag{1.7}$$

To ensure stability for the equation above, the eigenvalues of F must lie inside the unit circle. But note that equation (1.7) is also a VAR(1) representation, with the error term e_t including a variance covariance matrix $\Sigma_e = G^{-1}\epsilon_t G^{-1'}$ linking the contemporaneous relationship between countries. As such, it makes it possible to use all the resources of the VAR methodology, including the identification restrictions, impulse response analyses, historical decomposition, and the forecast error variance.

- BGSVAR: Bayesian estimation

One feature of the VAR is the high number of parameter estimates. A usual VAR contains $n + pn^2$ coefficients where n is the number of parameters and p is the number of lags, showing how quickly the number of coefficients grows fast. For example, a VAR with only 2 lags and 4 variables involves 36 parameters, but this same VAR with 4 lags has an incredible 68 parameters, which requires a much larger data set to estimate it. Even in the case of the GVAR approach which employs a smart strategy estimating a smaller number of parameters, we still face the aforementioned problem of degrees of freedom. This issue becomes more challenging when we deal with macroeconomic series that, traditionally, do not have a wide span coverage.

The Bayesian VAR comes to deal with this challenging issue of degrees of freedom. In this subsection, I strongly follow (FELDKIRCHER; HUBER, 2015) and (FELDKIRCHER; GRUBER; HUBER, 2019) which shows the application of the SSVS prior in the GVAR context. According to them, there are some interesting properties, that made the SSVS prior specification a good choice for the GVAR estimation. Hence, I will present some of these smart properties of the SSVS prior but recommend those papers if any doubt remains open.

The SSVS is a hierarchical prior selection that applies shrinking on the parameters of the model. Formally, the SSVS prior takes into consideration the uncertainty about the variable choice which is very useful for this kind of estimation where it is allowed to vary specifications between countries[2]. Denoting the vector of coefficients for country i as

[2] As I will show in the next section, some countries VAR are different from each other

$z_i = \{a_{10}^{'}, a_{1it}^{'}, vec\ \{\Lambda_{i0}\}, vec\{\Lambda_{i1}\}, vec\{\phi_i\}\}$ with $k_i = 2k_i + k_i(pk_i + qk_i^*)$ dimension, we have:

$$z_{ij}/\delta_{ij} \sim \mathcal{N}(0, \tau_{ij,0}^2)\delta_{ij} + \mathcal{N}(0, \tau_{ij,1}^2)(1 - \delta_{ij})\ for\ j = 1, ..., k_i \tag{1.8}$$

Where δ_{ij} is a random binary variable, assuming 1 if a variable j is included in the model and 0 otherwise; $\tau_{ij,0}^2$ and $\tau_{ij,1}^2$ are the prior variances representing the spike and the slab components, with $\tau_{ij,0}^2 >> \tau_{ij,1}^2$ and $\tau_{ij,1}^2$ set close to 0. Those prior variances mean that if there is a small coefficient in the model, the spikes component applies, pushing the posterior distributions toward zero. On the other hand, if the coefficient is higher, little shrink is used, leaving the prior as non-informative (the slab component). Hence, the posterior will be pushed towards zero or towards the value of the likelihood depending on the size of the coefficient.

The parameter δ_{ij} plays an important role in the prior selection because its value determines which prior variance of the Gaussian distribution in equation (1.8) is used. If δ_{ij} equals 1, the first term with the slab component is chosen and if δ_{ij} equals zero, the second term with the shrinking variance is adopted. Note that the parameter δ_{ij} should be estimated and following (FELDKIRCHER; HUBER, 2015) and (FELDKIRCHER; GRUBER; HUBER, 2019) I assume a Bernoulli distribution prior with prior inclusion probability of 0.5 for all i and j. This means that every variable is equally likely to be in the country VAR model such that: $p_{ij} = 0.5 = p(\delta_{ij} = 1/z_{it})$. So, given the probability δ_{ij} =1, the posterior distribution $p(\delta_{ij} = 1/z_{it})$ can be written as:

$$p(\delta_{ij} = 1/z_{ij}) = \frac{\mathcal{N}(z_{ij} \mid 0, \tau_{ij,0}^2)}{\mathcal{N}(z_{ij} \mid 0, \tau_{ij,0}^2) + \mathcal{N}(z_{ij} \mid 0, \tau_{ij,1}^2)} \tag{1.9}$$

Equation (1.9) shows that we have a mixture of densities based on the centered value of z_{ij}. Supposing that z_{ij} is close to 0, the shrinking component would prevail and the posterior density will be close to 0. On the other hand, if z_{ij} is higher, then the slab prior variance would overcome and the posterior distribution will approximate to 1. One important feature of the SSVS is that no variable is excluded from the model even if a variable equals 0.

Regarding the variance-covariance, I also follow an SSVS prior specification. But before introducing this, it is important to mention that I assume stochastic volatility for the variance-covariance in the estimation process. The stochastic volatility sets up an auto-regressive process for the log-volatilities of the error term, which might incorporate relevant characteristics of the series, like the periods of booms and busts and the volatility of the series[3]. This AR(1) process can be written as[4]:

$$s_{ij,t} = \mu_{ij} + \rho_{ij}(s_{ij,t-1} - \rho_{ij}) + \kappa_{ij,n} \tag{1.10}$$

where the s component comes from the diagonal element of the matrix $S_{it} = diag(\epsilon^{s_{i1,t}}, ..., \epsilon^{s_{ik,t}})$, μ_{ij} is the unconditional mean, ρ_{ij} represents the inertia parameter and $\kappa_{ij,n}$ is a white noise disturbance with variance ζ_{ij}^2. The SSVS prior specification for the variance-covariance has some parameters that can make the stochastic volatility given in Equation (10) work like a homoscedastic case or a more volatile one. To see this, let SSVS prior to the variance-covariance be represented by:

$$v_{ij,n}/\kappa_{ij,n} \sim \mathcal{N}(0, \xi_{ij,n0}^2)\kappa_{ij,n} + \mathcal{N}(0, \xi_{ij,n1}^2)(1 - \kappa_{ij,n}) \tag{1.11}$$

where $v_{ij,n}$ represents the elements of V, $\xi_{ij,n0}^2$ and $\xi_{ij,n1}^2$ are prior variances that denotes the shrink and slab components for the variance-covariance in such way: $\xi_{ij,n0}^2 >> \xi_{ij,n1}^2$, with $\xi_{ij,n1}^2$ close to 0. The $\kappa_{ij,n}$ is a random binary variable, with a Bernoulli distribution. As it has been done with the prior inclusion probability for the parameters, it is assumed that $\kappa_{ij,n}$ has a prior inclusion probability set equally, or in other words: $p(\kappa_{ij,n} = 1) = 0.5$. The ζ_{ij}^2 captures how the shrinking and slab components act. If we set the ζ_{ij}^2 as zero, for example, we will have a stable s, which means that we approximate to a homoscedasticity case, where the shrinking component applies.

For the estimation process, I consider the following hyperparameters values: $\tau_{ij,1}^2 = 0.1\hat{\sigma}_{ij}^2$ and $\tau_{ij,0}^2 = 3\hat{\sigma}_{ij}^2$ where σ_{ij}^2 is the OLS variance of the z_i along with $\xi_{ij,n0}^2 = 0.1$ and $\xi_{ij,n1}^2 = 7$ for the prior values for the variance-covariance. Additionally, with respect to the prior distributions for the stochastic volatility, I assume a Gamma prior on the $\zeta_{ij}^2 \sim \mathcal{G}(1/2, 1/2)$; a normal distribution prior for the $v_{ij,n} \sim \mathcal{N}(0, 10^2)$ and a Beta distribution for the ρ_{ij}. All of these hyperparameters values as the distribution choices follow closely (FELDKIRCHER; GRUBER; HUBER, 2019).

I used the R library BGVAR for estimate the BGSVAR. This package allows us to estimate the BGSVAR carrying out the MCMC methods, with a wide range of prior distributions and structural identification. For more technical details for example the algorithm that is used to do the MCMC and the posterior simulation see (BöCK; FELDKIRCHER; HUBER, 2020)[5]. In the estimation process, I considered a lag 1 BGSVAR with 60000 draws and 30000 burn-ins. Its descriptive statistics are shown in Appendix A.

3 The stochastic volatility improves the fit of the model and take into account the volatility of the series, controlling for heteroscedasticity problems.

4 Remember that according to Equation (1), the error term can be decomposed in the following variance-covariance matrix: $\Sigma_{it} = V_i S_{it} V_i^{'}$

5 The BGVAR package includes a lot of technical details as a brief explanation of the stochastic volatility used, the efficient algorithm for large VAR estimation and the SSVS prior distribution algorithm in the GVAR context applied.

- BGSVAR: sign restriction approach

I will carry out the sign and zero restriction as a structural identification approach. The sign and zero restrictions were first shown by (UHLIG, 2005). This kind of restriction was developed to avoid strong contemporaneous restrictions that usually come with the Cholesky decomposition. The sign restrictions employ an agnostic identification scheme based on a solid assumption of what is going on with the data or how this data usually responds to a shock. Uhlig (2017) justifies his method by giving interesting examples of how we can apply sign restrictions based on these good premises. Regarding (UHLIG, 2017) lessons, it is possible, in the context of the exchange rate pass-through, to insert a sign restriction taking into consideration some assumptions. For example, it is expected that after an exchange rate depreciation, consumer prices do not decrease, and the risk premium increases at the same time. Hence, we might apply this sign restriction if it is supported by theory or empirical evidence.

In the context of the GVAR, this strategy opens a wide variety of restrictions due to the fact that we deal with endogenous and weak exogenous variables. However, the GVAR approach allows only local identification schemes, closing the opportunity to restrict weak exogenous variables. This characteristic is easy to understand and does not erase the GVAR appeal because it would be very difficult to defend an identification scheme for foreign variables. The GVAR has another interesting feature in terms of identification strategy: (i) gives the possibility to shock the same variable of each country, at the same time, mimicking what should be a regional/global shock. (ii) it permits the analysis of the spillover effect even though it is not possible to impose any restriction in the weak exogenous variables.

Regarding the estimation process, the sign restriction uses the rotation matrix algorithm proposed by (ARIAS; CALDARA; RUBIO-RAMíREZ, 2019). It should be pointed out that, before we impose the sign restriction, the model is structural identified (Cholesky). So, indexing a country i by $i = 0$ we can introduce a $k_0 \times k_0$ dimension block diagonal rotation matrix $R_{0,t}$ with $R_{0,t}R'_{0,t} = I_{k0}$ in the following structural equation:

$$\tilde{Q}_{00,t}x_{it} = \tilde{a}_{i0,t} + \tilde{at}_{i0,t} + \tilde{\phi}_{i1,t}x_{it-1} + \tilde{\Lambda}_{i0,t}x^*_{it} + \tilde{\Lambda}_{i1,t}x^*_{it-1} + \tilde{R}_{i0,t}\epsilon_{it} \tag{1.12}$$

where $\tilde{Q}_{00,i} = R_{0,t}Q_{00,t}$ with $Q_{00,t}$ representing the contemporaneous relationship between the countries as long as the model is already identified, $\tilde{a}_{i0,t} = R_{0,t}a_{i0,t}$, $\tilde{at}_{i0,t} = R_{0,t}at_{i0,t}$, $\tilde{\phi}_{i1,t} = R_{0,t}\phi_{i1,t}$, $\tilde{\Lambda}_{i0,t} = R_{0,t}\Lambda_{i0,t}$ and $\tilde{\Lambda}_{i1,t} = R_{0,t}\Lambda_{i1,t}$. The matrix $R_{0,t}$ is orthogonal only to the country $i = 0$ which represents the local identify assumption, with the remaining countries having a general identification scheme. It is important to mention that the rotation matrix is time-varying and should be simulated at each point in time. Notice that equation 1.12 is equation 1.1 with the matrix R applied to it and considering that it is already identified.

Finally, two points should be mentioned in the sign restriction approach: the restrictions can be applied contemporaneously and for more periods (longer horizons). Indeed, increasing the number of restrictions decreases the uncertainty of the model, but it makes it harder to find a rotation matrix. So it is possible not to find any rotation matrix if the model is very restricted.

1.2.1 Data sample

We followed two directives for the data sample chosen: the first and most important is the need for a floating exchange rate regime. As we are evaluating the pass-through, the exchange rate must have some variability even though it is a dirty exchange rate float. The second directive is the availability of the data. The countries analyzed should have at least the GDP, the inflation rate, the nominal exchange rate, and the interest rate on a quarterly basis in a wider span.

In line with these directives, we cover five Latin American countries for the period between 2002Q1 and 2019Q4: Brazil, Chile, Colombia, Mexico, and Peru. Due to the weighted trade flows in the BGVAR approach, four big economies (China, Euro-Zone, Japan, and the USA) are added in the estimation, to mimic better the real trade flows, otherwise, it will settle much higher weight for the commerce between the Latin countries[6]. To construct the matrix of trade flows, we have used the average of 2017,2018 and 2019 bilateral trade flows. For the Latin countries' VAR estimation, we have the following indicators:

$$x_{it} = (y_{it}, dp_{it}, ner_{it}, embi_{it}, ir_{it})' \tag{1.13}$$

where: y is the output gap calculated by the HP filter with λ set at 1600, dp is the quarterly inflation rate, ner is the nominal exchange rate calculated as the domestic currency per US dollar, $EMBI$ is a Sovereign Risk Premium measured by the quarter mean of the Emerging Market Bond Index and IR is the annualized interest rate[7]. CPI NER and Sovereign Risk Premium are in log differences and the interest rate is annualized at level [8].

6 As mentioned before, the trade flows matrix is built to sum up 1 and this done by normalizing the matrix of the countries available in the estimation. If we add relevant countries in terms of trade flows to the Latin economies, the shock spillover between them is more approximated to the real trade flow. For this reason, we also have added Argentina in the estimation, although due to data problems, we do not show the result

7 One should note that including the long term interest rate would improve our estimation. However, for most of the Latin countries, the long-term interest rate is only available after 2005 and 2006

8 The original series of GDP and CPI are seasonally adjusted and comes from (MOHADDES; RAISSI, 2020). The original data set uses the real exchange rate (rer), so we compute the ner as $ner = dp * rer$.

we have assumed different variables set for the big economies, incorporating some particularities of these countries in the world economy. For the USA and China, for example, we include the commodities index due to the relevance of those economies to determine their prices by their demand movements. At the same time, we add the VIX for Europe and the USA as a source of volatility shock. The country-specific VAR estimation variables can be seen above:

$$\begin{aligned} USA :& x_t = (y_t, dp_t, fuel_t, agri_t, met_t, dyx_t, vix_t, ir_t)' \\ Euro :& x_t = (y_t, dp_t, fuel_t, ner_t, vix_t, ir_t)' \\ China :& x_t = (y_t, dp_t, fuel_t, agri_t, met_t, ner_t, ir_t)' \\ Japan :& x_t = (y_t, dp_t, ner_t, ir_t)' \end{aligned} \tag{1.14}$$

The commodity index is separated by its class. The $fuel$, $agri$, and met denote the log differences of the Fuel, Agriculture, and Metal prices indexes respectively[9]. we have separated the commodities by their class for two main reasons: (1) to avoid an ERPT improper analysis since the energy prices might been controlled in some countries. (2) to enable the richest analysis considering that Chile, Peru (metal exporters), and Brazil (metal and agriculture exporters) are relevant exporters on this market. The dyx is the trade-weighted dollar index. Considering the commodities index as endogenous for the USA and China economies is straightforward due to the relevance of those economies in determining the price of these products.

The dynamics of the Latin countries can be modeled by a VARX(p,q) with k endogenous variables defined in (1.13) and j weak exogenous variables coming from (1.14) and the economies of the other in (1.13). Hence, for each Latin country i, we have:

$$x_{it} = \sum_{s=1}^{p} \phi_{is} x_{it-s} + \sum_{r=0}^{q} \Lambda_{ir} x^*_{it-r} + \epsilon_{it} \tag{1.15}$$

where x_{it} is a $(k_i{\times}1)$ vector of endogenous variables, ϕ_{is} is a $(k_i{\times}k_i)$ diagonal coefficient matrix of each endogenous variables, Λ_{ir} is the matrix $(k_i^*{\times}k_i^*)$ associated to the weak exogenous variables x^*_{it} and ϵ_{it} is the error term with zero mean and time-varying variance-covariance matrix Σ_{it}.

The weak exogenous variables x^* are built as a weighted mean of other economies endogenous variables:

The ner is the average in the quarter. The interest rates are from (MOHADDES; RAISSI, 2020) but it has been transformed into an annualized basis series. For Colombia, the data comes from the official National Bureau statistics and Colombia's Central Bank.

9 The commodities indexes are from the Primary Commodity Price System of the IMF. The Agriculture index comprehends the Agriculture Price Index, including Food and Beverages and Agriculture Raw Materials Price Indices. The Metal index is the Base Metals Price Index, including Aluminum, Cobalt, Copper, Iron Ore, Lead, Molybdenum, Nickel, Tin, Uranium, and Zinc Price Indices. The fuel index includes Crude oil (petroleum), Natural Gas, Coal Price, and Propane Indices.

$$x^*_{it} = \sum_{j=0}^{N} \omega_{ij} x_{jt} \tag{1.16}$$

with ω_{ij} representing the bilateral trade flow between countries i and j. In the trade flow matrix, we have $\omega_{ij} = 0$ for $i = j$ and $\sum_{j=0}^{N} \omega_{ij} = 1$. This assumption considers that a country shock might not have a great impact on other countries unless they have a relevant commerce between them for example: Brazil/Japan, USA/Mexico, China/Chile, and so on. Following the GVAR approach, we let the nominal exchange rate as the only variable not included in x^*[10]. The weighted trade flows used in the estimation are shown in Appendix A.

1.3 Identification

Dealing with VAR identification is challenging. Since (SIMS, 1980) presented the VAR methodology as an approach to avoid imposing ad hoc restrictions, several VAR's structural identification strategies have been proposed. Most of these identification schemes have been scrutinized since some of them rely on strong assumptions. These assumptions stem from the fact that we should be confident if these restrictions come from exactly the shock that we are aiming to identify and not due to a linear combination of other shocks.

Taking this under consideration, (UHLIG, 2005) proposed a new identification strategy, with a minimalist approach, identifying structural shocks through sign restrictions. The idea is to impose a minimal restriction set to avoid controversial identifications. For example, many economists agree that after a positive monetary shock, the price level usually goes down and the interest rate rises. However, the GDP response is not so clear, particularly about the time horizon that is hit by the monetary policy shock. Some researchers argue that it takes time to GDP be affected and others support the notion that there is a small contemporaneous effect ((UHLIG, 2017), (FORBES; HJORTSOE; NENOVA, 2018)). Our strategy is to not enter into this kind of identification discussion because we could expend many pages discoursing about it, and there are other identification polemical examples. So, we will apply restrictions that are less controversial, covering the (UHLIG, 2017) idea: "If you know it, impose it; otherwise not". Following this line, if the literature has no closed opinion about some restriction, like the contemporaneous GDP reaction after a monetary policy shock, we will leave the variable unrestricted.

An important feature of the GVAR models is that we can either deal with individual countries' VARs and with the global representation of the model. Hence, it is possible to figure out how a single country responds to a domestic shock or how it responds to a

[10] The foreign nominal exchange rate is not included in the weak exogenous variables set because it will appear as an effective exchange rate, disturbing the analysis of the ERPT.

shock that comes from abroad. This external shock might come from an important trade partnership or from a group of countries (global shock). Indeed, as the model is locally identified, this shock can be at the same time internal and external which means that the same event hit all the economies. Considering this GVAR characteristic, we will analyze three sources of shocks for the Latin American countries: (i) a domestic shock of each individual Latin American country, (ii) a regional shock, a shock that hits all the Latin American countries at the same time and (iii) a global shock, an economic shock that spreads for the whole world.

For the domestic shock, we contemplate the usual shocks that have been applied in the VAR literature such as a monetary policy shock and a demand shock. The identification of those shocks has been exhaustively analyzed before, and we will just follow what has been applied. Additionally, we consider an EMBI shock to represent a risk premium shock. The identification of this shock is straightforward: the exchange rate depreciates after a positive risk premium shock, which raises the inflation rate, and the central bank reacts to this environment, increasing the interest rate. The risk premium shock may come from several sources that might affect the ability of a country to meet its external debt obligations, like the fiscal balance, business cycle expectation, risk aversion, and terms of trade. In spite of all this, an unidentified exchange rate shock is also considered as a benchmark. [11]

Regarding the regional shock, we contemplate a risk premium and a monetary policy shock for the Latin America region. we identify them as a shock hitting all the Latin American economies at the same time allowing the spillover effect between the countries. It's worth noting that this kind of shock has been chosen because they are relatively common in the region's history and uses non-polemical identification restrictions. Finally, a global shock is analyzed. we consider 2 types of shocks: an uncertainty shock, where the risk aversion goes up and a demand commodities shock. An important point should be highlighted because the identification of the commodities shock is non-trivial as long as this kind of shock is usually followed by an economic expansion as stressed by (BAUMEISTER; HAMILTON, 2019). So, even if we call it as a commodities shock, this shock can be seen as a demand shock as well.

In order to summarize the shocks identification, Table (1) presents how the sign restrictions are applied in each shock mentioned in this section:

[11] It is called an unidentified shock because its source has not been identified.

Table 1 – Identification restrictions - Latin Countries[1,2,3]

	Output Gap (Demand Shock)	CPI	Exchange rate Shock	Risk Premium Shock	Interest rate Shock	Risk Premium* Shock	Interest rate* Shock	VIX* Shock	Oil price index* Shock
Output Gap	$>^2$		0	0	0	0	0		
CPI	$>^2$		$>^2$	$>^2$	$<^2$	$>^2$	$<^2$		
Exchange rate	*		$>^2$	$>^2$	$<^2$	$>^2$	$<^2$		
Risk Premium	*		$>^2$	$>^2$	*	$>^2$	*		
Interest rate	0		0	0	$>^2$	0	$>^2$		
*Output Gap**						0	0	*	$>^2$
*CPI**						$>^2$	$<^2$	*	*
*Risk Premium**						$>^2$	$<^2$	*	*
*VIX**								$>^2$	*
*Oil price index**								*	$>^2$
*Agriculture price index**								*	$>^2$
*Metals price index**								*	$>^2$
*Interest rate**						0	$>^2$	*	*

1/ Variables bellow the dot line represents variables that are treated as weak exogeneous (superscript *) for the Latin countries.

2/ The restrictions can be applied only for existing variables for a country. So if I shock the Oil Price index, for example, the restrictions are avaiable only for the countries where the Oil Price is assumed as endogeneous in the estimation.

3/ The signs >, < and 0 are the sign and zero restrictions applied in the structural identification scheme. The superscript above the sign denotes the periods which the restrictions remain active. Asteriscs inside the matrix represents variables not restricted. Blanck spaces are variables not restricted due to the impossibility of doing that (remember that the shocks are locally identified).

Note that, according to Table (1), we consider each sign restriction to last for 2 periods. This assumption is usually made with sign restrictions approach as can be seen in UHLIG (2005, 2017), (FORBES; HJORTSOE; NENOVA, 2018), (FELDKIRCHER; GRUBER; HUBER, 2019) among others. However, as a robustness exercise, we also consider this sign restriction remaining only for the period when the shock occurs and there is no change in the results. Lastly, but no less important, for the Regional and Global shocks the sign restriction should hold for at least 75% of the draws[12].

1.4 Results

In this section, the results of the BGSVAR are presented. we highlighted the impulse response functions of the shocks identified in the last section and the values found for the ERPT. These tools enable us to answer how the exchange rate pass-through behaves after it is hit by the shocks. This analysis is provocative because it considers other important variables that influence the magnitude of the ERPT. Additionally, an important point should be highlighted when we investigate an ERPT with a VAR: there are more variables that affect the dynamics of the inflation rate in the subsequent periods after the shock, and it is unfeasible to separate the CPI response considering only the exchange rate movement. Thus, the ERPT is defined as the ratio of the inflation response in all periods after the exchange rate movement in time 0. Mathematically we have: $\frac{dp_{0,t+i}}{ner_{0,t}}$ where dp is the change of prices from a period t to i and ner is the change of the nominal exchange rate in time 0. This definition is also considered in some related literature, for example, in (AN; WANG, 2011), (FORBES; HJORTSOE; NENOVA, 2020).

12 We tried to let 100% of the draws holding for Global shocks but it is not possible to find a rotation matrix for some of them.

1.4.1 Impulse Response Functions

We divide the impulse response function (IRF) by its source. First, we show the response function of the domestic shocks, followed by the regional shock, and finally by the global ones[13]. In the following IRF plots the solid line represents the median of the posterior and the dark gray (50%) and light gray (68%) are the credible intervals of the successful rotation matrices found in each of the shocks estimated.

- Individual countries shocks:

The first shock analyzed is the exchange rate shock. According to Figure (1) it can be seen that following a shock in the nominal exchange rate the inflation rises in all countries. This upward pressure on the CPI remains for at least 2 quarters, with Peru having the more persistent response. The output reacts in different manners depending on the country analyzed, with Brazil, Colombia, and Peru experiencing a recession after the exchange rate depreciation and others like Chile having a boom in their economy. This result is in line with (AN; WANG, 2011), which does not find a regular output response for countries after an exchange rate depreciation. These different output reactions might come from several factors as for example the dollar liabilities in those countries. As stressed by (KEARNS; PATEL, 2016a) we have a general idea maybe coming from the trade channel view that an exchange rate depreciation might be expansionist. But the financial channel also plays an important role in tightening the domestic financial conditions, especially if the country has a large stock of foreign currency borrowing. The prevalence of one of these two channels may explain the different output responses. Note that the higher the inflation rate, the more intense the reaction of the monetary policy, raising the interest rate and contributing to the slowdown of the output gap. The output gap becomes negative maybe because of the rise of the interest rate and not due to the depreciation of the exchange rate. However, as we have not identified the source of the exchange rate depreciation, it is difficult to infer what should be the output response.

It is worth noting that this is a kind of shock that is difficult to explain as long as the exchange rate movements are consequences of what happens in the economy. In such a manner, it is complicated to analyze the exchange rate shock as an event that appears in an exogenous way without an identified source. Nevertheless, we consider this shock because it is relevant to show how the magnitude of the ERPT varies over other identified shocks.

According to Figure (2), a risk premium shock is followed contemporaneously by an exchange rate depreciation. This exchange rate movement leads to higher inflation

[13] As we are dealing with shocks in 8 countries, we consider the following shock size for each of the IRF: 0.1 for the exchange rate shock, a 0.2 for the risk premium shock, a 100 basis point for the monetary policy shock, a 0.02 for the demand shock, 1 for the VIX and 0.2 for the commodities indexes.

with Brazil and Colombia having a higher inflation rate in the subsequent quarters after the depreciation. In all countries, the Central Bank raises its interest rate to combat the inflationary upward pressure. This Central Bank's behavior may contribute to a decrease in the output gap in the following quarters. In addition, it is expected that the output gap should not get positive after a risk premium shock because this is a kind of shock that probably comes from some domestic or global stressful event. Thus, even if the Central Bank does not raise the interest rate, the GDP may decrease. Chile and Mexico are the countries in which we observe a rise in the GDP following the risk premium shock, a result that is somewhat puzzling.

Next, we consider a 100 basis point interest rate shock in Figure (3). The exchange rate appreciates contemporaneously with CPI tracking this movement. Remember that in the identification strategy, we let the CPI be impacted simultaneously by the monetary policy shock. This might be controversial but if we have assumed that the ERPT can occur contemporaneously, any movement in the exchange rate should impact the price level at the same time. Note that in all countries there is no price puzzle phenomenon. As seen in the risk premium shock, the response of the inflation rate is higher for Chile and Peru.

The demand shock is analyzed in Figure (4). Regarding the inflation rate this is the shock in which the CPI gets higher. This behavior of inflation increasing might occur even if the exchange rate pass-through remains stable since it is a characteristic of this kind of shock, i.e: output gap and inflation rate moving in the same direction. However, the exchange rate also depreciates following this shock which means that we might have a strong ERPT. As either the GDP growth is strong and the price level is increasing at the time when the exchange rate depreciates it creates a favorable scenario to have a higher degree of ERPT.

- Regional shocks:

The regional risk premium shock is an event that hits all the Latin American countries at the same time. We have seen a similar result in the domestic counterpart shock, with the GDP slowing down, the exchange rate depreciating, CPI rising in the first quarters and the Central Bank's increasing the interest rate in order to control this inflationary pressure. However, in the regional shock, it is possible to see a more complete picture of what happens when this kind of shock occurs. Regarding the EMBI, this is a variable that usually moves together across the countries, and considering this feature with the spillover effect is essential, particularly for some countries that have big trade partnerships in the region. According to Figure(5), it is interesting to note that in some countries, such as Brazil, for example, the output grows in the first quarter after the shock, and only after 2 quarters does it begin to enter the negative part. This polemical dynamic might be due to the forward characteristic of the risk premium, showing that there is something cloudy in the horizon but it will take time to hit the real economy. A possible precedent is a rise in government expenditure, enhancing the output in the short run and worsening the fiscal balance for the years coming. But as we are dealing with a shock that probably comes from abroad, this explanation is not complete because a worsening in Brazil's fiscal balance will not erase the risk premium of all of Latin America. The most suitable explanation is a worsening of the fiscal balance as a consequence of the risk premium shock that comes from abroad. Thus, the government reacts to this challenging scenario and the output remains stable in the first quarters after the risk premium shock. This output (positive) reaction can be seen for all Latin American countries but Colombia.

Next, we consider a joint monetary policy shock in Figure (6), called regional monetary policy shock. At the same time, all Latin American countries raised their interest rates. As a consequence, the exchange rate appreciates, and the inflation rate goes down in all countries. This result is quite similar to what we have seen in the domestic monetary policy shock. A possible reason for this similar result is due to the economic activity channel. Note that the output gap remains quite stable after the interest rate rise, which makes the spillover effect by the economic foreign activity channel less important.

- Global shocks:

The global shock is an event that comes from the biggest economies in the world and has the potential to spread through the world. The first scenario analyzed is when an uncertainty shock hits the US and European economies at the same time. I proxy the uncertainty with the VIX term and consider this variable to be shocked at time 0, letting the other variables in the VAR model unrestricted. Remember that only US and Europe VARs include the VIX in their VAR specification, being two important Latin American countries' trade partnerships. According to Figure (7) we see an instantaneous decrease in the output gap in all countries and the risk premium increasing in time 0, with a depreciation following this EMBI movement. The inflation rate in Brazil, Colombia, and Mexico goes up in the first quarters after the uncertainty shock, but in Chile and Peru, the price level decreases strongly. The output gap path may determine the response of the inflation rate since an economy in recession usually does not have demand pressures that could force the CPI to higher levels. In this case, the price level decreases, although there are other variables making inflationary pressure as a depreciation of the exchange rate, for example. To summarize, it looks like that in the uncertainty shock, the strong output response is responsible for the CPI path.

The commodities/demand shock is one of the most interesting shocks analyzed in this chapter since it includes some important characteristics for Latin American countries. First of all, remember that I have identified the global commodities shock as a shock with positive sign restriction for the output gap and the commodities indexes. Then, not only the foreign demand factor would hit the Latin American countries but also the higher price of those goods. As some of those countries are huge commodities exporters, the rise of these prices affects their trade balances, the terms of trade, the exchange rate, the risk premium, and the output gap.

According to Figure (8), a global demand/commodities shock decreases the risk premium of all countries with an appreciation of the exchange rate following this movement. The output gap is boomed contemporaneously, which shows the relevance of the terms of trade to economic activity. The inflation rate of Colombia and Mexico remains quietly stable despite the strong GDP growth in these countries. On the other hand, Chile and Peru experienced an increase in the price level, maybe because their GDP growth is stronger than the other country's GDP. In all countries, we observe a decrease in the risk premium with an appreciation of the exchange rate in time 0.

Figure 1 – Nominal exchange rate shock - Latin countries

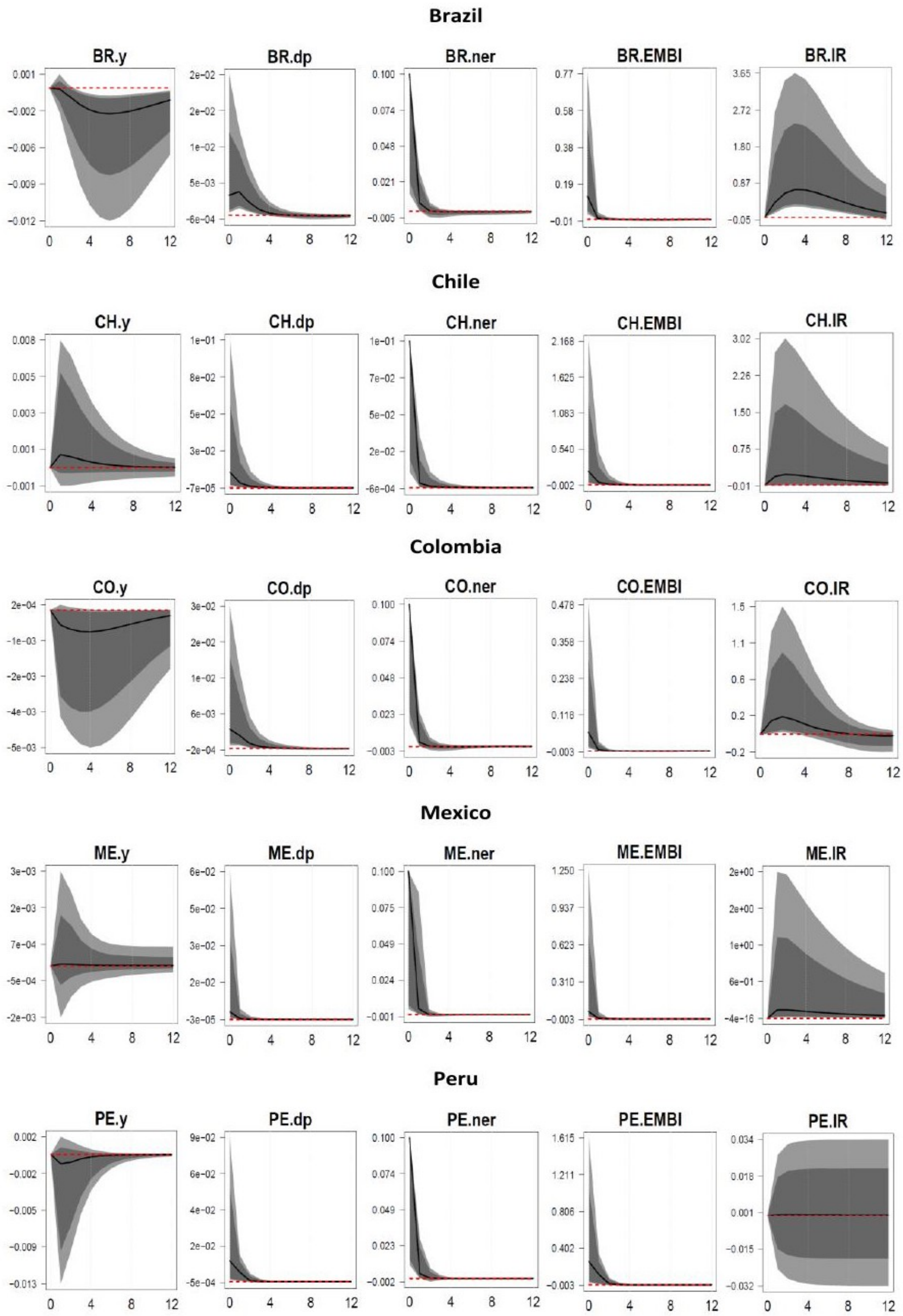


Figure 2 – Risk Premium shock - Latin countries

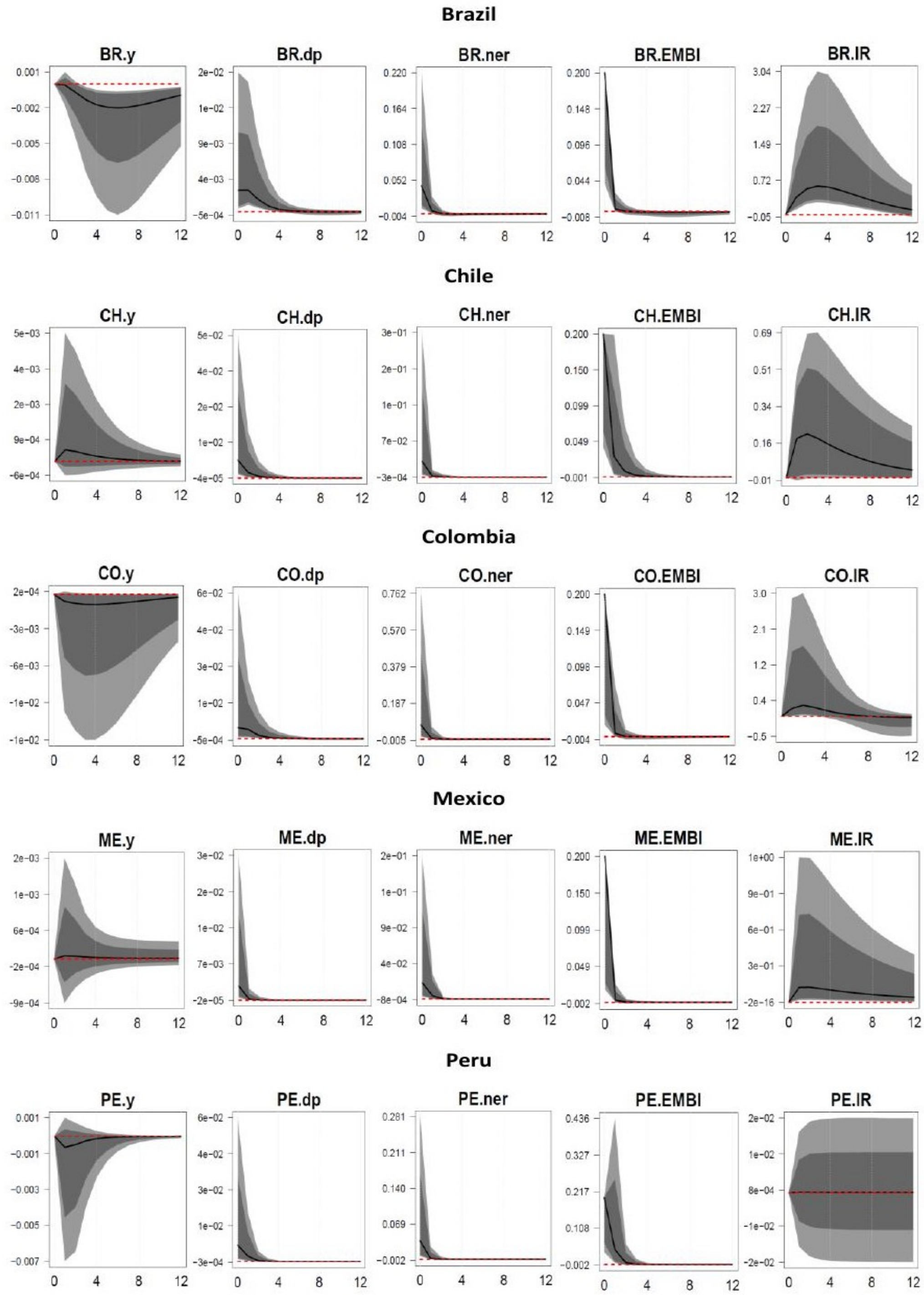


Figure 3 – Risk Premium shock - Latin countries

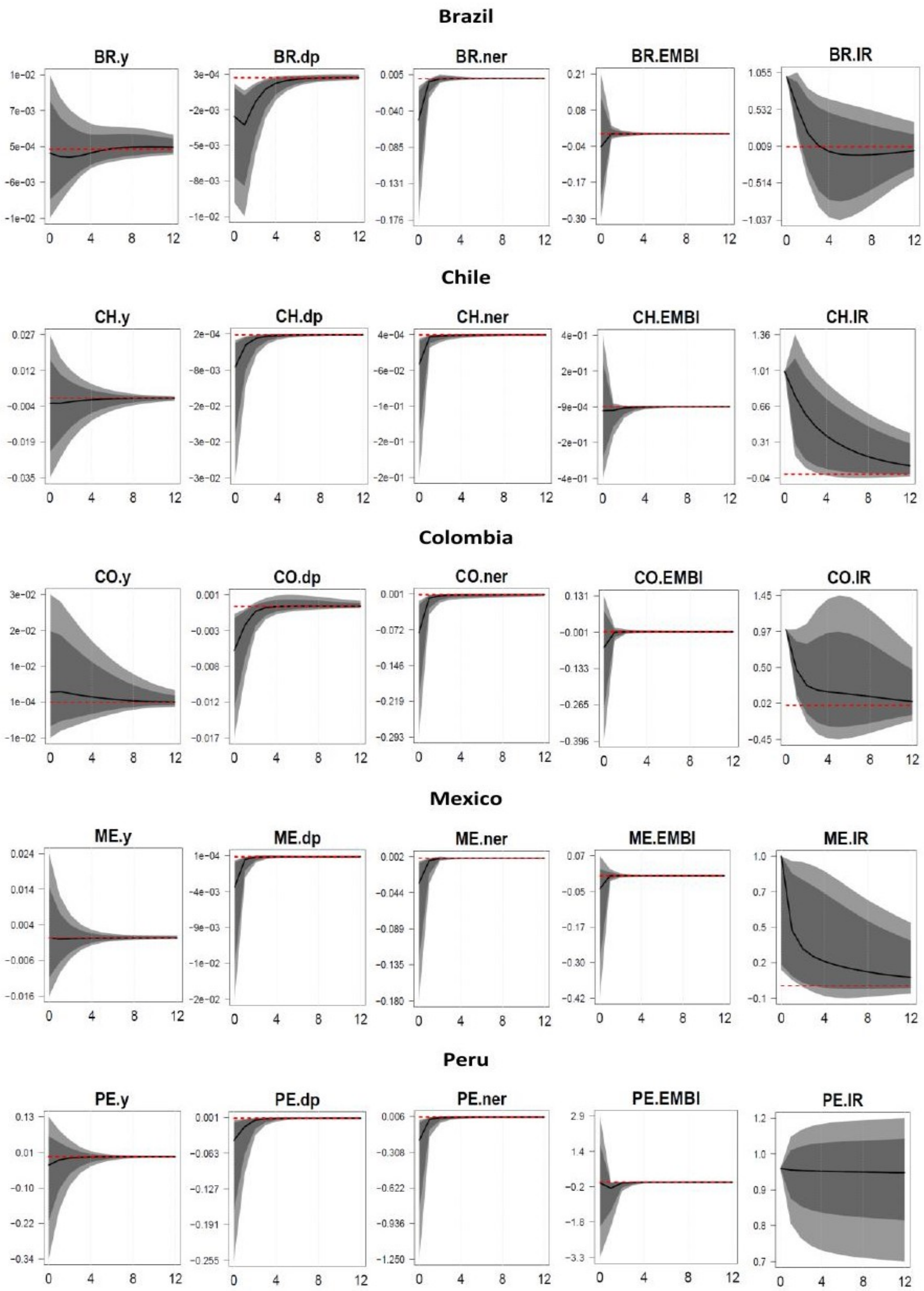


Figure 4 – Demand shock - Latin countries

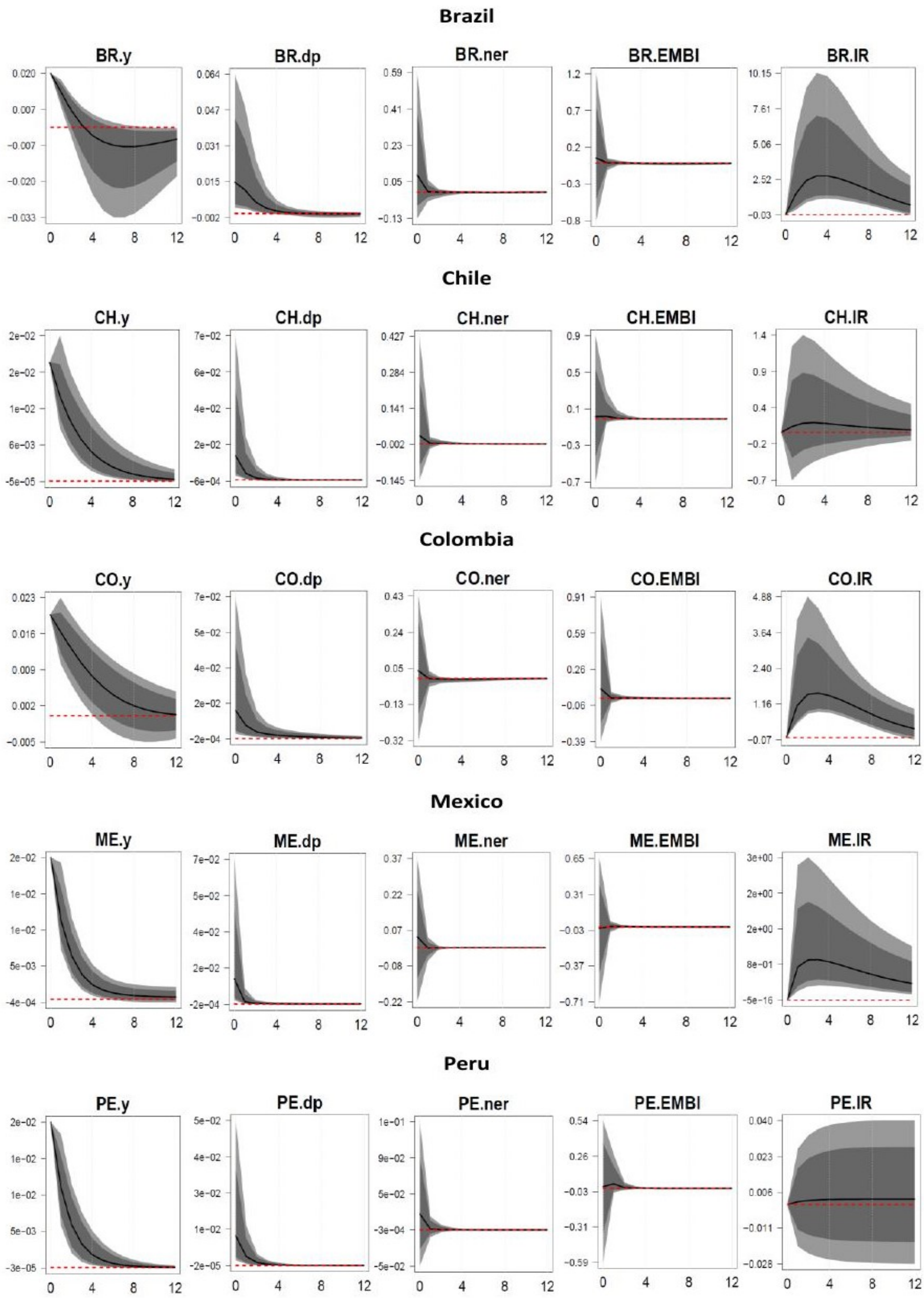


Figure 5 – Regional Risk Premium shock - Latin Countries

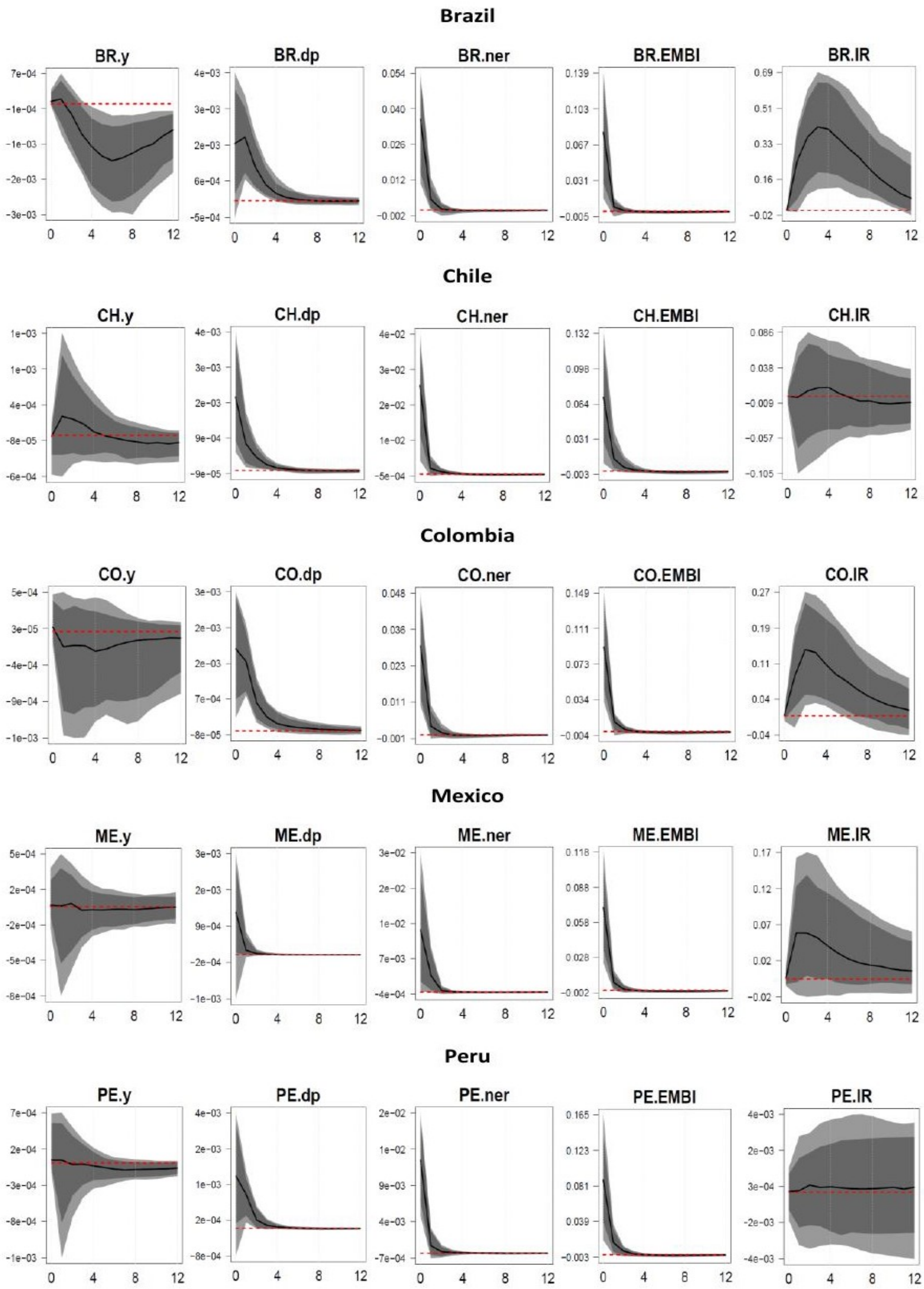


Figure 6 – Regional Interest rate shock - Latin Countries

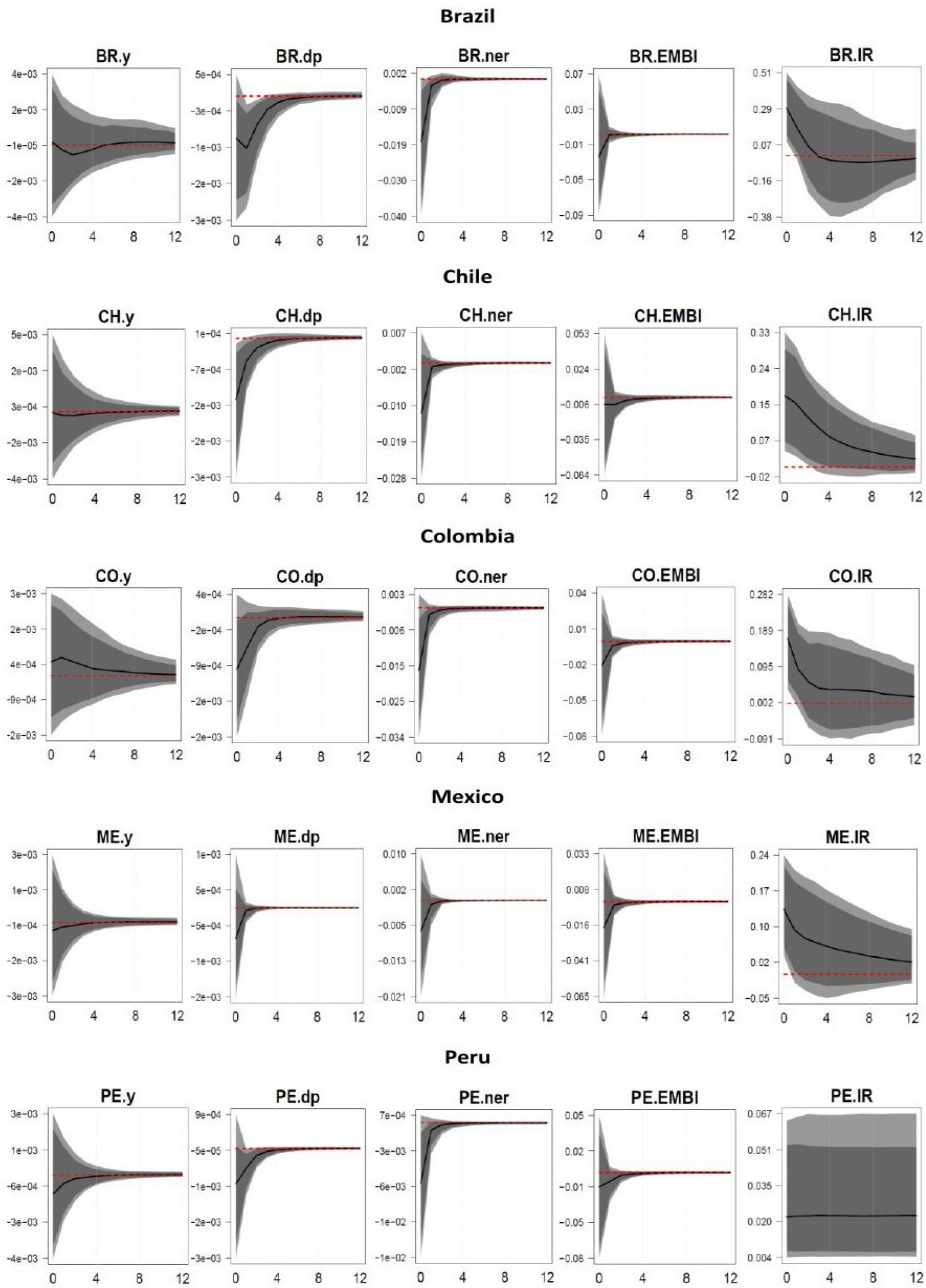


Figure 7 – Uncertainty shock - Latin Countries

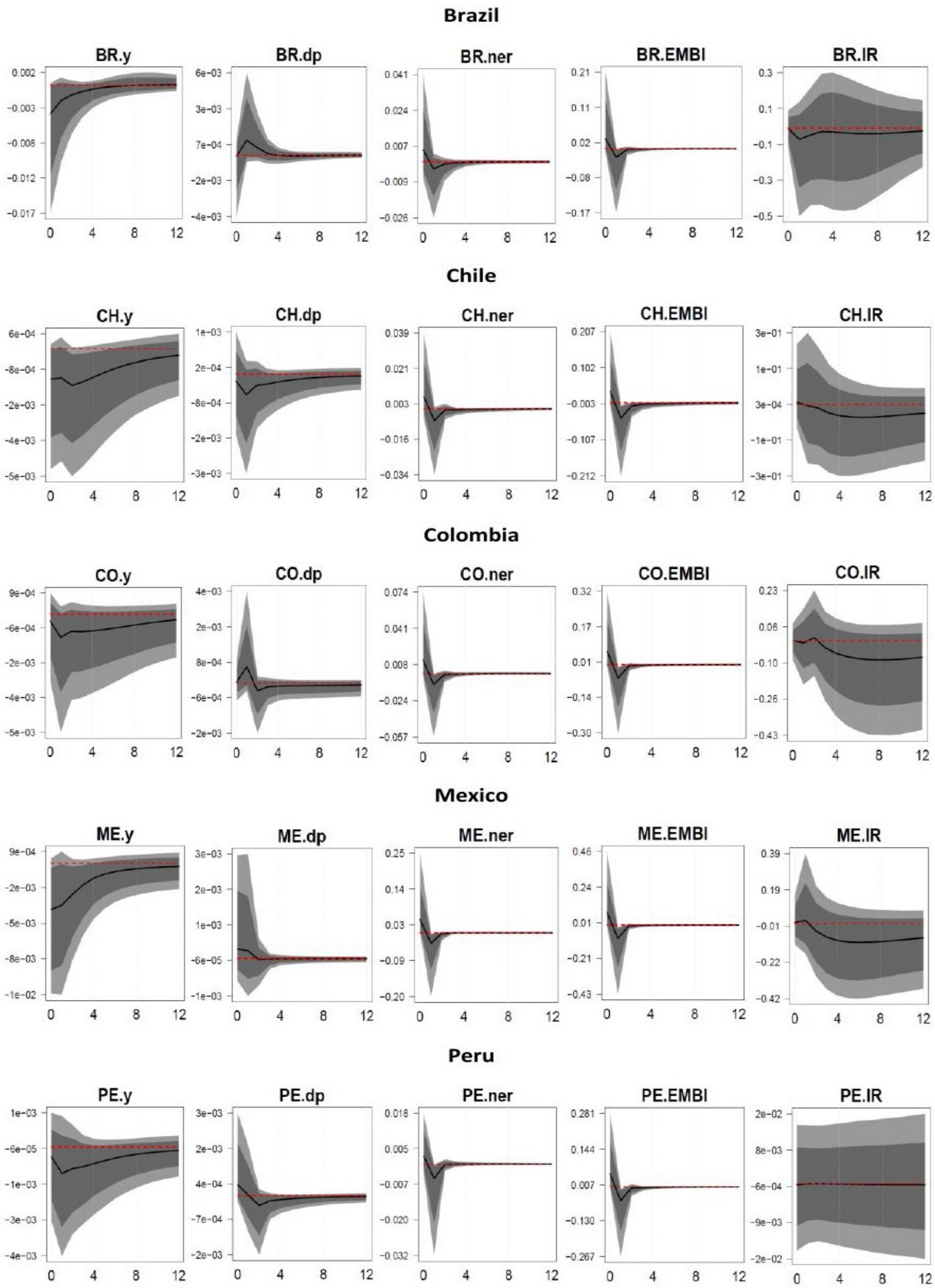
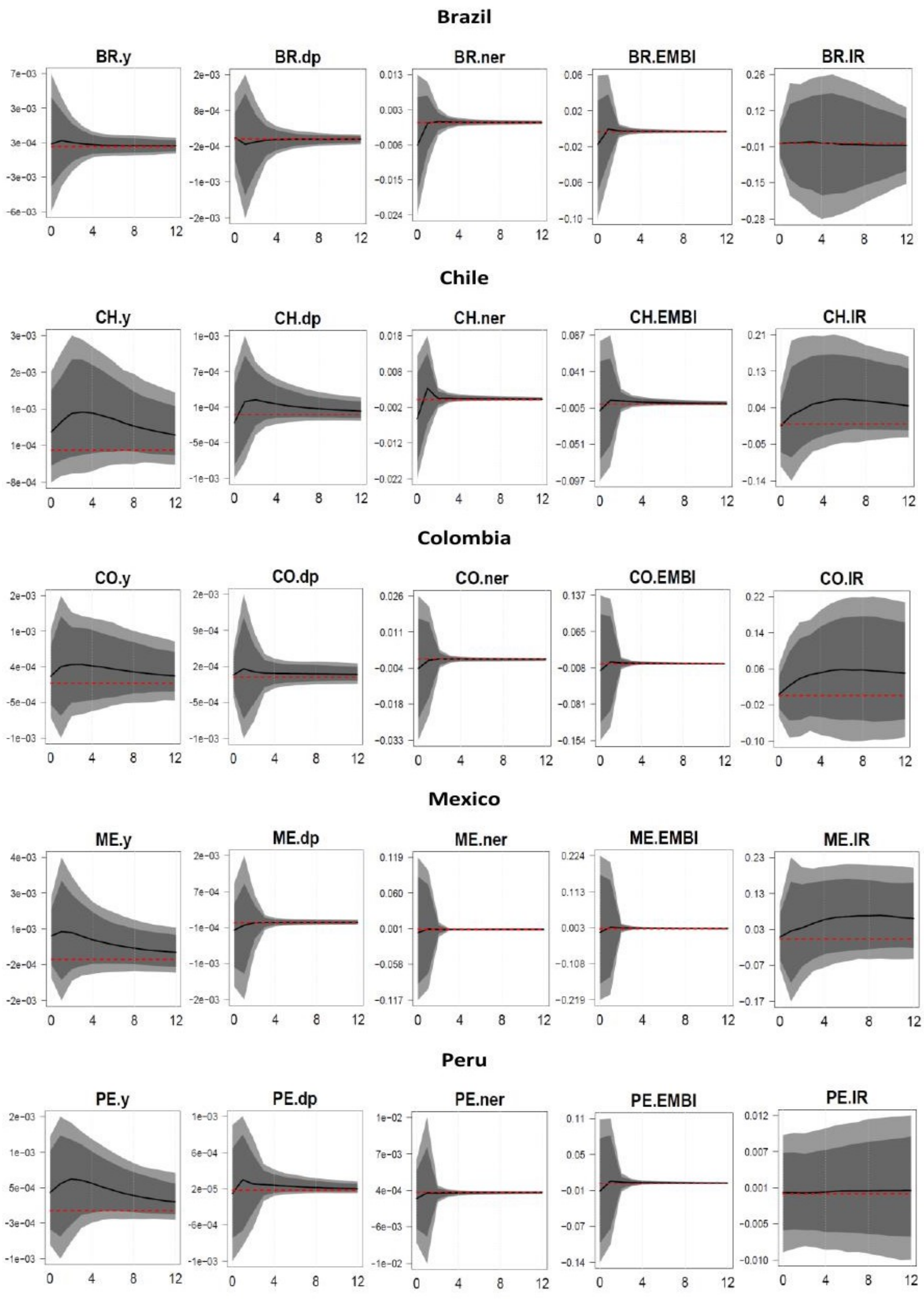


Figure 8 – Global commodities demand shock - Latin Countries



1.4.2 Exchange rate pass-through

In this subsection, we investigate the median response of the ERPT. It is calculated by the ratio $\frac{dp_{0,t+i}}{ner_{0,t}}$ and gives us a number of how different the pass-through for each of the shocks analyzed in the IRF. According to Table (2), the (unidentified) exchange rate shock is the event that has the lower ERPT in all countries. This result highlights the ERPT coming from a simple exchange rate shock might give us an incomplete picture of the dynamics of the economy. An interesting point is the relevance of identifying the shock to determine the magnitude of the ERPT is the risk premium shock compared with the exchange rate one. They have the same sign restriction even though the risk premium ERPT degree is much higher for all countries, with some, like Brazil, having a double degree of ERPT in time 0. Regarding the monetary policy shock, it is similar in magnitude of the ERPT to the risk premium shock.

The domestic demand shock exhibits the highest magnitude of the ERPT. This result might come from the fact that this shock covers some economic features that are important to determine the magnitude of the exchange rate pass-through. As mentioned before, the degree of the ERPT is higher when the average inflation is higher, and the economic activity is booming, and that's exactly what we have in the domestic demand shock. So, when the exchange rate moves (depreciates), it encounters a desirable scenario to pass through to the consumer price level. It is worth noting that even though this result contrasts with Forbes (2018, 2020), it is not directly comparable because they found a low degree of the ERPT for an appreciation case, and in all of our demand shocks, there is a depreciation of the exchange rate. Indeed, the reason claimed for this low ERPT in Forbes (2018, 2020) might justify the same result found here for a depreciation event: if the price setters have no incentive to decrease prices when they face strong demand growth, they also have more incentives to pass-through to its prices any increase in its costs; including a cost increasing that comes from an exchange rate depreciation.

The ERPT for the risk premium regional shocks has a diverse result compared to their domestic counterparts. Specifically for Brazil and Peru the ERPT of the regional risk premium is almost the same degree as for their domestic risk premium shock. On the other hand, Chile and Mexico have a lower degree of the ERPT for the regional case. It is important to understand the reason behind the differences in the results across the countries between the regional and domestic shocks. The relative relevance of the trade partnership with the big economies may help to explain this conundrum. For Mexico, for example, only 2.4% of their trade balance is with the other Latin American countries, which dampens any shock that comes from this region. However, this feature does not explain Chile's result since its weighted percentage trade balance is similar to Brazil's. Certainly, there are other characteristics not included in the model that may help to explain these results. Finally, regarding the size of the ERPT coming from the monetary policy regional shock is comparable with the domestic monetary policy shock. As the output gap remains quite stable after this shock, the foreign channel is less relevant in this case and may justify the equivalent result between the domestic and regional shocks.

As mentioned before, we consider two global shocks. The first one analyzed is an uncertainty shock that hits the big economies. In this case, we see a diverse ERPT across the countries, with some having a negative ERPT and others with the usual positive

ERPT. The point here is that the output is highly impacted by this event, and even with a depreciation of the exchange rate, the inflation rate is not affected too much by this cost pressure. In general, only Brazil has a sizeable positive ERPT but at longer horizons. The commodity/demand shock presents an interesting case, with all countries experiencing a negative ERPT. The exchange rate appreciates contemporaneously following the shock and the inflation rate rises a little at the same time. This price level behavior may be due to the strong domestic GDP growth with the exchange rate appreciation working to avoid additional increases in the CPI. This feature should be highlighted since we have at least two factors contributing to increase the GDP: a rise in the foreign demand and a commodities prices increment. Interestingly, during the years 2002-2008, the region experienced a period with these characteristics, and the exchange rate appreciation due to the commodities prices increase might have supported a lower inflation rate through these years.

Table 2 – Accumulated exchange rate pass-through - Latin Countries

Brazil

	Local shocks				Regional shocks		Global shocks	
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Commodities/Demand	Uncertainty
t	0.03	0.06	0.06	0.17	0.05	0.05	-0.01	-0.01
t+1	0.07	0.13	0.13	0.30	0.11	0.12	0.02	0.18
t+2	0.09	0.17	0.16	0.36	0.13	0.16	0.03	0.27
t+3	0.10	0.18	0.18	0.39	0.15	0.18	0.04	0.29
t+4	0.10	0.19	0.19	0.41	0.15	0.18	0.04	0.29

Chile

	Local shocks				Regional shocks		Global shocks	
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Commodities/Demand	Uncertainty
t	0.11	0.19	0.16	0.38	0.08	0.11	0.03	-0.03
t+1	0.14	0.25	0.20	0.48	0.10	0.16	-0.02	-0.12
t+2	0.15	0.26	0.21	0.51	0.12	0.17	-0.06	-0.17
t+3	0.15	0.27	0.21	0.52	0.12	0.18	-0.11	-0.21
t+4	0.16	0.27	0.21	0.52	0.13	0.19	-0.14	-0.25

Colombia

	Local shocks				Regional shocks		Global shocks	
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Commodities/Demand	Uncertainty
t	0.03	0.06	0.07	0.34	0.06	0.06	-0.01	0.00
t+1	0.06	0.11	0.09	0.50	0.11	0.09	-0.05	0.05
t+2	0.07	0.13	0.10	0.58	0.14	0.10	-0.08	0.03
t+3	0.07	0.13	0.10	0.64	0.15	0.10	-0.10	0.02
t+4	0.07	0.14	0.10	0.68	0.15	0.10	-0.12	0.01

Mexico

	Local shocks				Regional shocks		Global shocks	
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Commodities/Demand	Uncertainty
t	0.03	0.14	0.11	0.29	0.10	0.12	0.03	0.01
t+1	0.03	0.15	0.11	0.31	0.11	0.13	0.04	0.01
t+2	0.03	0.15	0.11	0.32	0.12	0.13	0.05	0.01
t+3	0.03	0.15	0.11	0.32	0.12	0.13	0.04	0.01
t+4	0.03	0.15	0.11	0.32	0.12	0.13	0.04	0.01

Peru

	Local shocks				Regional shocks		Global shocks	
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Commodities/Demand	Uncertainty
t	0.13	0.18	0.20	0.51	0.13	0.15	0.05	0.12
t+1	0.18	0.24	0.25	0.67	0.21	0.24	-0.10	0.13
t+2	0.19	0.25	0.26	0.72	0.23	0.27	-0.19	0.02
t+3	0.19	0.25	0.26	0.74	0.24	0.28	-0.28	-0.03
t+4	0.19	0.25	0.26	0.75	0.24	0.29	-0.35	-0.07

The exchange rate pass-through is calculated by $\frac{dp_{0,t+i}}{ner_0}$ where dp is the change of prices from a period t to i and ner is the change of the nominal exchange rate on impact

1.5 Robustness analysis

As a robustness check, we estimated the model using an alternative identification scheme. Specifically, we allowed the monetary policy to respond contemporaneously to the shocks outlined in Table (1) as can be seen in Table (16) in Appendix A which shows the identification applied in this context. Given that our model is estimated in a quarterly time frame, it's reasonable to allow the central bank to react within the same quarter as the shock. The results remain largely consistent with our primary findings.

For most countries, except Mexico, the domestic demand shock continues to exhibit the most significant ERPT. On the other hand, for certain countries, the ERPT from the risk premium shock is lower than to the ERPT from the exchange rate shock. However, both shocks are still relevant to explain the magnitude of the ERPT and show the central role of how the central bank reacts to those shocks. Finally, our findings related to regional and global shocks show similar magnitudes of ERPT, underscoring the robustness of our results.

Table 3 – Accumulated exchange rate pass-through (alternative identification) - Latin Countries

	Local shocks				Regional shocks		Global shocks	
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Commodities/Demand	Uncertainty
Brazil								
t	0.03	0.04	0.06	0.20	0.06	0.05	-0.01	-0.01
t+1	0.07	0.10	0.13	0.33	0.15	0.12	0.02	0.18
t+2	0.09	0.14	0.18	0.38	0.19	0.15	0.03	0.27
t+3	0.10	0.15	0.20	0.39	0.20	0.16	0.04	0.29
t+4	0.10	0.16	0.21	0.39	0.21	0.17	0.04	0.29
Chile								
t	0.30	0.19	0.16	0.25	0.28	0.14	0.03	-0.03
t+1	0.39	0.25	0.19	0.33	0.38	0.18	-0.02	-0.12
t+2	0.42	0.26	0.20	0.36	0.42	0.20	-0.06	-0.17
t+3	0.43	0.27	0.20	0.38	0.44	0.21	-0.11	-0.21
t+4	0.44	0.27	0.19	0.38	0.45	0.22	-0.14	-0.25
Colombia								
t	0.10	0.07	0.06	0.82	0.13	0.06	-0.01	0.00
t+1	0.15	0.10	0.09	1.13	0.15	0.09	-0.05	0.05
t+2	0.17	0.11	0.10	1.20	0.17	0.10	-0.08	0.03
t+3	0.18	0.12	0.10	1.22	0.18	0.11	-0.10	0.02
t+4	0.18	0.12	0.10	1.21	0.19	0.11	-0.12	0.01
Mexico								
t	0.03	0.11	0.09	-0.65	0.09	0.09	0.03	0.01
t+1	0.04	0.12	0.10	-0.68	0.09	0.09	0.04	0.01
t+2	0.04	0.13	0.10	-0.69	0.10	0.10	0.05	0.01
t+3	0.04	0.13	0.10	-0.69	0.10	0.10	0.04	0.01
t+4	0.04	0.13	0.10	-0.69	0.10	0.10	0.04	0.01
Peru								
t	0.31	0.20	0.08	0.92	0.23	0.18	0.05	0.12
t+1	0.38	0.28	0.16	1.05	0.33	0.27	-0.10	0.13
t+2	0.39	0.30	0.19	1.06	0.37	0.31	-0.19	0.02
t+3	0.39	0.30	0.20	1.06	0.38	0.32	-0.28	-0.03
t+4	0.39	0.30	0.20	1.05	0.39	0.33	-0.35	-0.07

The exchange rate pass-through is calculated by $\frac{dp_{0,t+i}}{ner_0}$ where dp is the change of prices from a period t to i and ner is the change of the nominal exchange rate on impact

1.6 Conclusion

Analyse the exchange rate pass-through considering its source is something that the literature only recently has began to research. A more common way to investigate the

ERPT is control for some variables that might affect the phenomenon. According to this strategy, it is possible to find some stylized facts for the ERPT as for example the role of the economic activity, the reaction of the central bank, the level and volatility of the CPI and so on. However, investigating the source of the exchange rate movement has its importance since the economic variables that will affect the magnitude of the exchange rate might react differently conditionally on these shocks. This chapter has shown that it is crucial to identify the shocks sources to figure out the magnitude of the ERPT.

We have seen that the inflation rate response varies according to the shock applied. If we take a simple exchange rate shock, the price level reacts weaker than the other identified shocks. This feature reveals the importance of identifying the shock, as it plays an important role in determining the magnitude of the exchange rate pass-through. Actually, the output gap is one of the main factors to determine the size of the ERPT. As attested, when the economy is in an expansion cycle, the ERPT is higher, making the GDP reaction crucial to our results. This can be seen for the domestic demand shock which is the higher ERPT, where the GDP is growing fast at the time when the exchange rate depreciates. An additional important economic characteristic is the level (and so the volatility) of the CPI when the exchange rate appreciates/depreciates. The higher the price level at the moment of the shock, the higher the exchange rate pass-through. In the demand shock, both features apply what might explain this higher exchange rate pass-through.

The exchange rate pass-through coming from the domestic risk premium shock and the domestic monetary policy shock have similar magnitudes between them for each country. For some countries like Chile and Mexico, the risk premium shock is slightly higher in terms of the exchange rate pass-through, than the monetary policy shock. The output gap response to these shocks might explain these different results, especially for Chile.

We also have considered regional Latin America shocks. We have analysed two shocks: a regional risk premium shock, which is a risk premium shock that hits all the countries at the same time, and a regional interest rate shock. The magnitude of ERPT coming from these regional shocks are not so different than their domestic counterpart. Regarding the regional risk premium shock, for Brazil and Peru, the ERPT is almost identical, but for Colombia, the regional shock is stronger. On the other hand, Chile's and Mexico's price levels are less impacted by this regional shock. For the regional monetary policy shock, the ERPT is similar to the domestic counterpart shock for all countries.

Finally, a global demand/commodities shock and an uncertainty shock are investigated. The ERPT from the uncertainty has the opposite sign which means that we have a decrease in the price level following a depreciation of the exchange rate. This weird result might be due to the other variables' responses since the economy enters in a recession cycle contemporaneously after this shock. In relation to the demand/commodities shocks, it is very interesting because it looks like that we have a positive supply shock at shorter horizons instead of a demand shock in the Latin American countries since the GDP rises and the inflation decreases. This result shows how important are the commodities prices for those economies.

2 Analysis of Stock Market Dynamics through Source of Shocks in Brazil

In this chapter, we delve into the analysis of the Brazilian stock market returns using the BGVAR approach, similar to the first chapter of this work. However, we have included three more variables representing different Brazilian stock market indexes in the VAR specification. We have analyzed the impact of shocks on the Brazilian stock market returns with a data span that covers eight countries, in addition to the euro zone. Using sign restriction identification, we have identified that the Brazilian stock market responds more to domestic shocks than regional and global shocks.

2.1 Introduction

Financial variables have the ability to respond to economic and financial events quickly. This enables them to anticipate potential impacts that may take longer to manifest in the real economy, a feature known as the 'forward-looking characteristic'. As a financial variable, the stock performance of companies listed on the stock market typically displays this forward-looking nature, reacting differently based on the specific economic sector involved. Therefore, companies associated with the commodities market might react differently to particular shocks than real estate companies.

The stock market plays an important role in raising capital for companies, facilitating their growth, and offering a vital avenue for wealth allocation for various savers, including pension funds and household savings. Given its significance, it is essential to understand how the stock market responds to economic shocks. In reality, a myriad of factors can affect the stock market, ranging from high-frequency indicators like daily or hourly equity trades to lower-frequency variables, primarily those stemming from the broader macroeconomic landscape. In line with this, numerous studies have explored stock market reactions to a wide range of influences, from breaking news that might affect company share prices to interest rate decisions made by central banks.

In Brazil, the scenario is not much different from that of the advanced economies. The B3 stock exchange, the largest in the region, underscores the significance of this financial instrument for Brazilian companies and households. However, Brazil faces unique characteristics as an emerging market, such as the nature of leading companies influencing stock market returns, the commodity prices role, domestic economic policies, and more. These specificities present a rich yet underexplored opportunity in literature to analyze the Brazilian stock market's response to events stemming from various sources.

To delve into these nuances, this chapter examines the Bovespa index, the industrial sector index (INDC), and the financial intermediation index (IFNC) within a Global VAR (GVAR) framework, aiming to discern how these indices respond to shocks originating from domestic, regional, and global sources. Importantly, we also identify shocks from commodity prices, enabling a more comprehensive interpretation of the Brazilian stock market's reactions. The structure of this chapter is as follows: the subsequent section offers a literature review and explains the connections between stock market dynamics and economic variables. The third section details the econometric methodology, focusing on the GVAR estimation process, shock identification, and the data sample utilized. The fourth section presents the results, and the chapter concludes with a summary and final thoughts.

2.2 Literature review

The stock market has emerged as a central financial instrument in the modern economies. Consequently, numerous studies have explored stock market returns, examining variables that might influence this market's behavior. In a seminal chapter, (FAMA, 1981) looks for the relationship between stock market returns and macroeconomic variables, yielding intriguing findings. One of the most notable discoveries is a puzzle correlation between stock returns and the inflation rate in US data. Intriguingly, a negative correlation was observed, implying that stock returns, which are anchored in real assets, are not hedged against inflation. (FAMA, 1981) stress that this correlation is not indicative of a causal relationship but rather signifies a negative association between real economic activity and inflation. In order to validate his hypothesis, the author employed various regression analyses with macroeconomic variables. The results substantiated his proposition, evident from a positive correlation between GDP and stock market returns and the real rate of capital return.

(GESKE; ROLL, 1983) offers an alternative explanation to the puzzle highlighted by (FAMA, 1981). Their argument evolves by employing a more comprehensive model that accounts for the linkage between fiscal and monetary policies: a random negative real shock impacts the stock market returns since it signals higher unemployment and lower tax revenue. In the face of an increase in the deficit, the government will increase the borrowing from the public, raising the real interest rate since the supply of debt securities is increased. Rational investors, anticipating these shifts in fiscal and monetary policies, consequently drive down the prices of short-term securities.

The insights provided by (FAMA, 1981) and (GESKE; ROLL, 1983) are important to see the channels and linkages between macroeconomic variables and the stock market, emphasizing the latter's role as a forward-looking indicator. Following this line, (LEE,

1992) incorporates the VAR (Vector Autoregression) methodology to study the relation among stock returns, economic activity, interest rates, and inflation. (LEE, 1992) findings suggest that stock returns contribute to explaining variance in real economic activity, indicating a positive relationship between them. Building on this approach, (CHATZIANTONIOU; DUFFY; FILIS, 2013) integrates the effects of both fiscal and monetary policies into their structural VAR analysis of stock market returns in developed nations. Their research reveals that while monetary policy, primarily via interest rates, consistently influences stock markets across the examined countries, fiscal policy appears less critical. Notably, fiscal policy's impact was only statistically significant for England.

In the context of emerging countries, (MURADOGLU; TASKIN; I., 2000) employs a range of macroeconomic variables in conjunction with stock market returns to uncover causal relationships. Their findings underscore that country-specific factors play a relevant role in explaining stock market dynamics. Shifting the lens to the BRICS nations, (JR, 2008) investigates the potential linkages between oil price changes, exchange rates, and stock market returns. Contrary to some expectations, they unearth no significant correlations with these variables. They argue that other macroeconomic determinants are more instrumental in elucidating stock market return fluctuations.

For Latin American nations, (ABUGRI, 2008) employs a VAR approach, determining that interest rates, exchange rates, and industrial production are significant predictors of stock market returns. Notably, when incorporating proxies for global variables, their analysis reveals that these global determinants consistently outweigh domestic ones in their influence on returns across different stock markets. Lastly, (TABAK; LIMA, 2003) highlights that shocks originating in the US stock markets exert varied effects across Latin American countries, suggesting a nuanced and heterogeneous impact.

Accessing how the stock market behaves after shocks that come abroad is a compelling area of interest. (ECB, 2022), for example, investigates macro risk shocks in the financial market with two country sources: China and the USA. They find that shocks from China have less effects on country markets than those from the US. This result is in line with (ZHANG et al., 2018) who also finds the US markets dominating the Chinese markets in the global markets, mainly when considering the uncertainty shocks.

It is important to note that when the literature investigates the stock market returns in emerging countries there is an interest to analyse the source of shocks. Such studies often employ proxies for variables seen as exogenous in their models, as exemplified by (ABUGRI, 2008). Alternatively, they might directly use variables determined externally, like oil prices or the US stock market index.

In the Brazilian context, researchers such as (TABAK; LIMA, 2003), (JR, 2008), and (LINCK; DECOURT, 2016) have explored the standard relationship between stock returns and macroeconomic variables. Some even venture into examining shocks emanating from developed markets. However, none of these studies embrace a model encompassing both spillover effects and a mix of endogenous and exogenous variables, as our study does. Furthermore, typical analyses of the Brazilian stock market predominantly fixate on the primary index, neglecting other important indices. Our approach distinguishes itself by implementing a model that precisely identifies the shocks conditional by their source. It creates a scenario where we can use regional and global shocks to analyze the stock market index return. Henceforth, to elucidate how we will implement our model, in the next section, we explain the data sample used in the estimation and also the GVAR methodology with its identification strategy.

2.3 Econometric methodology and data sample

I apply the Bayesian Global Structural Vector Auto-regression (BGSVAR) methodology to estimate impulse response functions for the Brazilian stock market. The BGSVAR methodology employs a VAR, estimated for a group of countries (or entities), and permits spillover effects between them. These spillover effects are identified using Bayesian techniques through sign and zero restrictions[1]. I first provide a brief overview of the data sample to offer a comprehensive understanding. Subsequently, I elucidate this methodology in three segments: its foundational structure based on the Global VAR (GVAR) approach, the Bayesian inference utilized for estimation, and the integration of the structural identification via its identification strategy.

2.3.1 Data sample

Our sample covers the period from 2005Q2 to 2019Q4 for five Latin American countries (Brazil, Chile, Colombia, Mexico, and Peru) and four major economies (China, Euro-Zone, Japan, and the USA)[2]. We include these countries in our estimation to analyze the Brazilian stock market's reaction to shocks based on their origin. Specifically, this setup allows us to discern and segregate shocks stemming from the Latin American region, advanced countries, or purely domestic events. For Brazil, we employ a specific VAR specification incorporating the following variables:

$$x_{it} = (y_{it}, dp_{it}, ner_{it}, embi_{it}, ir_{it}, bov_t, ifnc_t, indc_t)' \tag{2.1}$$

Where: y represents the output gap calculated using the HP filter with λ set at 1600, dp is the quarterly inflation rate, ner denotes the nominal exchange rate calculated as the domestic currency per US dollar, $EMBI$ stands for the Sovereign Risk Premium,

[1] In the existing literature, the BGSVAR is referred to as BGVAR without the term 'S'. This term was inserted to emphasize the potential for an identification strategy.

[2] The sample starts at 2005Q2 because of the availability of some Brazilian stock market indexes

measured by the quarterly mean of the Emerging Market Bond Index, IR is the annualized interest rate, bov refers to the Bovespa index, $indc$ is an industrial index, and $ifnc$ signifies the financial intermediation and financial services index provided by the B3 stock exchange. Both the CPI and the NER, as well as the Sovereign Risk Premium and the stock market indexes, are represented in log differences (indicating the quarterly return of the stock market indexes). Meanwhile, the interest rate is given at its level, though annualized. These stock market indexes were selected due to their broader availability and because they encapsulate important sectors of the Brazilian economy. For the other Latin countries, the following set of variables is assumed:

$$x_{it} = (y_{it}, dp_{it}, ner_{it}, embi_{it}, ir_{it}, stm_t)' \tag{2.2}$$

The variables for these countries reflect those utilized for Brazil, except the stock market index stm, which represents the FTSE index specific to each Latin Country[3]. For the major economies, we adopted a distinct set of variables that reflect the unique characteristics and significance of these economies[4]. For example, commodities prices are largely influenced by the economic activities within these major economies, and events within their borders often spread throughout the world. The variables for country-specific VAR estimation are detailed above:

$$\begin{aligned} USA :& x_t = (y_t, dp_t, fuel_t, agri_t, met_t, dyx_t, vix_t, ir_t, stm_t)' \\ Euro :& x_t = (y_t, dp_t, fuel_t, ner_t, vix_t, ir_t, stm_t),' \\ China :& x_t = (y_t, dp_t, fuel_t, agri_t, met_t, ner_t, ir_t, stm_t)' \\ Japan :& x_t = (y_t, dp_t, ner_t, ir_t, stm_t)' \end{aligned} \tag{2.3}$$

Commodity indexes are categorized based on their class: $fuel$, $agri$ and met represent the log differences of the Fuel, Agriculture, and Metal price indexes, respectively[5]. I categorized commodities this way because the Brazilian stock market may respond differently to each index. The dyx represents the trade-weighted dollar index.

We can model the Brazilian economy dynamics using a VARX(p,q) with k endogenous variables defined in (2.1), and j weak exogenous variables coming from (2.2) and (2.3). Hence, we have the next model for Brazil:

[3] The Financial Times-Stock Exchange (FTSE) is an index developed and distributed by the Financial Times. This index was chosen due to its availability at the beginning of the sample

[4] The original GDP and CPI series are seasonally adjusted and are sourced from (MOHADDES; RAISSI, 2020)

[5] These commodity indexes are sourced from the Primary Commodity Price System of the IMF. The Agriculture Index encompasses the Agriculture Price Index, which includes both Food and Beverages and Agriculture Raw Materials Price Indices. The Metal index pertains to the Base Metals Price Index, comprising Aluminum, Cobalt, Copper, Iron Ore, Lead, Molybdenum, Nickel, Tin, Uranium, and Zinc Price Indices. Meanwhile, the Fuel index includes indices for Crude oil (petroleum), Natural Gas, Coal, and Propane.

$$x_{it} = \sum_{s=1}^{p} \phi_{is} x_{it-s} + \sum_{r=0}^{q} \Lambda_{ir} x^*_{it-r} + \epsilon_{it} \tag{2.4}$$

where x_{it} is a $(k_i \times 1)$ vector of endogenous variables, ϕ_{is} is a $(k_i \times k_i)$ diagonal coefficient matrix of each endogenous variables, Λ_{ir} is the matrix $(k_i^* \times k_i^*)$ associated to the weak exogenous variables x^*_{it} and ϵ_{it} is the error term with zero mean and time-varying variance-covariance matrix Σ_{it}.

The weak exogenous variables x^* are built as a weighted mean of other economies' endogenous variables:

$$x^*_{it} = \sum_{j=0}^{N} \omega_{ij} x_{jt} \tag{2.5}$$

with ω_{ij} representing the bilateral trade flow between countries i and j. In the trade flow matrix, we have $\omega_{ij} = 0$ for $i = j$ and $\sum_{j=0}^{N} \omega_{ij} = 1$. This structure assumes that shocks in one country may not significantly impact another unless there's substantial trade between them, as mentioned in the previous chapter. In alignment with the GVAR approach, I also designate the nominal exchange rate as the sole variable excluded from x^*. The weighted trade flows utilized in the estimation can be found in Appendix B.

2.3.2 BGSVAR: specification.

We will first delve into the specifics of the BGSVAR methodology. This methodology is presented in a similar way to what has been done in the previous chapter. So, the reader can go directly to subsection 2.3.4 without any losses if has read the methodology section of the previous chapter.

The GVAR methodology was first introduced by (PESARAN; SCHUERMANN; WEINER, 2004), specifically designed to assess shock spillover effects between nations. While VAR models can theoretically handle such analysis, the rapid loss of degrees of freedom as more variables are included can make VAR estimation impractical. To circumvent this limitation, (PESARAN; SCHUERMANN; WEINER, 2004) proposed a methodology to estimate VARs that include spillover effects while mitigating the loss of degrees of freedom.

Consider a scenario with $i+1$ countries, each having x endogenous variables. Each country is evaluated based on its respective factors (the x endogenous variables) and the weak exogenous variables x^*, which represent the external variables from country i. For the sake of clarity, we will describe the following GVAR model with a lag of 1 for country i:

$$x_{it} = a_{i0} + a_{i1t}t + \phi_i x_{it-1} + \Lambda_{i0} x^*_{it} + +\Lambda_{i1} x^*_{it-1} + \epsilon_{it} \tag{2.6}$$

where: a_{i0} and $a_{i1t}t$ are the constant and deterministic time trend of the VAR model for the country i, x is a vector $(k_i \times 1)$ of endogenous variables, x^* is a vector $(k^*_i \times 1)$ of foreign (weak exogenous) variables, ϵ_{it} is a $(k_i \times 1)$ vector of idiosyncratic shocks and ϕ_i is a matrix $(k_i \times k_i)$ of lagged endogenous coefficient. The idiosyncratic shock can be decomposed in a time-varying variance-covariance matrix $\Sigma_{it} = V_i S_{it} V_i^{'}$ with V being a lower triangular matrix of dimension $k_i \times k_i$ with elements $v_{ij,n} = (j = 2, ..., k_i; n = 1, ..., j-1)$ and S being a diagonal matrix given by: $S_{it} = diag(\epsilon^{s_{i1,t}}, ..., \epsilon^{s_{ik,t}})$. The Λ_{i0} and Λ_{i1} are matrices $(k_i \times k^*_i)$ of contemporaneous and lagged coefficients of the foreign variables. Note that if $\Lambda_{i0} = \Lambda_{i1} = 0$, equation (2.1) defines a VAR(1), but if we allow the presence of foreign variables, Λ_{i0} and $\Lambda_{i1} \neq 0$, we turn to have a VARX(1,1) with the foreign variables entering in the model contemporaneously and lagged.

The weak exogenous variables are defined in the GVAR model as:

$$x^*_{it} = \sum_{j \neq i}^{N} \omega_{ij} x_{jt} \tag{2.7}$$

where ω_{ij} is a link matrix that is formed by the weighted trade flows or any other economic variables that represent the bilateral connection between the countries. It is worth noting that this bilateral linkage ω_{ij} is exogenous (and fixed) and the weak exogenous variables x^*_t is a function of x_t, allowing to be determined endogenously within the global system. Additionally, we must have $\sum_{j=0}^{N} \omega_{ij} = 1$.

The estimation procedure of the GVAR methodology entails two stages: initially, it estimates the individual VARs for each country, premising that the residuals, ϵ_{it}, are uncorrelated among countries. Subsequently, these individual VARs are integrated with the weak exogenous variables to achieve a global representation of the model. For this purpose, let us define z_t as:

$$z_{it} = \begin{bmatrix} x_{it} \\ x^*_{it} \end{bmatrix} \tag{2.8}$$

Rewriting model (2.6) with left-hand side contemporaneous terms yields::

$$A_i z_{it} = a_{i0} + a_{1t}t + B_i z_{it-1} + \epsilon_{it} \tag{2.9}$$

with $A_i = (I_k, -\Lambda_{i0})$ and $B_i = (\phi_i, -\Lambda_{i1})$. Recalling (2.7) it is possible to re-write the equation (2.9) using a W link matrix:

$$A_i W_i x_{it} = a_{i0} + a_{1t} t + B_i W_i x_{it-1} + \epsilon_{it} \tag{2.10}$$

which $A_i W_i$ and $B_i W_i$ are both $(k_i \times k)$ dimensional matrices. Once these matrices are stacked for all the countries in the model, we get:

$$G x_t = a_{i0} + a_{1t} t + H x_{t-1} + \epsilon_t \tag{2.11}$$

where $a_{i0} = [(a_{00})', ..., (a_{N0})']$, $a_1 = [(a_{01})', ..., (a_{N1})']$, $G = [(A_0 W_0)', ..., (A_N W_N)']$, $H = [(B_0 W_0)', ..., (B_N W_N)']$ and $\epsilon_t = [\epsilon'_{0,t}, ..., \epsilon'_{N,t}]$. Remind that we have assumed the nonzero contemporaneous shocks correlation between countries, hence $\epsilon_t = [\epsilon'_{0,t}, ..., \epsilon'_{N,t}]$ $\sim \mathcal{N}(0, \Sigma_\epsilon)$ with Σ_ϵ denoting a block diagonal matrix. As G is a full rank matrix and hence non-singular, we can multiply (2.11) from the left by G^{-1} yielding:

$$\begin{aligned} x_t &= G^{-1} a_{i0} + G^{-1} a_{1t} t + G^{-1} H x_{t-1} + G^{-1} \epsilon_t \\ &= b_0 + b_1 t + F x_{t-1} + e_t, e_t \sim \mathcal{N}(0, \Sigma_e) \end{aligned} \tag{2.12}$$

Stability is ensured for the equation above if the eigenvalues of F reside within the unit circle. It's important to note, however, that equation (2.12) also represents a VAR(1) form, with the error term e_t comprising a variance-covariance matrix $\Sigma_e = G^{-1} \epsilon_t G^{-1'}$ that reflects the contemporaneous relations between countries. Consequently, it is feasible to employ all the resources of the VAR methodology, encompassing identification restrictions, impulse response analyses, historical decomposition, and forecast error variance.

2.3.3 Bayesian estimation

A significant challenge in using the VAR model is the high number of parameter estimates. A usual VAR contains $n + pn^2$ coefficients where n is the number of parameters and p is the number of lags, showing how quickly the number of coefficients grows fast. For example, a VAR with only 2 lags and 4 variables involves 36 parameters. However, the same model with 4 lags demands a staggering 68 parameters. Such rapid growth in parameters necessitates larger data sets for accurate estimation, limiting our ability to incorporate more variables into the VAR framework. While the GVAR approach offers a partial solution by estimating fewer parameters, the fundamental challenge of limited degrees of freedom persists, especially when working with macroeconomic series that traditionally have limited data coverage.

The Bayesian VAR provides a solution to the challenge of limited degrees of freedom associated with traditional VAR models. This subsection draws primarily on the work of (FELDKIRCHER; HUBER, 2015) and (FELDKIRCHER; GRUBER; HUBER, 2019), who detail the application of the SSVS prior within the GVAR framework. Notably, they highlight several compelling properties that position the SSVS prior specification as a superior choice for GVAR estimation. While I will outline some of these essential properties, I encourage readers seeking a deeper understanding to consult these foundational chapters directly.

The SSVS is a hierarchical prior selection that applies shrinking on the parameters of the model. Formally, the SSVS prior takes into consideration the uncertainty about the variable choice which is very useful for this kind of estimation where it is allowed to vary specifications between countries, as shown before. Denoting the vector of coefficients for country i as $z_i = \{a_{10}^{'}, a_{1it}^{'}, vec\ \{\Lambda_{i0}\}, vec\{\Lambda_{i1}\}, vec\{\phi_i\}\}$ with $k_i = 2k_i + k_i(pk_i + qk_i^*)$ dimension, we have:

$$z_{ij}/\delta_{ij} \sim \mathcal{N}(0, \tau_{ij,0}^2)\delta_{ij} + \mathcal{N}(0, \tau_{ij,1}^2)(1 - \delta_{ij})\ for\ j = 1, ..., k_i \tag{2.13}$$

Where δ_{ij} is a random binary variable, assuming 1 if the variable j is included in the model and 0 otherwise; $\tau_{ij,0}^2$ and $\tau_{ij,1}^2$ are the prior variances representing the spike and the slab components, with $\tau_{ij,0}^2 >> \tau_{ij,1}^2$ and $\tau_{ij,1}^2$ set close to 0. Those prior variances mean that if there is a small coefficient in the model, the spikes component applies, pushing the posterior distributions toward zero. On the other hand, if the coefficient is higher, little shrink is used, leaving the prior as non-informative (the slab component). Hence, the posterior will be pushed towards zero or towards the value of the likelihood depending on the size of the coefficient.

The parameter δ_{ij} serves as a critical determinant in the selection of prior distributions. Specifically, its value dictates the chosen prior variance from the Gaussian distribution referenced in equation (2.13). When δ_{ij} equals 1, is equal to 1, the distribution adopts the slab component from the equation's first term. Conversely, if δ_{ij} is zero, the equation's second term, featuring the shrinking variance, is utilized. Note that the parameter δ_{ij} should be estimated and following (FELDKIRCHER; HUBER, 2015) and (FELDKIRCHER; GRUBER; HUBER, 2019) I assume a Bernoulli distribution prior with prior inclusion probability of 0.5 for all i and j. This means that every variable is equally likely to be incorporated into the country-specific VAR model, as evidenced by: $p_{ij} = 0.5 = p(\delta_{ij} = 1/z_{it})$. So, given the probability δ_{ij} =1, the posterior distribution $p(\delta_{ij} = 1/z_{it})$ can be written as:

$$p(\delta_{ij} = 1/z_{ij}) = \frac{\mathcal{N}(z_{ij} \mid 0, \tau_{ij,0}^2)}{\mathcal{N}(z_{ij} \mid 0, \tau_{ij,0}^2) + \mathcal{N}(z_{ij} \mid 0, \tau_{ij,1}^2)} \tag{2.14}$$

Equation (2.14) shows that we have a mixture of densities based in the centered value of z_{ij}. If z_{ij} is close to 0, the shrinking component dominates and the posterior density will be close to 0. On the other hand, if z_{ij} is higher, then the slab prior variance would overcome and the posterior distribution approximates to 1. A notable characteristic of the SSVS is that no variable is excluded from the model, even when the value of a variable is zero.

Regarding the variance-covariance matrix, I also adopt the SSVS prior specification. Before delving into this specification, it's vital to highlight my assumption of stochastic volatility during the estimation process. This assumption allows for an autoregressive (AR(1)) setup for the log volatility of the error term. Stochastic volatility captures crucial nuances of the time series data, such as periods of economic booms and busts, and the inherent volatility of the series[6]. This AR(1) process can be expressed as follows[7]:

$$s_{ij,t} = \mu_{ij} + \rho_{ij}(s_{ij,t-1} - \rho_{ij}) + \kappa_{ij,n} \tag{2.15}$$

where the s component comes from the diagonal element of the matrix $S_{it} = diag(\epsilon^{s_{i1,t}}, ..., \epsilon^{s_{ik,t}})$, μ_{ij} is the unconditional mean, ρ_{ij} represents the inertia parameter and $\kappa_{ij,n}$ is a white noise disturbance with variance ζ_{ij}^2. The SSVS prior specification for the variance-covariance has some parameters that can make the stochastic volatility given in 2.15 work like a homoscedastic case or a more volatile one. To see this, let SSVS prior to the variance-covariance be represented by:

$$v_{ij,n}/\kappa_{ij,n} \sim \mathcal{N}(0, \xi_{ij,n0}^2)\kappa_{ij,n} + \mathcal{N}(0, \xi_{ij,n1}^2)(1 - \kappa_{ij,n}) \tag{2.16}$$

where $v_{ij,n}$ represents the elements of V, $\xi_{ij,n0}^2$ and $\xi_{ij,n1}^2$ are prior variances that denotes the shrink and slab components for the variance-covariance in such way: $\xi_{ij,n0}^2$ $>> \xi_{ij,n1}^2$, with $\xi_{ij,n1}^2$ close to 0. The $\kappa_{ij,n}$ is a random binary variable following a Bernoulli distribution. As it has been done with the prior inclusion probability for the parameters, it is assumed that $\kappa_{ij,n}$ has a prior inclusion probability set equally, or in other words: $p(\kappa_{ij,n} = 1) = 0.5$. The ζ_{ij}^2 captures how the shrinking and slab components act. If we set the ζ_{ij}^2 as zero, for example, we will have a stable s, which means that we approximate to a homoscedasticity case, where the shrinking component applies.

For the estimation process, I consider the following hyperparameters values: $\tau_{ij,1}^2 = 0.1\hat{\sigma}_{ij}^2$ and $\tau_{ij,0}^2 = 3\hat{\sigma}_{ij}^2$ where σ_{ij}^2 is the OLS variance of the z_i along with $\xi_{ij,n0}^2 = 0.1$ and $\xi_{ij,n1}^2 = 7$ for the prior values for the variance-covariance. Additionally, with respect to the prior distributions for the stochastic volatility, I assume a Gamma prior on the ζ_{ij}^2 $\sim \mathcal{G}(1/2, 1/2)$; a normal distribution prior for the $v_{ij,n} \sim \mathcal{N}(0, 10^2)$ and a Beta distribution for the ρ_{ij}. All of these hyperparameters values as the distribution choices follow closely (FELDKIRCHER; GRUBER; HUBER, 2019).

[6] The inclusion of stochastic volatility enhances the model fit, accounting for the volatility of the series and addressing heteroscedasticity issues.

[7] Remember that according to Equation (1), the error term can be decomposed in the following variance-covariance matrix: $\Sigma_{it} = V_i S_{it} V_i^{'}$

I used the R library BGVAR to estimate the BGSVAR. This package allows us to estimate the BGSVAR carrying out the MCMC methods, with a wide range of prior distributions and structural identification. For more technical details for example the algorithm that is used to do the MCMC and the posterior simulation see (BöCK; FELDKIRCHER; HUBER, 2020)[8]. In the estimation process, I considered a lag 1 BGSVAR with 30000 draws and 15000 burn-ins. Its descriptive statistics are shown in Appendix B.

2.3.4 Sign restriction approach and identification strategy

I employ the sign and zero restriction techniques as a method for structural identification. First introduced by (UHLIG, 2005), this approach was developed as an alternative to the Cholesky decomposition, avoiding the need for strong contemporaneous restrictions. The essence of sign restrictions lies in an agnostic identification scheme that draws upon consistent assumptions about data responses to specific shocks. As highlighted by (UHLIG, 2017), when examining a specific economic variable reaction, we can implement sign restrictions based on certain empirically or theoretically supported assumptions. For example, following an unexpected increase in interest rates, one might anticipate a decline in the stock market and a contemporaneous local appreciation of the exchange rate due to this monetary policy shift. Such restrictions can be integrated provided they are grounded in empirical or theoretical evidence.

In the context of the GVAR, this strategy opens up a wide variety of restrictions due to our dealing with both endogenous and weak exogenous variables. However, the GVAR approach allows only for local identification schemes, limiting our ability to restrict weak exogenous variables. Despite this, the GVAR approach remains appealing due to its capacity to model the impact of regional or global shocks on the same variable across different countries and to analyze the spillover effect.

We use the rotation matrix algorithm proposed by (ARIAS; CALDARA; RUBIO-RAMíREZ, 2019) for the estimation process. It should be noted that before we impose the sign restriction, the model is structurally identified (Cholesky). So, indexing a country i by $i = 0$ allows us to introduce a $k_0 \times k_0$ dimension block diagonal rotation matrix $R_{0,t}$ with $R_{0,t}R_{0,t}^{'} = I_{k0}$ into the structural equation as follows:

$$\tilde{Q}00, txit = \tilde{a}i0, t + \tilde{a}ti0, t + \tilde{\phi}i1, txit - 1 + \tilde{\Lambda}i0, txit + \tilde{\Lambda}i1, txit - 1 + \tilde{R}i0, t\epsilon it \quad (2.17)$$

where $\tilde{Q}00, i = R0, tQ00, t$ with $Q00, t$ representing the contemporaneous relationship between the countries, given that the model is already identified, $\tilde{a}i0, t = R0, ta_{i0,t}$,

8 The BGVAR package includes a lot of technical details as a brief explanation of the stochastic volatility used, the efficient algorithm for large VAR estimation and the SSVS prior distribution algorithm in the GVAR context applied.

$\tilde{a}ti0,t = R0,tat_{i0,t}$, $\tilde{\phi}i1,t = R0,t\phi_{i1,t}$, $\tilde{\Lambda}i0,t = R0,t\Lambda_{i0,t}$ and $\tilde{\Lambda}i1,t = R0,t\Lambda_{i1,t}$. Note that the matrix $R_{0,t}$ is orthogonal only to the country $i = 0$, which represents the local identification assumption, with the remaining countries having a general identification scheme. Two additional points should be mentioned in the sign restriction approach: (i) The restrictions can be applied contemporaneously and over longer horizons. (ii) While increasing the number of restrictions can reduce model uncertainty, it also makes finding a rotation matrix more challenging. In some highly restricted cases, finding a suitable rotation matrix might not be possible."

Finally, to carry over the identification, we follow the (UHLIG, 2005) sign restriction approach. The idea is to impose a minimal restriction set to avoid controversial identifications. For example, many economists agree that after an unanticipated positive monetary shock, the stock market usually decreases and the interest rate rises. As we have seen, an exciting feature of the BGVAR is that we can identify several kinds of shocks considering their source. If we take a look at the BGVAR literature, it is possible to see how this methodology is applied, particularly regarding the monetary policy shock coming from big economies such as the US or Euro Zone to peripheral economies. This BGVAR characteristic of identifying the source of the shock enables us to explore the stock market reaction in a way that it has not yet been done: analysis of the stock market reaction to shocks conditional in its source. In order to do that, I will analyze three types of shocks for Brazil:

1. Domestic shocks: includes shocks that come from the financial sector and real economic activity. This kind of shock is specific to Brazil's internal dynamics. We consider 4 domestic shocks: an exchange rate shock (depreciation of local currency), a premium risk shock, a monetary policy shock (rise of interest rate), and finally a demand shock.

2. Regional shocks: represents a shock that hits all the Latin American countries at the same time. These shocks impact all Latin American countries concurrently and can arise due to factors common to the region. Examples might include regional trade agreements, fluctuations in commodity prices that the countries predominantly export, or geopolitical events. We have 3 regional shocks: a premium risk shock, a monetary policy shock, and a demand shock.

3. it is an economic shock that comes from a big economy and spreads through the world. Global shocks could arise from shifts in monetary policy by major central banks, global recessions, major geopolitical events, or international trade wars. Three shocks are considered: an uncertainty shock, a demand shock, and a commodity price shock.

As previously mentioned, I will employ an identification strategy that minimizes restrictions and selects the least controversial ones. In order to do that, the restriction set of the domestic shocks follows what has been done in the literature[9].Regarding re-

[9] Hence, for the domestic shock, for example, we apply an identification for a positive sign for both the

gional shocks, we apply similar restrictions as those for domestic shocks but encompass all countries in the region. For global shocks, however, we refrain from restricting any of Brazil's responses. This is partly because some variables, such as the Uncertainty Index and commodity prices, aren't included in Brazil's VAR. Furthermore, these shocks are characterized as emanating from major economies. The subsequent Table 4 will outline our identification. It's imperative to underscore that our primary focus remains the Brazilian stock market's response.

Table 4 – Identification restrictions - Brazil[1,2,3]

	Output Gap (Demand Shock)	CPI	Exchange rate Shock	Risk Premium Shock	Interest rate Shock	Risk Premium* Shock	Interest rate* Shock	VIX* Shock	Oil price index* Shock
Output Gap	$>^1$		0	0	0	0	0		
CPI	$>^1$		$>^1$	$>^1$	$<^1$	$>^1$	$<^1$		
Exchange rate	*		$>^1$	$>^1$	$<^1$	$>^1$	$<^1$		
Risk Premium	*		$>^1$	$>^1$	*	$>^1$	*		
Interest rate	0		0	0	$>^1$	0	$>^1$		
Bov	$>^1$		$<^1$	$<^1$	$<^1$	$<^1$	$<^1$		
IFNC	$>^1$		$<^1$	$<^1$	$<^1$	$<^1$	$<^1$		
INDC	$>^1$		$<^1$	$<^1$	$<^1$	$<^1$	$<^1$		
*Output Gap**						0	0	*	$>^1$
*CPI**						$>^1$	$<^1$	*	*
*Risk Premium**						$>^1$	$<^1$	*	*
*VIX**								$>^1$	*
*Oil price index**								*	$>^1$
*Agriculture price index**								*	$>^1$
*Metals price index**								*	$>^1$
*Interest rate**						0	$>^1$	*	*

1/ Variables bellow the dot line represents variables that are treated as weak exogeneous (superscript *) for the Latin countries.

2/ The restrictions can be applied only for existing variables for a country. So if I shock the Oil Price index, for example, the restrictions are avaiable only for the countries where the Oil Price is assumed as endogeneous in the estimation.

3/ The signs >, < and 0 are the sign and zero restrictions applied in the structural identification scheme. The superscript above the sign denotes the periods which the restrictions remain active. Asteriscs inside the matrix represents variables not restricted. Blanck spaces are variables not restricted due to the impossibility of doing that (remember that the shocks are locally identified).

2.4 Results

In this section, I detail the findings from the BGSVAR analysis. The impulse response functions of the shocks identified in the previous section are presented, focusing on the dynamics of the Brazilian stock market return[10]. Furthermore, the magnitude of the stock market indices' reactions to these shocks is explored. The central aim of this analysis is to discern the distinct behaviors exhibited by the Brazilian stock market indices when subjected to various shocks. This inquiry is particularly interesting as it is based on several important variables that can potentially influence stock market reactions. Additionally, I present the stock market's reaction quantified as the ratio of the stock market index over various periods post the initial shock at time 0. Mathematically we have: $\frac{index_{0,t+i}}{shock_{0,t}}$

output gap and the inflation rate, with the stock market indexes following this movement. For the monetary policy shock, a positive sign is set for the interest rate, and a negative sign is applied both for the exchange rate and the inflation rate.

10 For clarity, impulse response function plots for other variables have been relegated to Appendix B and are not presented in the main text.

where *index* is the reaction of the stock market index from a period t to i and *shock* is the magnitude of the variable shocked in time 0.

2.4.1 Impulse Response Functions

I divide the presentation of the impulse response function (IRF) by its source. First, I show the response function of the domestic shocks, followed by the regional shock, and finally by the global ones[11]. In the following IRF plots the solid line represents the median of the posterior and the dark gray (50%) and light gray (68%) are the credible intervals of the successful rotation matrices found in each of the shocks estimated.

- Individual countries shocks:

We present the domestic shocks for Brazil in Figure (9). As shown by Table 4, we investigate how the stock market indexes react to shocks coming from the exchange rate, the risk premium, the interest rate (monetary policy), and a demand shock. We focus on the response of the stock index return, but the entire set of the impulse response function can be viewed in Appendix B. According to Figure (9), the exchange rate shock provides a stronger reaction to the Brazilian stock market indexes than the risk premium shock. This outcome might be attributed to the fact that a depreciation of the exchange rate probably causes a rise in the inflation rate, a phenomenon known as exchange rate pass-through, which makes the central bank raise its interest rate. As these financial market indexes work as a forward-looking variable, this movement anticipates a movement that will hit the economy. Indeed, a depreciation of the local currency is a signal of adverse shock affecting the economy.

The comparative analysis of the indexes' reactions reveals nuanced distinctions. Notably, both the Bovespa and the IFNC indexes exhibit a slightly more pronounced reaction than the INDX. Given that the INDX index comprises companies from the industrial sector, an exchange rate depreciation might lend them a competitive edge against imported industrial products. However, it's crucial to note that many of these industrial companies also consume imported goods, which can inflate their operational costs. Furthermore, when we turn our attention towards the risk premium, we should remember that the increased cost of foreign funding, reflecting a surge in the sovereign risk premium, impacts businesses differently. This outcome impacts the companies that are affordable to borrow from abroad, which makes the INDX index respond more to this kind of shock.

In essence, both the exchange rate shock and the risk premium shock induce a negative response across all the stock market indexes. Those results contrast with (JR,

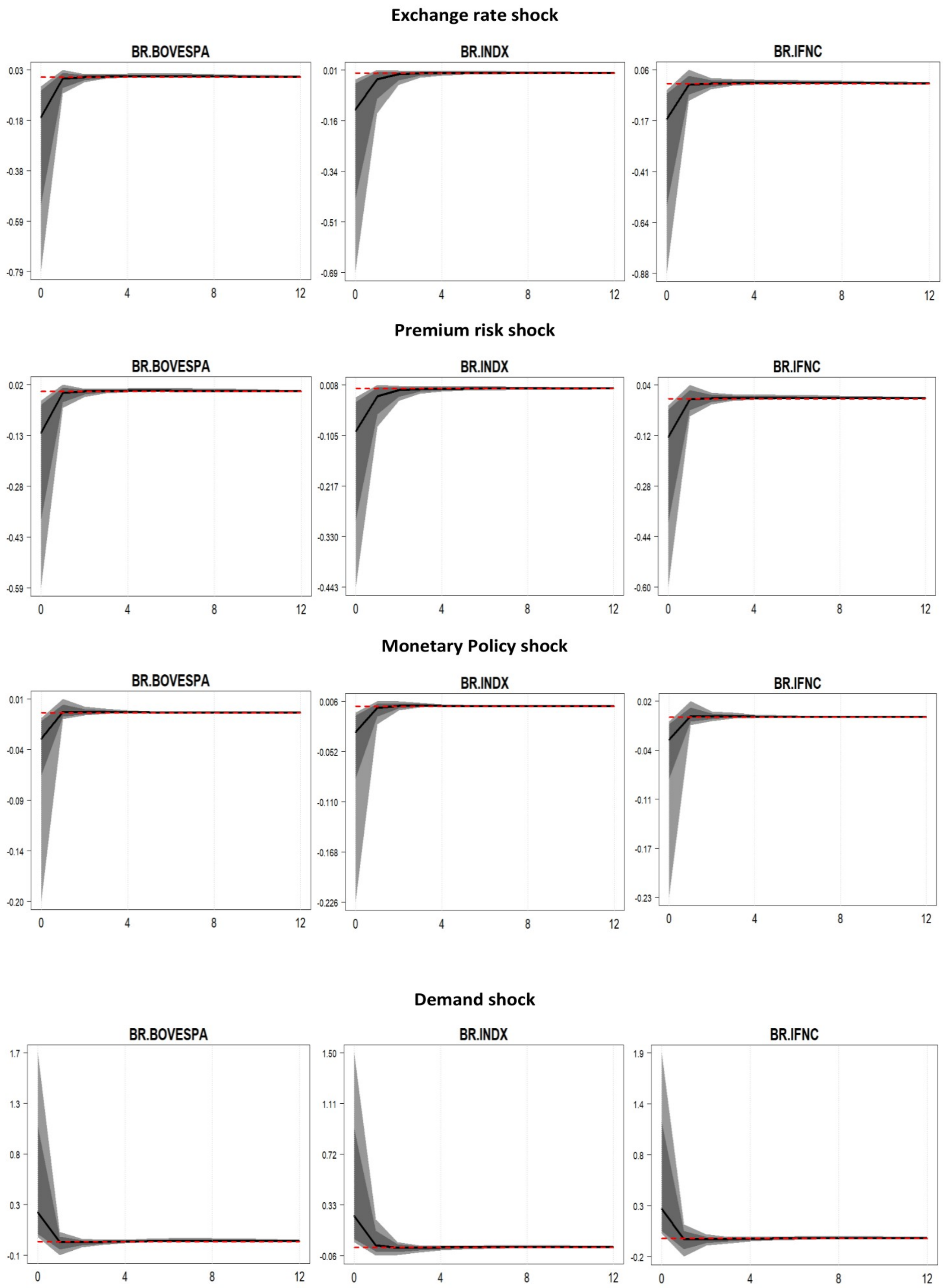
[11] As I am dealing with different shocks I consider the following shock size for each of the sources: 0.1 for the exchange rate shock, a 0.2 for the risk premium shock, a 100 basis point for the monetary policy shock, a 0.02 for the demand shock, 1 for the VIX and 0.2 for the commodities indexes.

2008) which found an opposite result. (JR, 2008) defend that local currency depreciation positively impacts the stock market since some economies would be export-oriented. Although Brazil is not an exported-oriented economy, the leading companies listed in the stock market are big exporters and this could explain (JR, 2008) outcome. Nevertheless, as highlighted earlier, local currency depreciation signifies more than just an economic downturn. Its adverse effects, including surges in inflation and interest rates, will hit the economy, with the stock market indexes anticipating this outcome.

The stock market indexes also exhibit a negative reaction following a monetary policy shock. This outcome, commonly seen in the literature, illustrates the competitive dynamics between the stock and bond markets and underscores the linkage between real economic activity and corporate performance. Specifically, a rise in interest rates often curtails domestic activity, dampening local businesses' financial performance. This observation aligns with findings from (LINCK; DECOURT, 2016) and (ABUGRI, 2008), who documented similar patterns for Brazil.

The demand shock is shown in the fourth line of Figure (9). As can be seen, the stock market rose following this shock. In this case, we have a scenario of economy-boosting which might increase the firms' profit and create an environment of less unemployment, higher wages, and a rise in the people's income and firms' revenues. The financial indexes react more than the other indexes, reflecting that the demand for those services might be strong in the short term and, simultaneously, a bigger probability of loan payments. This demand shock, often referred to as an output shock, has the most pronounced effect on stock market returns.

Figure 9 – Domestic shock - Brazil

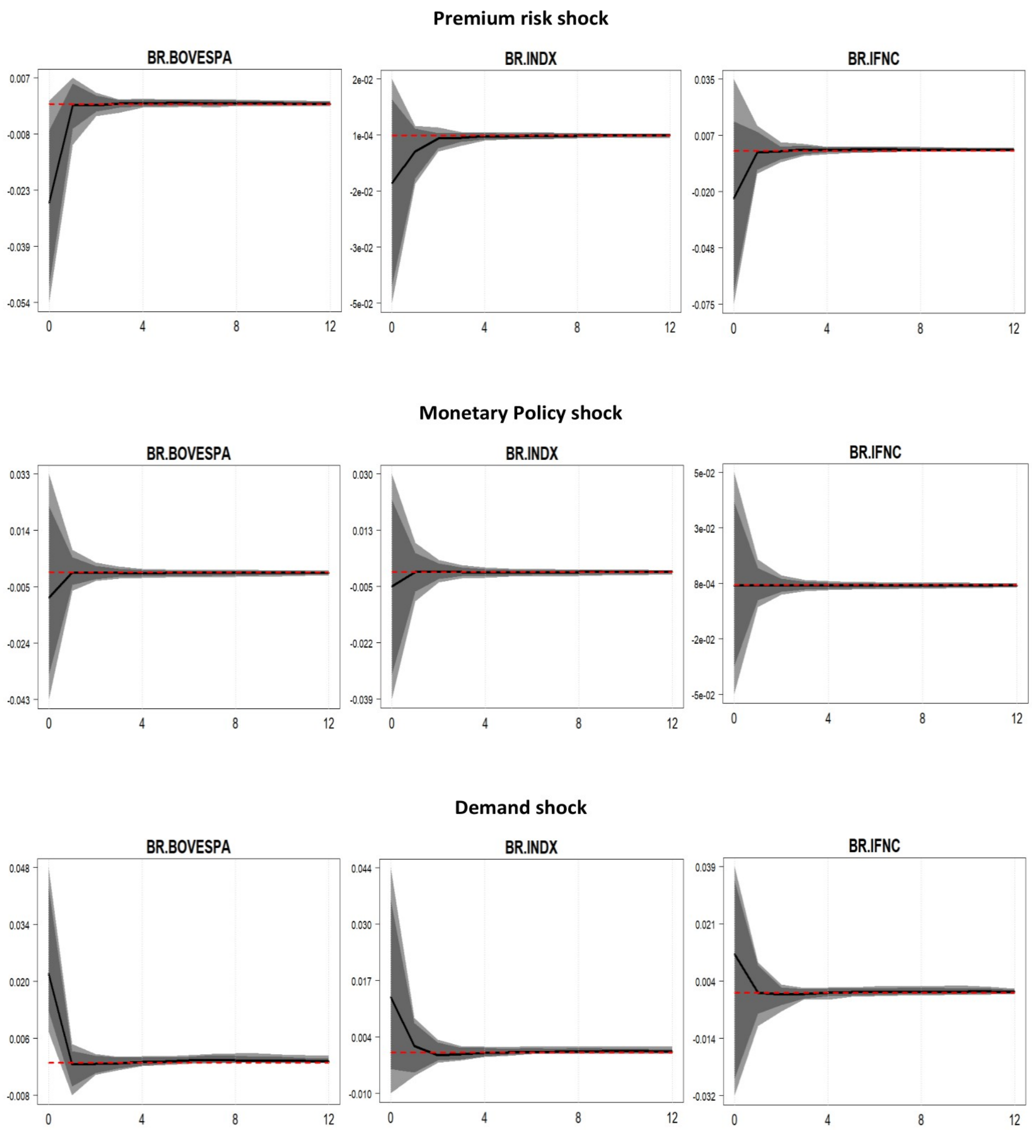


- Regional shocks:

We define a regional shock as an event that simultaneously impacts all Latin American countries. Historically, there have been instances where this region faced significant economic stress, such as in the late 1990s and early 2000s. We've selected three primary events to represent these regional shocks.

The first one is the risk premium shock. As illustrated in Figure (10), all Brazilian indexes exhibit a negative response to this regional shock, though the reaction is less pronounced compared to the domestic one. In fact, this trend is consistent across all regional shocks when juxtaposed with their domestic counterparts. One possible explanation for this pattern is the relative strength and development of the Brazilian stock market. Being the most advanced within Latin America, Brazil's market might be perceived as a safer place during regional disturbances. Another intriguing observation is the moderated reaction to demand shocks, indicating that the Brazilian market may not be as closely integrated with its regional counterparts. The limited spillover effects from neighboring countries highlight Brazil's distinctiveness within the region.

Figure 10 – Regional shock - Brazil



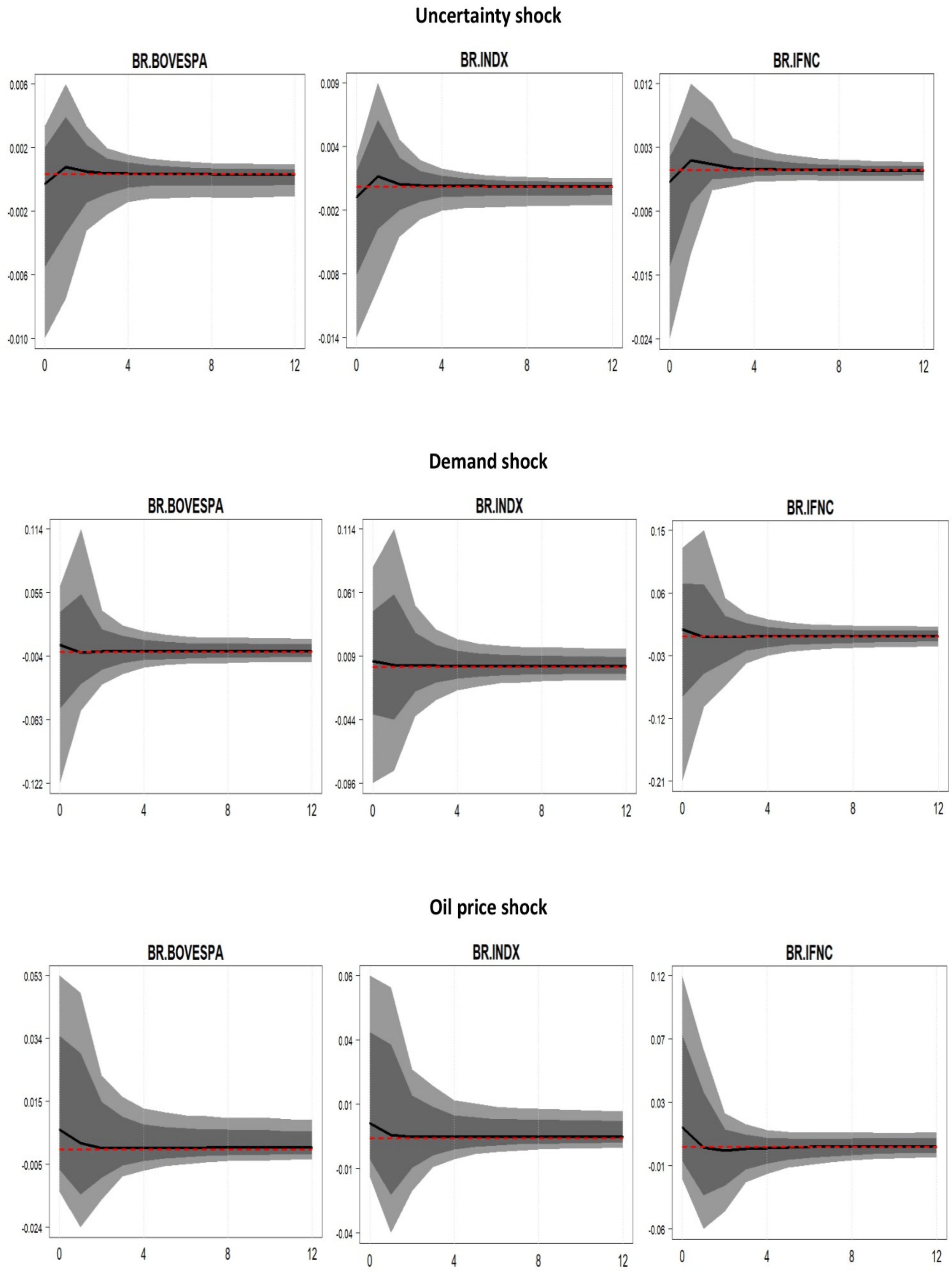
- Global shocks:

The global shock is an event that comes from the biggest economies in the world and has the potential to spread throughout the world. We deal with 3 kinds of shocks, one concerning a demand shock, the second one to an uncertainty shock that comes from Europe and the USA, and a commodities price shock. In this case, we estimate the commodities market as endogenous with the biggest economies since they are capable of affecting their prices through their economic activity. We shock the three indices of commodities (agriculture, metal, and oil) to investigate how the Brazilian stock market responds to them but for presentation purposes, I shown in Figure (11) only the oil price shock.

Before we proceed, it's crucial to highlight some distinctions concerning Brazil's position in global shock analyses: (i) As the commodities price shock is not considered endogenous to Brazil, it is not possible to shock Brazil directly with this kind of variable. (ii) Brazil is not considered a big economy and I have assumed a shock that comes from those major countries. This methodological choice undoubtedly influences the impulse response functions (IRFs) and their respective confidence intervals. The Brazilian stock market would likely experience more significant perturbations if directly influenced by these shocks. Nonetheless, understanding these indirect influences remains valuable. Moreover, it's plausible that the repercussions witnessed here from global shocks could be additive to those stemming from domestic shocks.

According to Figure (11), a rise in oil prices leads to an increase in the Brazilian stock market. This behavior can be explained by the relevance of commodities export companies in B3 and also by the importance of those products to the Brazilian economy. Regarding the uncertainty shock, the stock markets respond negatively, a result in line with what we have seen when those circumstances arise. A global demand shock represents a shock that comes from the major economies in the world. As Figure (11) shows, the Brazilian stock market reacts positively to this environment but with a lower response than the domestic counterpart. In the literature, the shocks that come from the USA usually hit the Brazilian stock market index stronger than the domestic shock, as can be seen in (ABUGRI, 2008). But the fact that in our model, that kind of shock only impacts Brazil indirectly may help to explain this result.

Figure 11 – Global shock - Brazil



2.4.2 Stock market return

In this subsection, I present the results of the median response concerning the Brazilian stock market returns conditional on the size of the shocks applied. Here, we are able to compare the stock return controlling for the size of each shock. But before we present the results, it is important to remember that we do not show the global shocks since we do not shock directly any variable included in Brazil's VAR. In this case, we are not able to take any conditional measure. According to the Table (12) the stock market return responds more to exchange rate shock than the other financial domestic shocks. However, the demand shock exhibits a strong effect on the stock market meaning that those companies, as expected, are highly impacted by the real economy.

The regional shocks exhibit a different pattern in relation to the domestic shock. Even though the Brazilian stock market is negatively affected by regional risk Premium shock, the Bovespa Index is not affected by the regional monetary policy shock. Undoubtedly, it is a weird outcome. Regarding the demand shock, the Brazilian stock market reacted according to the theory, with the Bovespa index having a stronger response.

Figure 12 – Stock market return - Brazil

Bovespa index

	Local shocks				Regional shocks		
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Demand
t	-1.64	-0.62	-0.22	13.38	-0.18	0.02	0.40
t+1	-1.70	-0.64	-0.21	12.96	-0.18	0.02	0.31
t+2	-1.70	-0.64	-0.21	12.69	-0.18	0.02	0.26

IFNC index

	Local shocks				Regional shocks		
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Demand
t	-1.65	-0.62	-0.25	15.05	-0.17	-0.01	0.20
t+1	-1.69	-0.63	-0.13	14.66	-0.18	-0.01	0.13
t+2	-1.68	-0.63	-0.11	14.32	-0.18	-0.01	0.05

INDX index

	Local shocks				Regional shocks		
	Exchange Rate	Risk Premium	Monetary Policy	Demand	Risk Premium	Monetary Policy	Demand
t	-1.27	-0.48	-0.25	12.13	-0.18	0.00	0.34
t+1	-1.47	-0.56	-0.14	13.04	-0.21	0.00	0.34
t+2	-1.52	-0.58	-0.13	12.94	-0.22	0.00	0.32

The values shown represents the median of the stock market return conditional on the geographical source and size of specific shock. They are calculated by $\frac{index_{0,t+i}}{shock_{0,t}}$ where *index* is the return of each of the stock market index from a period *t* to *i* and *shock is the size of shock applied*

2.5 Robustness analysis

As a robustness exercise, I have estimated the model with a different set of sign restrictions. The results remain similar. Another exercise is to consider more than 1-period horizon for the sign restriction. Although the sign restriction can be applied for more periods, for some of the shocks applied, it is not possible to find a successful rotation matrix, which requires us to change the probability of successful matrices. There is no deep change in the results with those alternative specifications and they are available upon request.

2.6 Conclusion

In this chapter, we have investigated how the Brazilian stock market indexes react to financial and macroeconomic shocks. Using a BGVAR approach, we have divided the shocks by their source and also by the variable shocked. This procedure has not yet been done by the literature and permits to analyze if the origin of the shock can influence the magnitude of the Brazilian stock market return. Indeed, we apply a methodology in which the countries are jointly estimated, allowing spillover between them.

The Brazilian share prices respond strongly to the exchange rate shock (depreciation of local currency) and less to the domestic risk premium shock. This outcome reflects that the local currency dynamics are important to the companies listed in the stock market and also to the consequences of the local currency depreciation. Regarding the monetary policy shock, the stock market indexes reacted negatively after a rise in the interest rate. This is a conventional result that has been seen in several studies before and reflects how the bond market competes with the stock market and also the economic consequences of this interest rate rise. Still in the domestic part, the demand shock impacts strongly the Brazilian share prices, anticipating a rise in the companies' rise in revenue, profits, higher wages, and so on.

Regarding the regional shocks, we consider shocks that hit at the same time all the Latin countries used in the estimation. In general, the Brazilian stock market responds with a lower magnitude in relation to the domestic shocks counterpart. This result shows that the Brazilian stock market appears to be more resilient to shocks that hit the region, probably because of its singularities and importance. Finally, we have considered the global shocks hitting the Brazilian stock market. As, by construction, those shocks only impact Brazil indirectly, we have a small response from the Brazilian stock market. However, certain global shocks reflect a globally optimistic economic environment, which spreads through emerging markets, including Brazil.

3 Exchange Rate Movements and Economic Activity: The role of Trade and Financial channels

The chapter examines how exchange rate movements affect economic activity across a panel of countries from 2002 to 2021. In addition to analyzing banks' liabilities, the chapter introduces a novel approach that considers the asset side of their balance sheets. By doing so, it highlights the importance of banks' net financial position in determining the significance of the financial channel through which exchange rate fluctuations impact output. The results confirm that both the trade and financial channels are essential in driving the impact of exchange rate movements on economic activity. However, the direction and magnitude of the financial channel depend on the banks' net financial position, underscoring the importance of analyzing both sides of their balance sheets.

3.1 Introduction

Fluctuations in exchange rates have consistently been a significant area of concern in several economies. Such changes are regularly covered in daily news updates and directly influence individuals' lives and business operations. According to conventional wisdom, local currency depreciation has an expansionary effect. This is because depreciation in the local exchange rate makes local tradable goods more affordable, stimulating foreign demand. Simultaneously, imported goods become more expensive, which suppresses domestic demand for these goods. This results in an increase in net exports, thereby boosting the economy. However, the contractionary impact of domestic depreciation episodes casts doubt on this positive link between economic activity and the exchange rate. Other factors also play a role in the dynamics of output after exchange rate movements.

One additional impact of fluctuations in exchange rates on activity would come from the role of the exchange rate on the balance sheet of the private sector. Firms and banks may have their assets and liabilities denominated in foreign currency, and any local currency movement will impact their balance sheet, and consequently investment and output. In times of more financial integration, this financial channel may play a more critical role than the traditional trade channel.

It's worth noting that when formulating a measure for the financial channel, researchers often focus solely on the liability side of the balance sheets of banks and firms as stressed by (AVDJIEV; KOCH; SHIN, 2017). However, neglecting claims [1] it may not fully capture the impact of the financial channel, since the claim side of the balance sheet could act as a financial buffer against exchange rate movements—particularly when a country's foreign assets greatly exceed its liabilities.

This chapter moves forward by incorporating foreign claims into the analysis and investigating their significance in the financial channel. To enrich the existing literature and explore the relevance of the foreign currency claims side of balance sheets for banks, we propose a new measure for examining the financial channel. Therefore, the chapter evaluates the financial channel by analyzing the foreign currency position of banks in local currency within each country analyzed. Differently than in other studies in the literature, in addition to the liability of the banks, we also consider the claims side of the balance sheet when evaluating the financial channel of exchange rate fluctuations.

The results show that both channels - trade and financial channels - contribute to the impact of the exchange rate on economic activity. Yet, by considering the asset side of banks' balance sheets in addition to their liabilities, the chapter finds that the size and magnitude of the financial channel depend on the net financial position of the banks. Net creditors in foreign currency observe a positive impact on currency depreciations, indicating that a local currency depreciation undoubtedly enhances economic activity in these countries. In opposition, net debtors in foreign currency observe a fall in economic activity after currency depreciations due to the negative financial channel. The chapter also shows that the symmetry in the response for appreciations and depreciations and nonlinearities in the response also depends on the net financial position of the banks; therefore, the chapter highlights the importance of considering the claims side of banks' balance sheets when analyzing the financial channel resulting from exchange rate fluctuations.

The chapter is organized as follows: in section 2, we discuss the literature on the relationship between exchange rate movements and economic activity, mainly focusing on the financial channel. In section 3, we explain the data and the econometric methodology. The results are shown in section 4, followed by some robustness exercises. Section 5 concludes.

3.2 Literature Review

The trade channel states that an exchange rate depreciation stimulates the economy by improving the trade balance. As pointed out by Kearns and Patel (2016), the significance of the trade channel will depend on different factors like the impact of ex-

[1] One should note that we use the claims name instead of the usual assets name. This is because the balance sheet shown by the BIS exhibits explicit Claims instead of Liabilities and also because Claims represent assets, liabilities, and equity. According to BIS, the claims side represents how much banks located in a particular country lend to borrowers in other countries.

change rate movements on traded goods prices and volumes, as well as the international trade share of the economies.

In terms of the financial channel, there are two primary interpretations of its source in the literature. The first interpretation suggests a currency mismatch in firms' or banks' balance sheets, while the second interpretation suggests an increase in foreign funding costs affecting domestic financial conditions. While both interpretations usually lead to contraction (expansion) in domestic activity following a local currency depreciation (appreciation), their specific operational channels differ. For example, foreign funding becoming more costly following significant local currency depreciation weakens foreign-currency domestic borrowers' balance sheets and deteriorates domestic financial conditions. Conversely, a currency mismatch can directly erode local banks' and firms' balance sheets, slowing domestic economic activity via a balance sheet effect[2].

The relationship between exchange rate movements and financial conditions has been extensively studied. Factors such as expectations about future exchange rate movements, the U.S. interest rate, the global economic outlook, and the local currency's position often determine the incentive to source resources abroad. A study by (KOHN; LEIBOVICI; SZKUP, 2020) examined how exports respond to large depreciations, assuming the existence of financial frictions and foreign-denominated debt within a general equilibrium model. He found that exports are negatively impacted following significant real depreciations.

Another study by (BRUNO; SHIN, 2015) found evidence that the banking sector's leverage is influenced by currency appreciation. In countries with expansionary financial conditions and appreciating local currency, the banking sector's leverage increases, amplifying the financial channel of exchange rate movements through the balance sheet effect. U.S. monetary policy also plays a role, as the risk-taking channel may become prominent under specific conditions. (BRUNO; SHIN, 2014) argued that easing financial conditions in the advanced world over many years led emerging countries to borrow abroad. In such a scenario, any interest rate hike would significantly impact emerging countries, given their high levels of dollar-denominated debt. (BEBZUCK; GALINDO; PANIZZA, 2006) highlights the impact of exchange rate movements on consumption and investment decisions in countries with high levels of dollar-denominated external debt.[3]

Additionally, a measure called the Debt-Weighted Exchange Rate (DWER) was introduced by (KEARNS; PATEL, 2016b) to highlight how the financial channel goes

[2] It's worth noting that in the literature, the term 'risk-taking channel' is often used when domestic firms' balance sheets are sensitive to exchange rate changes. This term is frequently used interchangeably with 'financial channel', given the close link between currency mismatch and the importance of foreign funding in the domestic economy.

[3] The significance of currency mismatches decreases if firms are hedged against exchange rate fluctuations. However, in countries where financial restrictions are a major concern, such financial instruments may not be readily available.

through the influence of exchange rate movements on foreign funding availability and cost, subsequently affecting domestic economic activity. The DWER is an index that weighs the total foreign currency-denominated debt using the five major currencies. Therefore, it is postulated that the financial channel operates through a negative correlation, implying that an exchange rate depreciation leads to recessionary effects. In their chapter, which covers more than 40 countries, (KEARNS; PATEL, 2016b) employs a univariate Autoregressive Distributed Lag (ARDL) model to investigate each country's financial and trade channels. The authors found the expected signs for both channels in almost all the countries analyzed: a negative sign concerning the financial channel and a positive sign for the trade channel.

(BECKMANN; COMUNALE, 2021) extended the ideas of (KEARNS; PATEL, 2016b), employing a local projections approach and analyzing the total credit to non-bank borrowers in foreign currency to investigate the impact of exchange rate fluctuations on domestic activity. Using the measure mentioned above to examine the financial channel, they found that the trade channel predominates over the financial channel in several emerging countries. Interestingly, (BECKMANN; COMUNALE, 2021) observed that domestic credit often decreases with exchange rate appreciations, while foreign currency borrowing increases simultaneously. Moreover, the local projections approach allowed them to uncover additional causalities, such as the business cycle's role in determining domestic and foreign credit demand.

Finally, (GEORGIADIS; ZHU, 2021) suggests that countries with considerable financial exposure in foreign currency might experience a fear-of-floating phenomenon in line with (CALVO; REINHART, 2002). This means that the monetary authority would act to minimize exchange rate changes to avoid any financial implications. According to (GEORGIADIS; ZHU, 2021), this fear-of-floating is more pronounced in countries with a tightened monetary policy and debt instruments.

3.3 Database and Econometric Methodology

We use the Liabilities and Claims data in foreign currencies available in Table A5 of the Local Banking Statistics (LBS) from the BIS website. To encapsulate the total foreign currency position, we sum the Claims and Liabilities for both cross-border and local positions. According to the BIS, the foreign currency liability account represents borrowings in foreign currency taken by banks located within the country from other banks situated abroad. Conversely, the Claims account represents lending made by local banks. For clarity, we provide in Appendix C an example of Table A5 for Brazil in the first quarter of 2019, with the chosen account highlighted in red.

Several factors are worth noting regarding selecting this variable to identify the financial channel. Firstly, the greater the foreign currency liabilities, the more exchange rate fluctuations may impact the bank's balance sheet. If banks have significant foreign currency borrowings, any change in the exchange rate will affect their balance sheets, especially if these banks' claims are in the national currency. This situation could reduce lending capacity, thereby negatively affecting the economy. Simultaneously, some banks fund their lending through external resources. A local depreciating exchange rate makes these funding resources more costly, making lending more expensive for firms in the country. Thus, we see two channels operating in the same direction: one that weakens the bank's balance sheet, impacting lending capacity, while the other makes funding resources more expensive.

It's worth noting that other studies have already chosen some variables from Table A5 to investigate the financial channel. For example, the Debt-Weighted Exchange Rate (DWER) from (KEARNS; PATEL, 2016b) is constructed considering liabilities in foreign currency. (BECKMANN; COMUNALE, 2021) use, among other variables, the total credit to non-bank borrowers in foreign currency. They argue that they do not consider cross-border banking loans as they are investigating credit demand, which is primarily made by firms and households. Nonetheless, the focus of (BECKMANN; COMUNALE, 2021) is more extensive, as they also examine the determinants of foreign credit demand.

Some discussions regarding our data may emerge. However, the other variables used in existing literature also have their own features that complicate their use in this chapter. There are at least three notable points: (1) for some countries, the share of foreign-denominated debt for non-bank corporations is relatively low in the total credit, thus making the non-bank cross-border position act more as a residual. (2) Borrowings and lendings for non-bank corporations in local and cross-border positions are not segregated by foreign and domestic currency. If domestic currency is used in these operations (which is not shown in Table A5), the financial channel's impact through banks' balance sheet effects may not be observable. (3) Both liabilities and claims in cross-border and local positions have their own foreign currencies separation, making it challenging to combine a debt and credit currencies weighted index.

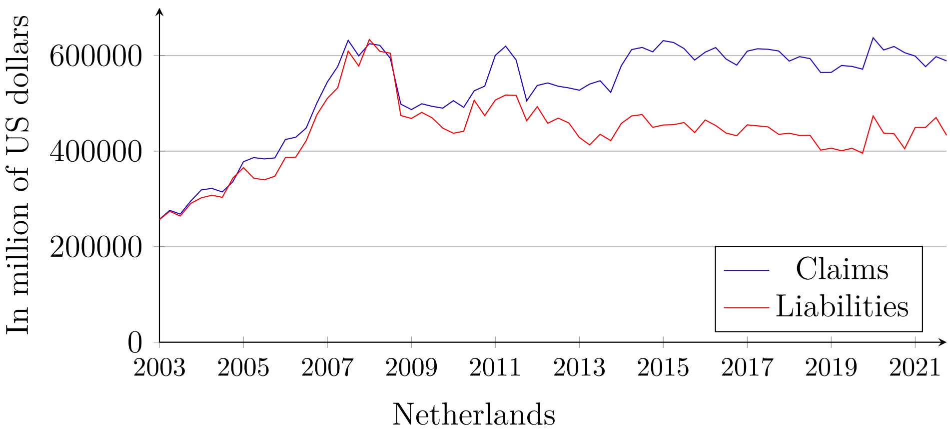
Examining the main drivers of movements in foreign currency claims and liabilities in banks' balance sheets is intriguing. From Table A5, we can extract useful data to evaluate foreign credit demand, domestic financial market development, and the impact of domestic and foreign monetary policy, among other variables. These have already been used as observed in (KEARNS; PATEL, 2016b) and (BECKMANN; COMUNALE, 2021). However, the aim of our chapter is not to investigate the drivers of foreign claims and liabilities. Our focus is on studying the financial channel of exchange rate fluctuations, considering the role of claims and liabilities in foreign currencies on banks' balance sheets. Therefore, we select the aforementioned data.

After summing the accounts highlighted in red (shown in Appendix C), we calculate the net position by taking the difference between the liabilities and the claims with the following formula:

$$Position_t = Liabilities_t - Claims_t ExtPosition_t = ln(1 + \frac{Position_t}{1000000}) \quad (3.1)$$

where: $Liabilities_t$ is the sum of the foreign currency liabilities in both the cross-border and local positions. $Claims_t$ represents the sum of the foreign currency claims in both positions. We take a log transformation of this variable to deal with negative values; i.e.: countries with more claims than liabilities. Our data cover 13 countries: Brazil, Chile, Mexico, Turkey, Austria, Belgium, France, Italy, Germany, Netherlands, Canada, Australia and Japan from Q4 2002 to Q4 2021. Although there is a data-base for countries like the USA and China we choose not to incorporate those countries in the estimation since China has a very dirty exchange rate policy and the US Dollar is the world's dominant reserve currency which makes the USA a special case[4]. For a better understanding of $Position_t$, we present the $Liabilities_t$ and the $Claims_t$ in two countries: Chile, which has more liabilities than claims, and the Netherlands, which has more claims than liabilities. [5]

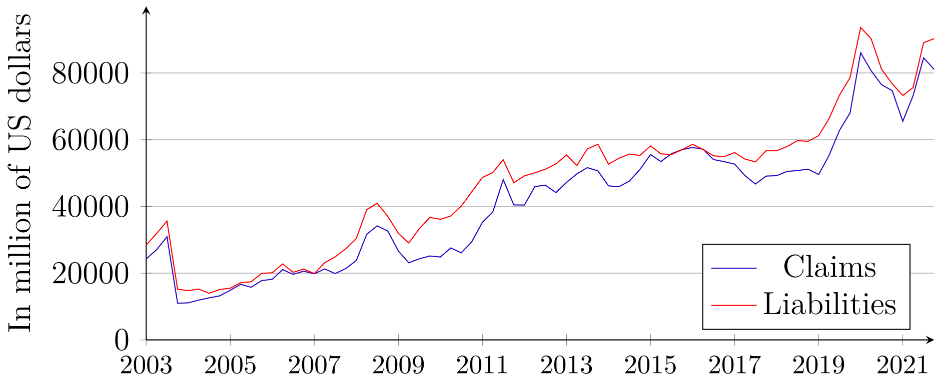
Figure 13 – Claims and Liabilities in foreign currency



The dynamics shown in Figure 13 raise important questions about analyzing the financial channel. For example: should we only consider liabilities when examining it? Do countries with more claims than liabilities respond differently to those with more liabilities than claims in terms of the financial channel? The variables shown in Figure 13 allow us to explore these questions and open up a new approach to include the claims side in our

[4] As stressed by (MAGGIORI, 2017) the US dollar being the main currency in the international trade gives the USA some great benefits as the opportunity to runs persistent trade deficits, its currency is the world's reserve currency and earns a safety premium.

[5] The graphs for all countries included in the sample estimation can be found in Appendix C



Chile

analysis[6]. This new approach potentially provides a more comprehensive understanding of the financial channel of exchange rate movements.

To achieve our objective, we employ a dynamic panel estimation with country-fixed effects to account for each country's particularities. Our data set is an unbalanced panel, with most countries beginning their sample period in 2002Q4 and ending in 2021Q4. The dynamic panel is estimated with a lag, as follows:

$$\Delta y_{it} = \alpha + \rho \Delta y_{it-1} + \delta \Delta ner_{it-1} + \phi ExtPosition_{it-1} \Delta ner_{it-1} + \lambda \Delta x_{it-1} + \epsilon_{it} \tag{3.2}$$

Where: y_{it} is the GDP, the Δner_{it-1} is the nominal exchange rate change measured in terms of the country's currency against the US dollar and x are control variables such as CPI, a commodities index represented by the CRB, the interest rate, the Global GDP, a trend term and a time dummy representing the economic crises periods which covers the 2008/2009 financial crises and COVID period. All the variables but the interest rate are in a quarterly time period and in log differences[7]. Note that we multiply the $ExtPosition_{it-1}$ by the nominal exchange rate change to account for the effect of exchange rate changes. Although there are other currencies in the claims and liabilities, the US Dollar has maintained its prevalence (by far) in international operations and even gained space against the Euro in the last years, as shown by (MAGGIORI; NEIMAN; SCHREGER, 2019). So, it is not a strong assumption to take the bilateral US dollar exchange rate in the $ExtPosition_t$. Finally, we take 4 countries' subsets partitioned by geographic locations, level of development, and $Position_t$ negative which means the countries that have more

[6] Figure 13 add several relevant questions regarding the dynamics of claims and liabilities. Looking at those variables We might ask what economic circumstances determine the level of foreign currency liabilities, and what motivates banks to source funding internationally. Although these are important inquiries, the primary focus of this chapter is to explore the role of the financial channel in response to exchange rate fluctuations, with particular emphasis on the claims side of banks' balance sheets.

[7] The GDP and its components are calculated as the cumulative growth in four quarters against its previous cumulative four quarters growth. The CPI is seasonally adjusted. All the variables but the $ExtPosition_{it-1}$ and ner_{it-1} are taken from the IFS database.

claims than liabilities[8] [9]. We expect that the trade channel measured by Δner_t will be positive, while $ExtPosition\Delta ner$ will be negative. However, for countries with $Position_t$ negative, the financial channel may be positive as a local depreciation should strengthen the balance sheets of the banks and increase the domestic economic activity.

It is interesting to highlight that we use the nominal exchange rate as the primary variable in our investigation of the trade channel, as opposed to other studies that typically use the real exchange rate or the effective nominal exchange rate. Our choice is due to the fact that we want a variable that can also be used by the financial channel, and it is public and clear. The effective exchange rate, for example, is an index created from the weighted commercial trade making it unreliable for use in the financial channel. The real exchange rate, on the other hand, is not used in daily operations, and its difference to the nominal exchange rate may arise over long periods rather than just one period, as we are investigating in the equation (2.2).

Note that since we are dealing with a dynamic panel estimation, we need to consider the potential issues of endogeneity and auto-correlation that may arise. We have two possible sources of endogeneity. The first one is due to the cause-and-effect relationship between the exchange rate and the External Position with the GDP growth. The second one comes from the lagged GDP in the right-hand side of the equation (2.2) and the error term, such as: $E[\Delta y_{it-1}|\epsilon_{it}] \neq 0$. In fact, reverse causality is a significant problem in equations that investigate the impact of exchange rates on GDP. For example, an economic activity expansion period might cause an appreciation of the exchange rate, bringing foreign money due to the robust economic scenario. This issue has been covered by (HABIB; MILEVA; STRACCA, 2017) where they use external instruments to deal with the reverse causality, and also in (BUSSIéRE; LOPEZ; TILLE, 2015) and (RODRIK, 2008) where they used GMM techniques. While this might hold true for specific instances, our primary interest is the influence of exchange rates on economic activity. To mitigate endogeneity concerns, many studies employ either a VAR methodology or an instrumental variables approach as citeHabib17, Aguirre and Calderon (2015), Kamber et al (2016), among others. In equation (2.2), the endogeneity concern is reduced since we are using lagged variables on the right-hand side. Although some variables are forward-looking, such as the exchange rate and the External Position, it will be very strong to assume a reverse causality phenomenon. But, at the same time, the endogeneity problems may persist due to the lagged dependent variable. A possible solution is to use the (ARELLANO; BOND,

[8] The Latin countries are: Brazil, Chile, and Mexico. The European countries are: Austria, Belgium, Netherlands, Germany, France, and Italy. The Advanced countries are: the European Countries, Canada, Australia, and Japan. And finally, the Net positive are the countries that have more claims than liabilities: Austria, Netherlands, Mexico, and Japan.

[9] As for some countries occasionally the liabilities are higher than the claims and vice-versa, we assume that claims should be higher than the liabilities at least in 90% of the data-sample to be in the $Position_t$ negative subgroup.

1991) estimator. However, the (ARELLANO; BOND, 1991) estimator is valid only with large N and small T, which is the opposite of our database characteristic. If T is large, as in our case, dynamic panel bias becomes insignificant, and a more straightforward fixed-effects estimator works as (ROODMAN, 2009) points out. As [10]. Therefore, given that the Arellano-Bond estimator does not apply in our case and also because we are dealing with lagged independent variables, we will use the usual country fixed-effects estimator. Nonetheless, as a robust exercise, I will provide the equation (2.2) estimation with the Arellano-Bond estimator and also with contemporaneous independent variables.

Equation (2.2) is a simple yet crucial tool that allows us to explore alternative specifications of how the commercial channels operate. For instance, the magnitude of exchange rate movements is likely to have a significant role in determining their impact on GDP. A small depreciation in the exchange rate may not be as impactful for the trade channel as a larger one. Thus, in Equation (2.3) we separate exchange rate movements at certain levels to investigate the extent to which the magnitude affects the GDP.

$$\Delta y_{it} = \alpha + \rho\Delta y_{it-1} + \delta_1\Delta ner_{b,it-1} + \delta_2\Delta ner_{a,it-1} + \phi_1 ExtPosition_{it-1}\Delta ner_{b,it-1} + \phi_2 ExtPosition_{it-1}\Delta ner_{a,it-1} + \lambda\Delta x_{it-1} + \epsilon_{it} \quad (3.3)$$

where $ner_{a,it-1}$ and $ner_{b,it-1}$ represent the exchange rate changes above and below the absolute terms of the quartiles of each subgroup. Note that we keep both sides (above and below) in the estimation to capture the complementary effect of the changes analyzed. Also, to preserve the degrees of freedom, we estimate one panel for each level of exchange rate change.

Another interesting issue to explore is the possible asymmetry in exchange rate movements. Appreciation and depreciation of the exchange rate might have distinct effects on GDP. While there is wide literature proving the asymmetry in the exchange rate pass-through, the literature is more restricted in analyzing the GDP's impact of appreciation and depreciation of the exchange rate. Thus, we estimate the following equation:

$$\Delta y_{it} = \alpha + \rho\Delta y_{it-1} + \delta_1\Delta ner_{pos,it-1} + \delta_2\Delta ner_{neg,it-1} + \phi_1 ExtPosition_{it-1}\Delta ner_{pos,it-1} + \phi_2 ExtPosition_{it-1}\Delta ner_{neg,it-1} + \lambda\Delta x_{it-1} + \epsilon_{it} \quad (3.4)$$

where the subscript *pos* and *neg* represent the depreciation and appreciation of the exchange rate respectively. The control variables x_{it-1} as those used in the other equations. Equation (2.4) allows us to explore how the commercial and financial channels work through appreciation and depreciation.

[10] (ROODMAN, 2009) show, the number of instruments in difference and system GMM tends to explode with T. As we are dealing with a large T we tend to have a huge number of instruments.

In summary, we have presented three types of dynamic panel equations with four subsets of countries. Our aim is to explore not only the financial and trade channels in the usual manner but also the asymmetries and magnitudes of the exchange rate movement and their impact on GDP. In the following section, we will present the results of the estimation.

3.4 Results

This section presents the results of panel estimations for countries, categorized into subgroups based on geographic location, level of development, and bank position characteristics, such as net positive liabilities. To account for specific country peculiarities, country-fixed effects are applied in all estimations. GDP is used as the dependent variable in the tables presented below, but additional estimations with GDP components like household consumption, government consumption, exports, and investment are available in Appendix C.

Table (5) shows that exchange rate depreciation leads to an increase in GDP, which is statistically significant across all analyzed subgroups. This result aligns with the trade channel. However, the financial channel has a negative sign, suggesting that local exchange rate depreciation dampens domestic economic activity. This channel may operate through three pathways: the balance sheet effect, the increase in the cost of funding resources, and potential currency mismatches. It's worth noting that the financial channel for the Net Positive group carries the opposite sign. This implies that local depreciation boosts the economy. This observation highlights the importance of considering foreign claims within the financial channel and underscores the innovation of this chapter in addressing both sides of banks' balance sheets. When foreign claims exceed liabilities, local depreciation can improve banks' balance sheets, potentially enhancing credit conditions within the economy.

Table 5 – Complete model - Equation (2.2)

	Dependent variable:				
	GDP				
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
GDP(-1)	0.731***	0.729***	0.628***	0.653***	0.672***
	(0.035)	(0.061)	(0.047)	(0.034)	(0.044)
NER(-1)	0.006	0.014*	0.031 **	0.026 ***	0.027 **
	(0.011)	(0.004)	(0.008)	(0.005)	(0.006)
External Position(-1)	−0.075	−2.428*	0.439	0.124	0.179*
	(0.112)	(0.576)	(1.861)	(0.113)	(0.069)
CPI(-1)	0.089	0.107	0.137	0.015	0.109
	(0.075)	(0.072)	(0.106)	(0.095)	(0.140)
CRB(-1)	0.019 ***	0.027	0.011 **	0.013 ***	0.007
	(0.005)	(0.010)	(0.004)	(0.003)	(0.007)
Interest Rate(-1)	−0.062 ***	−0.134 ***	0.131	0.026	−0.065
	(0.011)	(0.011)	(0.075)	(0.047)	(0.093)
World GDP(-1)	0.294 ***	0.395 **	0.312 ***	0.289 ***	0.342 ***
	(0.032)	(0.084)	(0.025)	(0.026)	(0.055)
Trend	0.000	−0.000	0.000 ***	0.000 **	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.007 ***	−0.005	−0.013 **	−0.010 ***	−0.009 **
	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)
Observations	978	224	450	678	298
R^2	0.865	0.897	0.879	0.872	0.894
Number of countries	13	3	6	9	4

*Note: Robust standard errors in parentheses: *p<0.1; **p<0.05; ***p<0.01.*

The table (5) helps us determine which channel is more influential following a fluctuation in exchange rates. In Latin countries, the financial channel has a much bigger impact compared to the trade channel. On the other hand, in Advanced and European countries, the financial channel seems to have little significance, and the trade channel is the only factor affecting economic activity. This finding is consistent with (KEARNS; PATEL, 2016b), who also noticed the significant influence of the financial channel in emerging countries and the predominance of the trade channel in advanced countries.

(KEARNS; PATEL, 2016b) also found the appropriate signs for the trade and financial channels and determined which channel predominates by summing the estimated coefficients. When we apply this exercise to the data from Table (5), we find that the financial channel supersedes the trade channel in Latin American and Net Positive countries. This implies that the potential benefits of local currency depreciation through international trade could be offset by financial repercussions. However, it's worth noting that for net-positive countries, the commercial gains are amplified by the financial channel.

The financial channel of the Net Positive subgroup (5) possesses several intriguing characteristics. For instance, the operation of the financial channel may not align with the pathways previously described, since foreign funding resources will invariably be affected in the same direction following a local currency depreciation. In this scenario, funding resources become more expensive, tightening credit conditions, especially if local banks habitually obtain resources in foreign currency. However, if claims in foreign currency exceed liabilities, the financial channel — through the balance sheet effect and currency mismatch - might stimulate the economy following a local exchange rate depreciation. Therefore, we might observe three channels operating in the same direction for countries with more liabilities than claims, and two channels for Net Positive countries. This peculiarity might explain why a negative sign could be identified in the financial channel for Net Positive countries if their banks typically source a substantial amount of their resources in foreign currencies.

Table 6 – Complete model - Arellano-Bond estimator - Equation (2.2)

	Dependent variable:				
	GDP				
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
GDP (-1)	0.788∗∗∗	0.745∗∗∗	0.670∗∗∗	0.690∗∗∗	0.669∗∗∗
	(0.036)	(0.043)	(0.042)	(0.037)	(0.039)
NER(-1)	0.008	0.017∗∗∗	0.030∗∗∗	0.028∗∗∗	0.031∗∗∗
	(0.011)	(0.001)	(0.008)	(0.004)	(0.009)
External Position(-1)	−0.011	−1.679∗∗∗	0.447	0.150∗	0.229∗∗
	(0.109)	(0.506)	(1.732)	(0.088)	(0.109)
CPI(-1)	0.245∗∗∗	0.075	0.191∗	0.065	0.216
	(0.089)	(0.079)	(0.099)	(0.092)	(0.154)
CRB(-1)	0.022∗∗∗	0.032∗∗∗	0.013∗∗∗	0.016∗∗∗	0.007
	(0.004)	(0.009)	(0.004)	(0.004)	(0.005)
Interest Rate(-1)	−0.012	−0.079∗∗∗	0.033	0.089∗∗	−0.002
	(0.014)	(0.017)	(0.090)	(0.041)	(0.033)
World GDP(-1)	0.246∗∗∗	0.379∗∗∗	0.302∗∗∗	0.262∗∗∗	0.332∗∗∗
	(0.031)	(0.066)	(0.018)	(0.028)	(0.040)
Trend	0.000∗∗∗	−0.000∗∗	0.000∗∗∗	0.000∗∗∗	0.000∗
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.008∗∗∗	−0.005	−0.011∗∗∗	−0.011∗∗∗	−0.010∗∗∗
	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)
Observations	978	224	450	678	298
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: **p<0.1;* ***p<0.05;* ****p<0.01.*

In order to control for potential endogeneity issues, we use the Arellano-Bond estimator in equation (2.2). However, we should remember that this estimator might not be reliable since our panel is short (not many countries) and the periods analyzed are long (T large). As pointed out by (ROODMAN, 2009), the country fixed-effects estimator is more desirable, but we still apply the Arellano-Bond estimator to ensure that the results remain stable.

In our case, the independent variables may not have endogeneity issues in the estimation since they are already lagged. However, the lagged dependent variable can give us problems of endogeneity. To address this, we follow the standard strategy of instrumenting the potential issues of endogeneity by lagging the dependent variable as long as the other independent variables are theoretically exogenous.

According to Table (6), the Latin American countries continue to exhibit the signs found in the estimation with the country-fixed effects. The financial channel operates strongly in those countries, and the trade channel is significant but less important. Interestingly, we find a positive sign for the financial channel for the advanced countries, which mimics what we have found for the net positive countries. Overall, we have results that are very similar and significant to those of Table (5).

Table 7 – Asymmetric movements - Equation(2.4)

	Dependent variable:				
	GDP				
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
GDP(-1)	0.730***	0.729***	0.630***	0.655***	0.667***
	(0.035)	(0.067)	(0.046)	(0.034)	(0.044)
NER pos (-1)	−0.000	0.033	0.041**	0.047***	0.010
	(0.021)	(0.019)	(0.010)	(0.007)	(0.007)
NER neg (-1)	0.014	−0.019	0.020*	0.001	0.052*
	(0.014)	(0.027)	(0.008)	(0.014)	(0.020)
External Position pos (-1)	0.130	−1.725	0.632	0.638***	0.362***
	(0.326)	(0.803)	(1.666)	(0.101)	(0.062)
External Position neg (-1)	−0.315	−5.099	0.259	−0.469**	−0.014
	(0.255)	(4.647)	(2.151)	(0.181)	(0.177)
CPI(-1)	0.093	0.098	0.131	−0.002	0.110
	(0.084)	(0.087)	(0.104)	(0.106)	(0.161)
CRB(-1)	0.019***	0.029	0.012**	0.014***	0.005
	(0.005)	(0.010)	(0.004)	(0.003)	(0.007)
Interest Rate (-1)	−0.061***	−0.138***	0.132	0.032	−0.061
	(0.011)	(0.009)	(0.075)	(0.045)	(0.096)
World GDP(-1)	0.294***	0.404**	0.310***	0.289***	0.342***
	(0.033)	(0.084)	(0.024)	(0.025)	(0.050)
Trend	0.000	−0.000	0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.007***	−0.005	−0.014**	−0.011***	−0.009**
	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)
Observations	978	224	450	678	298
R^2	0.865	0.898	0.879	0.873	0.895
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Another compelling characteristic involves the asymmetries of the financial and trade channels. In the case of exchange rate pass-through, the literature has found significant asymmetries between appreciation and depreciation of the exchange rate. Likely, appreciations and depreciations of the exchange rate might influence output in distinct ways. This is what we investigate in Table (7).

Table (7) reveals that only local currency depreciations are statistically significant for the trade channel in both the European and the Advanced subgroups. In these cases, appreciations of local currency may not have an effect on economic activity. Interestingly, for Latin countries, local currency movements do not influence GDP through the financial and trade channels. In contrast, for the Advanced subgroup, the financial channel consistently has a positive impact on economic activity, a unique result that might be explained by the 'flight to quality' phenomenon. This concept suggests that when an event leading to currency depreciation occurs in advanced countries, it likely stems from a global event that also affects emerging countries. Such a scenario may facilitate a flight to quality, where capital flows from emerging to advanced economies.

The trade channel for the European countries is significant and shows the expected direction, while the financial channel is not significant. This finding may be attributed to the fact that European countries primarily trade among themselves and might face fewer financial restrictions, which could explain the results observed in Table 3. On the other hand, for the Net Positive countries, the trade and financial channels are significant only for appreciations and depreciations respectively. Interestingly, the trade channel negatively impacts the GDP of Net Positive countries during appreciations, while the financial channel positively impacts it during depreciations. These findings emphasize the importance of considering asymmetries in exchange rate movements when analyzing the trade and financial channels. Moreover, these asymmetries are dependent on the characteristics of the group of countries analyzed.

Beyond the observed asymmetry, the magnitude of exchange rate movements could also play a crucial role in determining the impact of the channels explored in this chapter. This introduces a form of non-linearity, enabling us to investigate whether larger exchange rate movements affect the economy differently than smaller movements. Consequently, we will estimate four models for each group of countries, considering the quartiles of exchange rate changes in the sample period in each of the subgroups of the countries.

Table (8) displays the results for Latin American countries. It is noteworthy that the magnitude of exchange rate changes is not statistically significant. This outcome may be attributed to the financial constraints faced by firms in these countries when significant local depreciation impacts emerging economies. In such situations, firms may be unable to increase their production due to restricted and costly lending operations, as demonstrated by (KOHN; LEIBOVICI; SZKUP, 2020). Concerning the financial channel, any changes explain the GDP impact.

Table 8 – Latin Countries - Equation (2.3)

	Dependent variable:		
	GDP		
	1^{th} Quartile	2^{nd} Quartile	3^{rd} Quartile
	(1)	(2)	(3)
GDP(-1)	0.741^{***}	0.742^{***}	0.739^{***}
	(0.049)	(0.048)	(0.051)
NER - below (-1)	−0.018	0.006	−0.021
	(0.106)	(0.034)	(0.024)
NER - above (-1)	0.016	0.016	0.024
	(0.010)	(0.012)	(0.019)
External Position - below (-1)	−0.521	−0.547	−0.484
	(0.235)	(0.269)	(0.285)
External Position - above (-1)	−0.417	−0.374	−0.454
	(0.452)	(0.427)	(0.426)
CPI(-1)	0.126	0.121^{*}	0.118^{**}
	(0.044)	(0.039)	(0.024)
CRB(-1)	0.023	0.023	0.023
	(0.011)	(0.011)	(0.011)
Interest Rate(-1)	-0.156^{***}	-0.154^{***}	-0.157^{***}
	(0.015)	(0.014)	(0.015)
World GDP(-1)	0.388^{**}	0.383^{**}	0.389^{**}
	(0.072)	(0.071)	(0.077)
Trend	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.006	−0.006	−0.007
	(0.004)	(0.004)	(0.004)
Observations	224	224	224
R^2	0.899	0.899	0.899
Number of countries	3	3	3

Note: The Quartiles are the following: 1^{th} *= 1.5%;* 2^{nd} *= 2.9%;* 3^{rd} *= 5.4%*

The results for European countries differ considerably from those of Latin America. This confirms that the appreciation and depreciation of local currencies have diverse impacts on trade and financial channels. These effects depend on the specific characteristics of the groups of countries that are analyzed. As indicated in Table (9), the financial channel appears to be less influential, while the trade channel has a substantial impact on significant exchange rate movements. Given that these countries typically encounter fewer financial constraints, they can enhance their exports under such circumstances. However, the trade channel exhibits the opposite sign for minor exchange rate changes, implying that local depreciation (appreciation) exerts a negative (positive) effect on GDP.

Table 9 – European Countries - Equation (2.3)

	Dependent variable:		
	GDP		
	1^{th} Quartile	2^{nd} Quartile	3^{rd} Quartile
	(1)	(2)	(3)
GDP(-1)	0.647***	0.639***	0.638***
	(0.041)	(0.046)	(0.050)
NER - below (-1)	−0.539***	−0.083	0.006
	(0.051)	(0.046)	(0.021)
NER - above (-1)	0.037***	0.036***	0.041***
	(0.006)	(0.004)	(0.006)
External Position - below (-1)	−0.012	−0.031	−0.002
	(0.109)	(0.053)	(0.040)
External Position - above (-1)	0.043	0.046	0.041
	(0.026)	(0.028)	(0.044)
CPI(-1)	0.144	0.236	0.162
	(0.092)	(0.130)	(0.112)
CRB(-1)	0.011**	0.009*	0.013**
	(0.004)	(0.004)	(0.004)
Interest_Rate(-1)	0.110	0.112	0.107
	(0.069)	(0.077)	(0.085)
GDP_G20(-1)	0.276***	0.293***	0.306***
	(0.021)	(0.022)	(0.024)
trend	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Dummy_covid	−0.014***	−0.015***	−0.013***
	(0.003)	(0.003)	(0.003)
Observations	450	450	450
R^2	0.883	0.882	0.880
Number of countries	6	6	6

Note: The Quartiles are the following: 1^{th} *= 1.1%;* 2^{nd} *= 2.5%;* 3^{rd} *= 4.3%*

Table (10) shows that advanced countries have outcomes similar to those of European countries. The trade channel only has a significant impact when there are larger movements in the exchange rate. The coefficient has an opposite sign for changes below the 1st threshold, which may be due to global supply chains. These countries have tightly integrated industrial bases in worldwide production chains. As a result, local currency depreciation may increase the prices of imported industrial supplies, thus making their tradable goods and exports more expensive. Interestingly, this process does not apply in larger exchange rate movements, where the trade channel is positively significant above the threshold. The trade channel could improve the country's net exports through its conventional path. Regarding the financial channel, we find a positive sign for large movements in the exchange rate, which is an intriguing result.

Table 10 – Advanced Countries - Equation (2.3)

	Dependent variable:		
	GDP		
	1^{th} Quartile	2^{nd} Quartile	3^{rd} Quartile
	(1)	(2)	(3)
GDP(-1)	0.660***	0.655***	0.660***
	(0.033)	(0.035)	(0.036)
NER - below (-1)	−0.392***	−0.040	−0.003
	(0.112)	(0.030)	(0.011)
NER - above (-1)	0.028***	0.027***	0.033***
	(0.005)	(0.005)	(0.007)
External Position - below (-1)	0.013	0.009	0.013
	(0.021)	(0.020)	(0.019)
External Position - above (-1)	0.011	0.036*	0.025*
	(0.018)	(0.018)	(0.012)
CPI(-1)	0.006	0.032	0.026
	(0.098)	(0.108)	(0.100)
CRB(-1)	0.013***	0.012***	0.014***
	(0.003)	(0.003)	(0.003)
Interest Rate(-1)	0.029	0.024	0.021
	(0.047)	(0.049)	(0.049)
World GDP(-1)	0.275***	0.284***	0.285***
	(0.024)	(0.026)	(0.026)
Trend	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.011***	−0.011***	−0.010***
	(0.002)	(0.002)	(0.002)
Observations	678	678	678
R^2	0.875	0.874	0.873
Number of country	9	9	9

Note: The Quartiles are the following: 1^{th} = 1.1%; 2^{nd} = 2.4%; 3^{rd} = 4.3%

Lastly, we look at the Net Positive countries in Table (11). These countries don't exhibit any distinct pattern with the thresholds. The financial channel becomes non-significant, and the trade channel is only relevant for larger changes in the exchange rate.

Table 11 – Net Positive Countries - Equation (2.3)

	Dependent variable:		
	GDP		
	1^{th} Quartile	2^{nd} Quartile	3^{rd} Quartile
	(1)	(2)	(3)
GDP(-1)	0.677***	0.672***	0.676***
	(0.043)	(0.044)	(0.044)
NER - below (-1)	−0.186	−0.029	−0.008
	(0.154)	(0.053)	(0.018)
NER - above (-1)	0.021***	0.022**	0.027**
	(0.003)	(0.006)	(0.007)
External Position - below (-1)	−0.005	−0.010	−0.005
	(0.027)	(0.023)	(0.023)
External Position - above (-1)	−0.007	0.023	0.010
	(0.023)	(0.017)	(0.018)
CPI(-1)	0.093	0.104	0.105
	(0.124)	(0.165)	(0.139)
CRB(-1)	0.006	0.005	0.007
	(0.007)	(0.007)	(0.006)
Interest Rate(-1)	−0.080	−0.072	−0.075
	(0.107)	(0.105)	(0.104)
World GDP(-1)	0.337***	0.341***	0.342***
	(0.055)	(0.049)	(0.054)
Trend	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.009**	−0.010**	−0.009**
	(0.002)	(0.002)	(0.002)
Observations	298	298	298
R^2	0.897	0.896	0.894
Number of country	4	4	4

Note: The quartiles are the following: 1^{th} = 1.1%; 2^{nd} = 2.4%; 3^{rd} = 4.1%

3.5 Robustness exercise

In this section, we use the Arellano-Bond estimator to estimate equation (2.2) while considering the contemporaneous impact of independent variables. We follow a standard strategy in order to instrument the potential issues of endogeneity. In the case of the contemporaneous independent variable, we apply the domestic contemporaneous independent variables lags to instrument the estimation [11].

Table (12) is very similar to Table (6), where the financial channel of Latin countries is negative and the Net Positive countries are positive. However, there is a significant difference between the results, particularly in the trade channel, which is not statistically significant in any of the subgroups analyzed. This could be because it takes time for any exchange rate movement to impact economic activity through the trade channel. Despite

[11] In those estimations we use a high number of instruments as usually is done for the Arellano-Bond estimator. However, we also perform estimations with much fewer instruments, and the results remain the same in terms of conclusion. Those estimations are available upon request

this, the external position remains statistically significant, as seen in the last section. This result raises questions about whether the financial channel may operate faster than the trade channel for some countries.

Table 12 – Complete model with contemporaneous - Arellano-Bond estimator - Equation (2.2)

	Dependent variable:				
			GDP		
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
GDP (-1)	0.870 ∗ ∗∗	0.871 ∗ ∗∗	0.843 ∗ ∗∗	0.843 ∗ ∗∗	0.812 ∗ ∗∗
	(0.017)	(0.026)	(0.015)	(0.022)	(0.031)
NER	0.004	0.004	−0.001	0.001	0.009
	(0.005)	(0.013)	(0.002)	(0.004)	(0.013)
External Position	0.118	−1.553 ∗ ∗∗	−0.372	0.137	0.296 ∗ ∗
	(0.156)	(0.204)	(1.027)	(0.131)	(0.118)
CPI	0.225 ∗ ∗∗	0.162 ∗ ∗∗	0.209 ∗ ∗	0.107	0.294 ∗ ∗∗
	(0.048)	(0.056)	(0.106)	(0.088)	(0.112)
CRB	−0.004	−0.007	−0.013 ∗ ∗∗	−0.008 ∗ ∗∗	−0.017 ∗ ∗∗
	(0.005)	(0.008)	(0.002)	(0.003)	(0.006)
Interest Rate	−0.024 ∗ ∗∗	−0.062 ∗ ∗∗	−0.087∗	−0.012	−0.025
	(0.007)	(0.011)	(0.046)	(0.038)	(0.024)
World GDP	0.404 ∗ ∗∗	0.472 ∗ ∗∗	0.438 ∗ ∗∗	0.386 ∗ ∗∗	0.399 ∗ ∗∗
	(0.026)	(0.035)	(0.037)	(0.036)	(0.039)
Trend	0.000 ∗ ∗∗	0.000	0.000 ∗ ∗∗	0.000 ∗ ∗∗	0.000 ∗ ∗∗
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	0.000	0.000	−0.000	−0.001	−0.004 ∗ ∗∗
	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)
Observations	978	224	450	678	298
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Finally, it is worth noting that the the financial channel for both European and Advanced countries is not statistically significant. This suggests that the timing might not be uniform for the groups analyzed and that particularities of the financial system and other issues should be considered. This is an area that should be thoroughly examined in future research. Nonetheless, we have obtained similar results by incorporating contemporaneous effects.

3.6 Conclusion

In this chapter, we have explored the trade and financial channels of exchange rate movements. The trade channel is determined by the responses of international trade to fluctuations in the local currency. Typically, depreciations of local currency are expected to boost economic activity and appreciations to reduce GDP, primarily through net exports. The financial channel, on the other hand, represents the balance sheet effects caused by exchange rate fluctuations. If banks are leveraged in dollars and fund their resources from abroad, any local currency depreciation might weaken their balance sheets, thereby slowing down economic activity. Moreover, domestic firms may face currency mismatches in their cash flow, which can also negatively impact the economy. These channels can interact since local firms may encounter financial constraints following depreciation events.

As the global economy becomes more financially integrated, the financial channel has gained increased attention. However, the focus has been mostly on the liability side of banks' balance sheets. This bias is justified as financial distress from stressful events can severely impact countries with substantial foreign currency liabilities. Nevertheless, foreign claims held by the banking system also play a role in the financial channel. If a country has a net positive position in foreign currency, a local currency depreciation may strengthen the bank's balance sheet, increase lending capacity and stimulate domestic economic activity.

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Appendices

A Chapter 1

Table 13 – Trade Weighted Matrix - Latin Countries

	AR	BR	CH	CO	CN	EU	JA	ME	PE	US
AR	0.0%	37.2%	5.4%	24.5%	1.4%	6.2%	2.3%	3.6%	2.2%	17.2%
BR	9.0%	0.0%	3.3%	33.6%	1.6%	21.4%	3.5%	3.5%	1.4%	22.6%
CH	3.8%	8.6%	0.0%	35.8%	1.8%	14.6%	8.3%	3.2%	2.6%	21.3%
CN	0.8%	6.4%	2.4%	0.0%	0.8%	29.3%	19.3%	3.4%	1.4%	36.0%
CO	1.6%	6.6%	2.7%	21.2%	0.0%	16.2%	2.7%	8.2%	2.9%	37.9%
EU	1.1%	4.2%	1.2%	36.6%	0.8%	0.0%	9.1%	4.4%	0.7%	41.9%
JA	0.2%	1.6%	1.3%	44.2%	0.3%	18.0%	0.0%	2.5%	0.4%	31.6%
ME	0.3%	1.4%	0.5%	11.7%	0.7%	8.0%	3.0%	0.0%	0.3%	74.2%
PE	2.4%	6.4%	3.9%	35.7%	3.5%	14.9%	4.8%	3.6%	0.0%	24.7%
US	0.6%	3.2%	1.2%	28.8%	1.3%	27.5%	9.7%	26.9%	0.8%	0.0%

Note: The lines represent the wheighted trade flows between the countries and must sum up 1. For Europe Union, I consider the sum of the following countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. The data source is from the United Nations data: https://comtrade.un.org/data

Table 14 – F test:first order serial autocorrelation of cross-unit residuals

>0.1	30	54.55%
0.05-0.1	2	3.64%
0.01-0.05	3	5.45%
<0.01	20	36.36%

Table 15 – Average pairwise cross-unit correlation of unit-model residuals

p-values	*y*		*dp*		*ner*		*EMBI*		*IR*		*poil*		*pmat*		*pmetal*		*VIX*	
<0.1	7	70.0%	10	100.0%	1	10.0%	5	83.33%	3	30.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
0.1-0.2	3	30.0%	0	0.0%	3	30.0%	0	0.0%	6	60.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
0.2-0.5	0	0.0%	0	0.0%	6	60.0%	1	16.67%	1	10.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
>0.5	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	100.0%	2	100.0%	2	100.0%	2	100.0%

Table 16 – Alternative identification restrictions - Latin Countries[1,2,3]

	Output Gap (Demand Shock)	*CPI*	*Exchange rate Shock*	*Risk Premium Shock*	*Interest rate Shock*	*Risk Premium* Shock*	*Interest rate* Shock*	*VIX* Shock*	*Oil price index* Shock*
Output Gap	$>^2$		*	*	$<^1$	*	*		
CPI	$>^2$		$>^2$	$>^2$	$<^2$	$>^2$	$<^2$		
Exchange rate	*		$>^2$	$>^2$	$<^2$	$>^2$	$<^2$		
Risk Premium	*		$>^2$	$>^2$	*	$>^2$	*		
Interest rate	*		*	*	$>^2$	*	$>^2$		
*Output Gap**						*	0	*	$>^2$
*CPI**						$>^2$	$<^2$	*	*
*Risk Premium**						$>^2$	$<^2$	*	*
*VIX**								$>^2$	*
*Oil price index**								*	$>^2$
*Agriculture price index**								*	$>^2$
*Metals price index**								*	$>^2$
*Interest rate**						*	$>^2$	*	*

1/ Variables bellow the dot line represents variables that are treated as weak exogeneous (superscript *) for the Latin countries.

2/ The restrictions can be applied only for existing variables for a country. So if I shock the Oil Price index, for example, the restrictions are avaiable only for the countries where the Oil Price is assumed as endogeneous in the estimation.

3/ The signs >, < and 0 are the sign and zero restrictions applied in the structural identification scheme. The superscript above the sign denotes the periods which the restrictions remain active. Asteriscs inside the matrix represents variables not restricted. Blanck spaces are variables not restricted due to the impossibility of doing that (remember that the shocks are locally identified).

B Chapter 2

Figure 14 – Exchange rate shock - Brazil

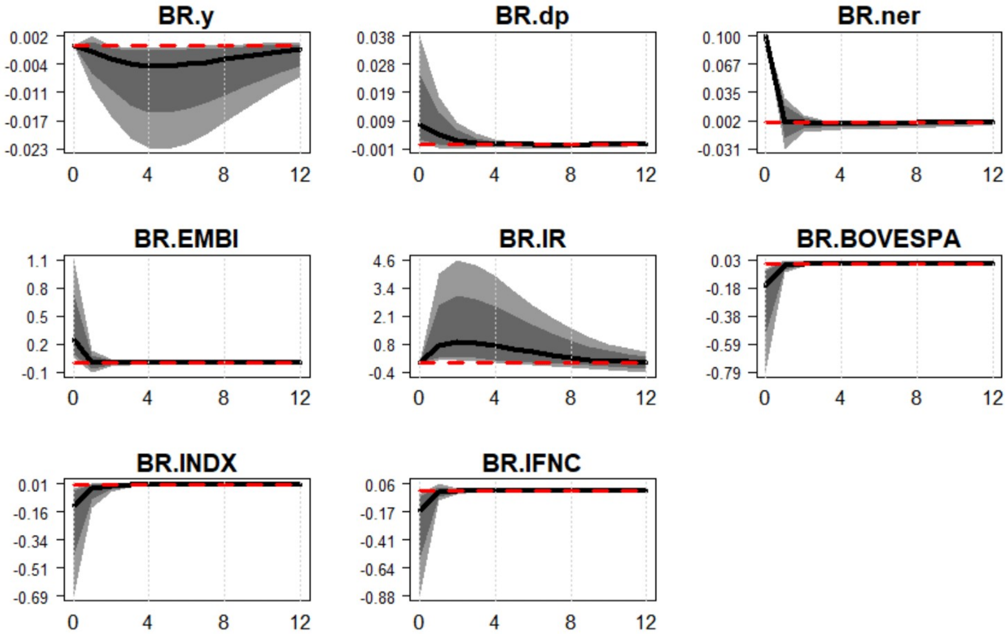


Figure 15 – Premium risk shock - Brazil

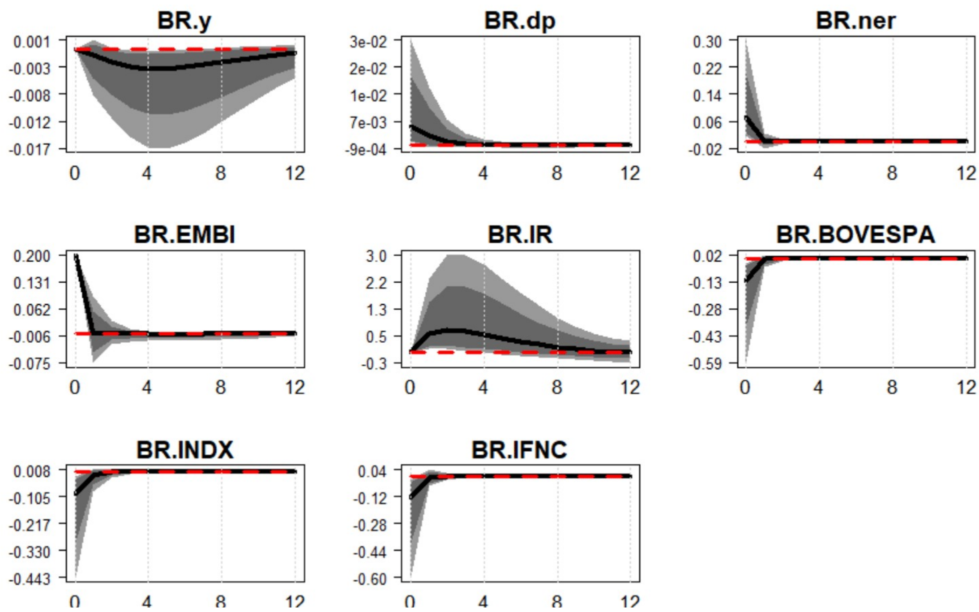


Figure 16 – Monetary Policy shock - Brazil

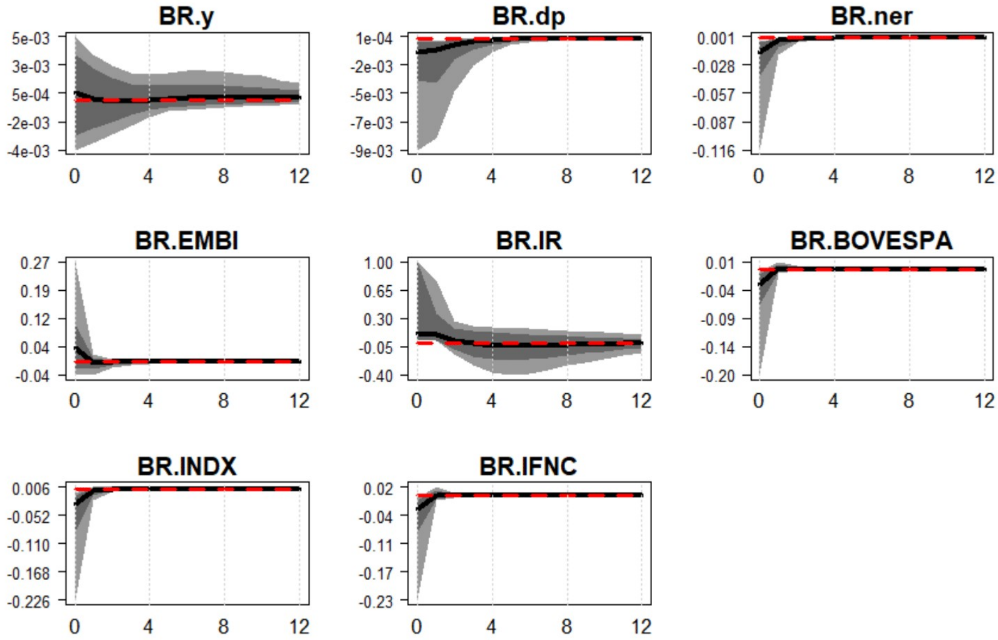


Figure 17 – Demand shock - Brazil

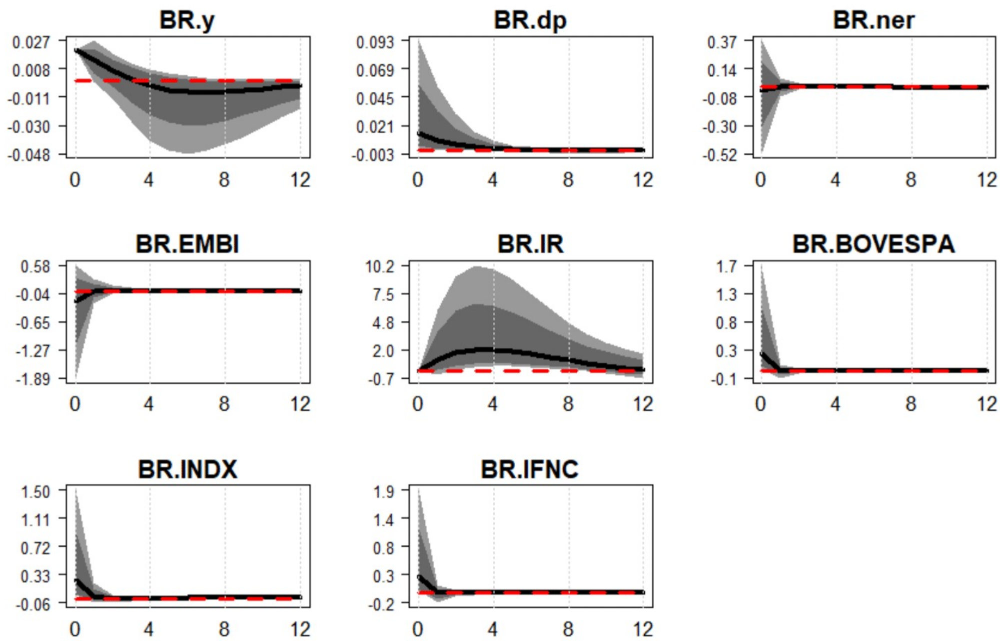


Figure 18 – Regional premium risk shock - Brazil

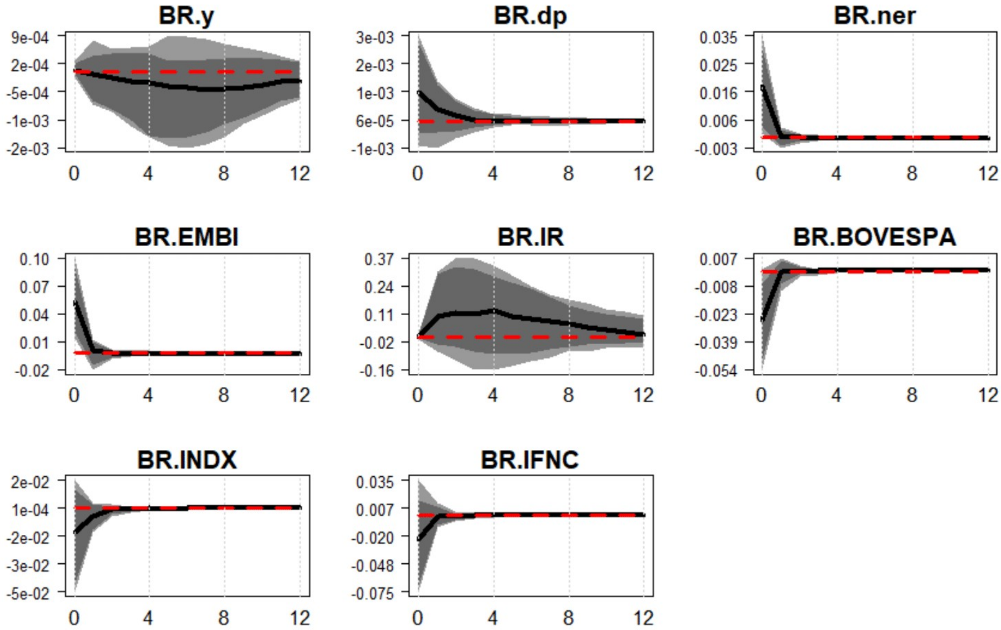


Figure 19 – Regional Monetary Policy shock - Brazil

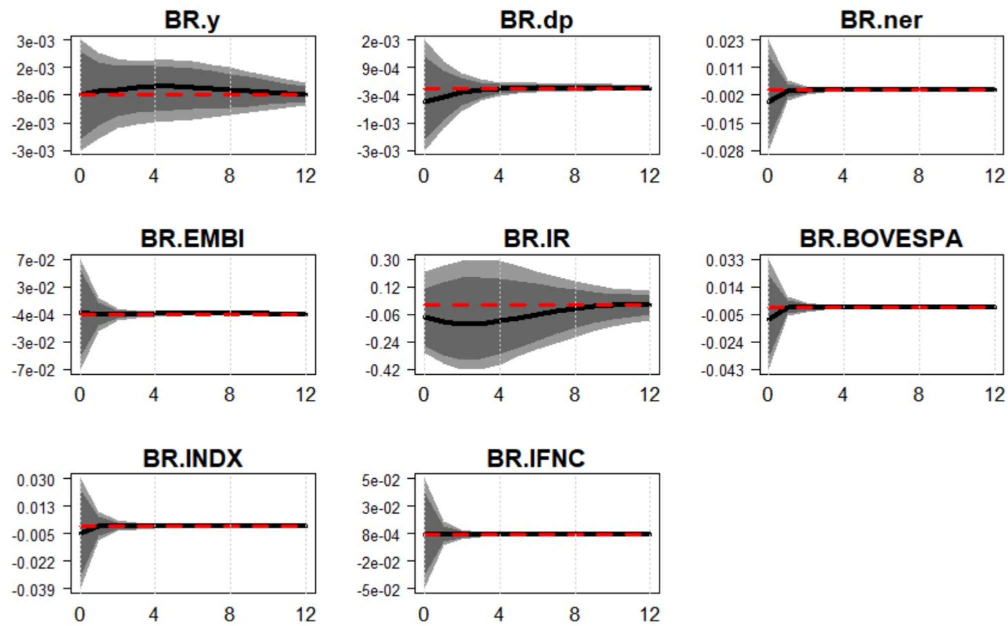


Figure 20 – Regional demand shock - Brazil

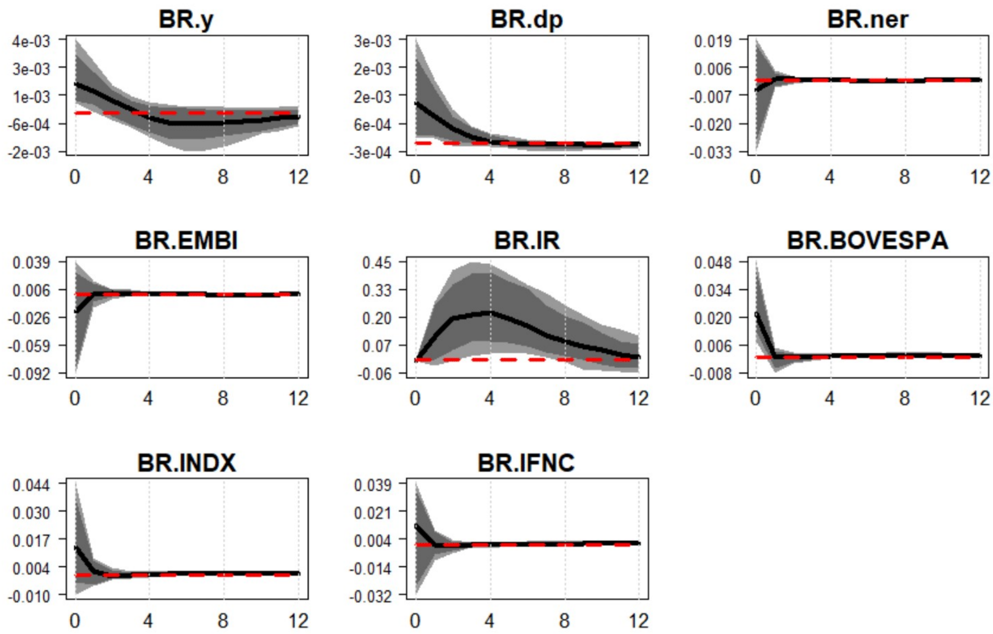


Table 17 – Trade Weighted Matrix - C

	AR	BR	CH	CO	CN	EU	JA	ME	PE	US
AR	0.0%	37.2%	5.4%	24.5%	1.4%	6.2%	2.3%	3.6%	2.2%	17.2%
BR	9.0%	0.0%	3.3%	33.6%	1.6%	21.4%	3.5%	3.5%	1.4%	22.6%
CH	3.8%	8.6%	0.0%	35.8%	1.8%	14.6%	8.3%	3.2%	2.6%	21.3%
CN	0.8%	6.4%	2.4%	0.0%	0.8%	29.3%	19.3%	3.4%	1.4%	36.0%
CO	1.6%	6.6%	2.7%	21.2%	0.0%	16.2%	2.7%	8.2%	2.9%	37.9%
EU	1.1%	4.2%	1.2%	36.6%	0.8%	0.0%	9.1%	4.4%	0.7%	41.9%
JA	0.2%	1.6%	1.3%	44.2%	0.3%	18.0%	0.0%	2.5%	0.4%	31.6%
ME	0.3%	1.4%	0.5%	11.7%	0.7%	8.0%	3.0%	0.0%	0.3%	74.2%
PE	2.4%	6.4%	3.9%	35.7%	3.5%	14.9%	4.8%	3.6%	0.0%	24.7%
US	0.6%	3.2%	1.2%	28.8%	1.3%	27.5%	9.7%	26.9%	0.8%	0.0%

Note: The lines represent the wheighted trade flows between the countries and must sum up 1. For Europe Union, I consider the sum of the following countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. The data source is from the United Nations data: https://comtrade.un.org/data

Table 18 – F test:first order serial autocorrelation of cross-unit residuals - C

>0.1	39	58.21%
0.05-0.1	4	5.97%
0.01-0.05	2	2.99%
<0.01	22	32.84%

Figure 21 – Average pairwise cross-unit correlation of unit-model residuals - C

p-values	y		dp		ner		EMBI		IR		Stock market		poil		pmat		pmetal		VIX	
<0.1	9	90.0%	9	90.0%	0	0.0%	5	83.3%	2	20.0%	3	30.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
0.1-0.2	1	10.0%	1	10.0%	4	40.0%	0	0.0%	5	50.0%	6	60.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
0.2-0.5	0	0.0%	0	0.0%	6	60.0%	1	16.7%	3	30.0%	1	10.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
>0.5	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	100.0%	2	100.0%	2	100.0%	2	100.0%

C Chapter 3

Table 19 – Complete model - Private Consumption - Equation (2.2)

	Dependent variable:				
			PrivateC		
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
PrivateC (-1)	0.764 ∗ ∗∗	0.789 ∗ ∗∗	0.637 ∗ ∗∗	0.621 ∗ ∗∗	0.679 ∗ ∗∗
	(0.041)	(0.065)	(0.041)	(0.034)	(0.019)
NER(-1)	0.007	0.021	0.052 ∗ ∗∗	0.031 ∗ ∗	0.023∗
	(0.010)	(0.024)	(0.008)	(0.012)	(0.007)
External Position(-1)	−0.036	−1.458 ∗ ∗	1.394	0.147	0.243
	(0.131)	(0.202)	(1.303)	(0.196)	(0.132)
CPI(-1)	0.008	−0.002	0.224	0.120	0.093
	(0.063)	(0.123)	(0.134)	(0.106)	(0.194)
CRB(-1)	0.013	0.020 ∗ ∗	−0.001	−0.001	−0.001
	(0.008)	(0.004)	(0.007)	(0.004)	(0.005)
Interest Rate(-1)	−0.033∗	−0.120 ∗ ∗	0.156∗	0.102 ∗ ∗	−0.032
	(0.018)	(0.012)	(0.072)	(0.040)	(0.088)
World GDP(-1)	0.233 ∗ ∗∗	0.513	0.115 ∗ ∗	0.146 ∗ ∗∗	0.250∗
	(0.057)	(0.197)	(0.031)	(0.026)	(0.106)
Trend	0.000	−0.000	0.000∗	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.013 ∗ ∗∗	−0.005	−0.027 ∗ ∗∗	−0.024 ∗ ∗∗	−0.019 ∗ ∗∗
	(0.003)	(0.009)	(0.003)	(0.003)	(0.003)
Observations	978	224	450	678	298
R^2	0.835	0.885	0.848	0.856	0.859
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 20 – Complete model - Government Consumption - Equation (2.2)

	Dependent variable:				
	GovernmentC				
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
GovernmentC (-1)	0.882 ∗ ∗∗	0.825 ∗ ∗∗	0.912 ∗ ∗∗	0.928 ∗ ∗∗	0.946 ∗ ∗∗
	(0.029)	(0.045)	(0.026)	(0.017)	(0.015)
NER(-1)	0.006	0.009	0.025 ∗ ∗	0.020 ∗ ∗∗	0.030
	(0.007)	(0.004)	(0.009)	(0.005)	(0.018)
External Position(-1)	0.020	−3.988 ∗ ∗	0.774	0.221 ∗ ∗	0.201
	(0.108)	(0.690)	(0.719)	(0.074)	(0.101)
CPI(-1)	−0.094	−0.120	−0.072∗	−0.081∗	−0.065
	(0.057)	(0.054)	(0.035)	(0.036)	(0.082)
CRB(-1)	0.010∗	0.012	0.019 ∗ ∗	0.017 ∗ ∗∗	0.016 ∗ ∗
	(0.005)	(0.009)	(0.006)	(0.004)	(0.005)
Interest Rate(-1)	−0.010	−0.045	0.184 ∗ ∗	0.116 ∗ ∗∗	0.035
	(0.012)	(0.017)	(0.051)	(0.030)	(0.021)
World GDP(-1)	0.042	0.133	0.005	0.003	0.019
	(0.025)	(0.064)	(0.030)	(0.020)	(0.041)
Trend	−0.001	−0.005	−0.001	−0.000	0.001
	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)
Dummy Covid	−0.003	0.011	−0.027 ∗ ∗∗	−0.019 ∗ ∗∗	−0.007
	(0.004)	(0.010)	(0.006)	(0.004)	(0.008)
Observations	978	224	450	678	298
R^2	0.757	0.813	0.805	0.821	0.838
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 21 – Complete model - Investment - Equation (2.2)

	Dependent variable:				
			Investment		
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
Investment (-1)	0.843 * **	0.870 * **	0.694 * **	0.756 * **	0.716 * **
	(0.037)	(0.055)	(0.062)	(0.065)	(0.071)
NER(-1)	0.004	0.039	0.024	0.006	0.009
	(0.017)	(0.028)	(0.032)	(0.022)	(0.037)
External Position(-1)	−0.322	−2.648	−6.787	−0.315	−0.109
	(0.349)	(3.930)	(8.556)	(0.261)	(0.409)
CPI(-1)	0.057	0.474	−0.738 * *	−0.511*	−0.072
	(0.231)	(0.428)	(0.204)	(0.248)	(0.302)
CRB(-1)	0.051 * **	0.051	0.045 * *	0.043 * *	0.001
	(0.016)	(0.037)	(0.016)	(0.017)	(0.011)
Interest Rate(-1)	−0.132 * **	−0.301 * *	0.320	0.091	−0.072
	(0.038)	(0.065)	(0.325)	(0.196)	(0.270)
World GDP(-1)	0.473 * **	0.835 * **	0.492 * **	0.455 * **	0.562 * *
	(0.072)	(0.049)	(0.044)	(0.035)	(0.148)
Trend	−0.000	−0.000	0.000*	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	0.008*	0.016	−0.008	0.001	−0.009
	(0.004)	(0.006)	(0.009)	(0.007)	(0.009)
Observations	978	224	450	678	298
R^2	0.806	0.892	0.667	0.719	0.656
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: **p<0.1;* ***p<0.05;* ****p<0.01.*

Table 22 – Complete model - Exports - Equation (2.2)

	Dependent variable:				
			Exports		
	All	Latin	European	Advanced	Net positive
	(1)	(2)	(3)	(4)	(5)
Exports (-1)	0.748 * **	0.789 * **	0.707 * **	0.741 * **	0.709 * **
	(0.024)	(0.034)	(0.018)	(0.024)	(0.017)
NER(-1)	0.071*	0.079*	0.086 * **	0.106 * **	0.101*
	(0.040)	(0.025)	(0.017)	(0.012)	(0.037)
External Position(-1)	0.234	5.287*	−1.824	0.252	0.310
	(0.308)	(1.743)	(3.628)	(0.200)	(0.408)
CPI(-1)	0.532 * *	0.701	0.623 * *	0.184	0.405
	(0.183)	(0.379)	(0.210)	(0.238)	(0.301)
CRB(-1)	0.048 * **	0.060 * *	0.041 * **	0.050 * **	0.066 * *
	(0.014)	(0.014)	(0.010)	(0.009)	(0.016)
Interest Rate(-1)	−0.044	−0.092	−0.509 * **	−0.389 * **	−0.462 * **
	(0.030)	(0.069)	(0.075)	(0.108)	(0.029)
World GDP(-1)	0.583 * **	0.249	0.803 * **	0.715 * **	0.805 * *
	(0.105)	(0.145)	(0.082)	(0.113)	(0.151)
Trend	0.000	−0.000*	−0.000	−0.000*	−0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dummy Covid	−0.013 * **	−0.007	−0.003	−0.007	−0.004
	(0.004)	(0.006)	(0.006)	(0.005)	(0.004)
Observations	978	224	450	678	298
R^2	0.848	0.808	0.897	0.876	0.856
Number of countries	13	3	6	9	4

Note: Robust standard errors in parentheses: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

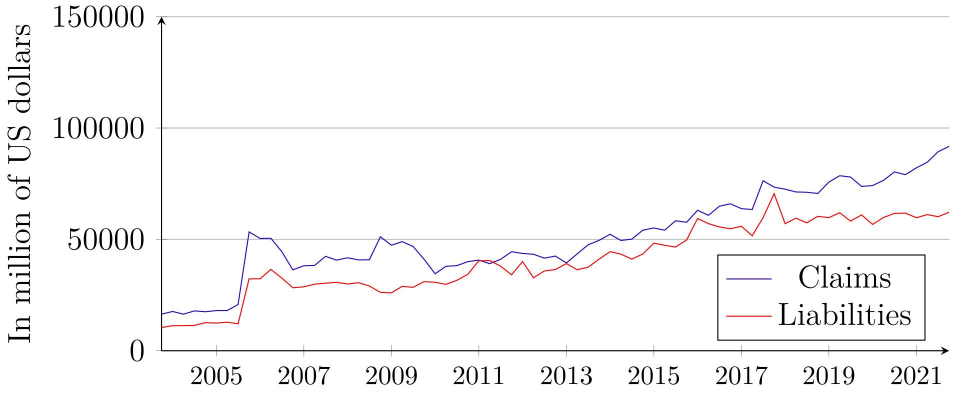
Table 23 – BIS Table A5 - Brazil - 1th quarter of 2019

Banks located in Brazil

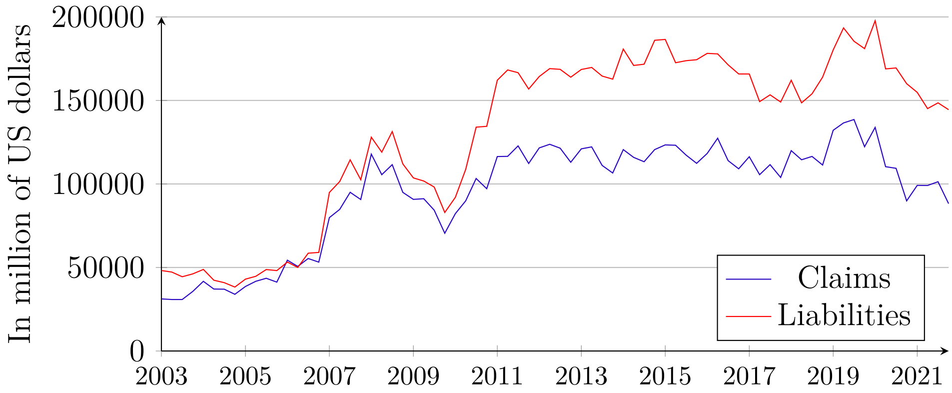
Positions reported by banking offices located in the specified country regardless of the nationality of the controlling parent
in millions of US dollars

Brazil	Outstanding					
	Cross-border positions		Local positions		Unallocated positions by residence	
	Claims	Liabilities	Claims	Liabilities	Claims	Liabilities
	Q1 19	Q1 19	Q1 19	Q1 19	Q1 19	Q1 19
Total	**94,450**	**146,593**	**1,779,599**	**1,567,476**	**321**	**1,007**
By sector of counterparty						
Banks	91,397	145,626	654,557	129,409	321	976
Of which: intragroup [1]	57,355	55,169	...	...	...	...
Non-banks	3,053	967	1,125,042	1,438,067	\	31
Of which: non-bank financial	...	...	...	...	...	...
Of which: non-financial	...	...	...	...	...	...
Non-financial corporations	...	...	...	...	...	...
Households						
General government						
Unallocated	...	...	...	...	...	...
By currency						
Local currency	1,032	554	1,740,883	1,533,272	\	32
Foreign currencies	93,418	146,040	38,716	34,203	321	975
Of which: US dollar	69,973	128,364	36,814	31,166	179	889
Of which: euro	17,100	13,402	1,636	938	116	81
Of which: yen	1,039	1,062	202	83	1	3
Of which: pound sterling	1,121	972	43	140	10	2
Of which: Swiss franc	170	176	1	12	1	...
Of which: other currencies	4,015	2,064	20	1,864	14	0
By instrument						
Of which: loans and deposits	41,870	124,126	1,342,693	950,681	320	586
Of which: debt securities	3,247	13,877	269,774	396,880	\	421
By type of bank						
Domestic banks	...	...	...	...	...	...
Foreign banks' subsidiaries	...	...	...	...	...	...
Foreign banks' branches	...	...	...	...	...	...

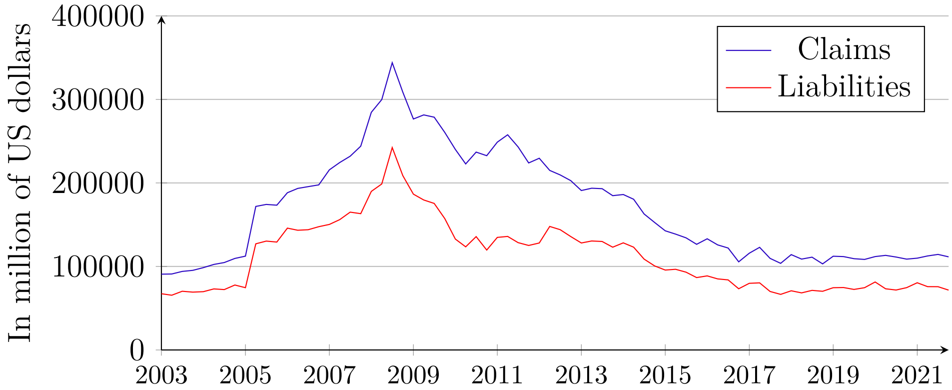
Figure 22 – Claims and Liabilities in foreign currency - (all countries)



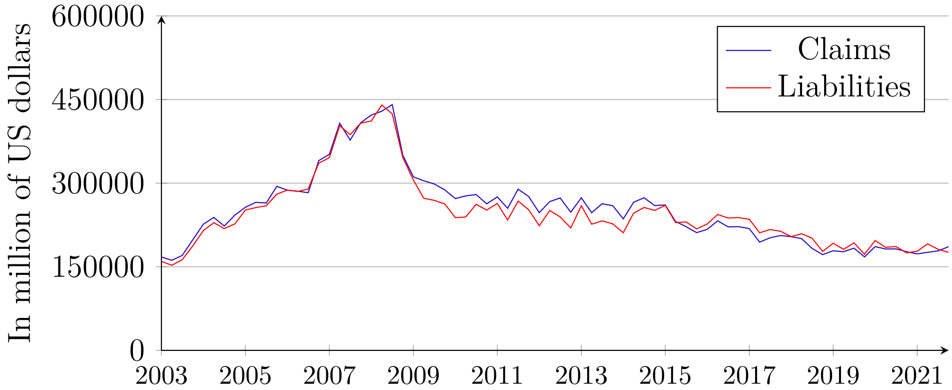
Mexico



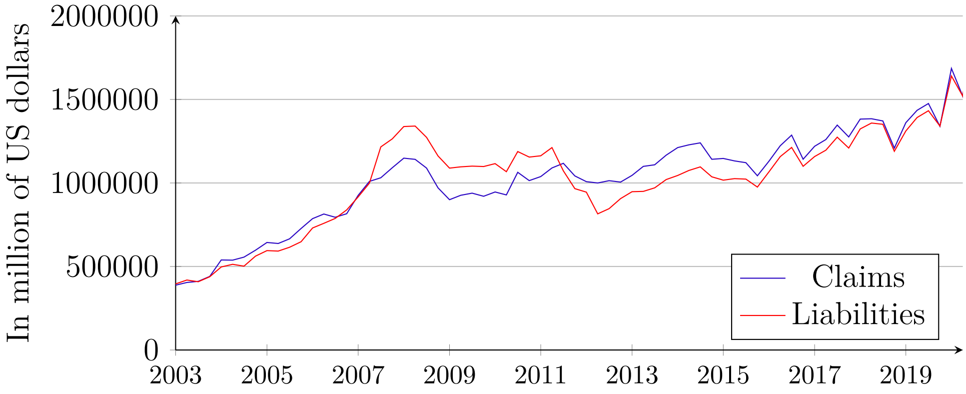
Brazil



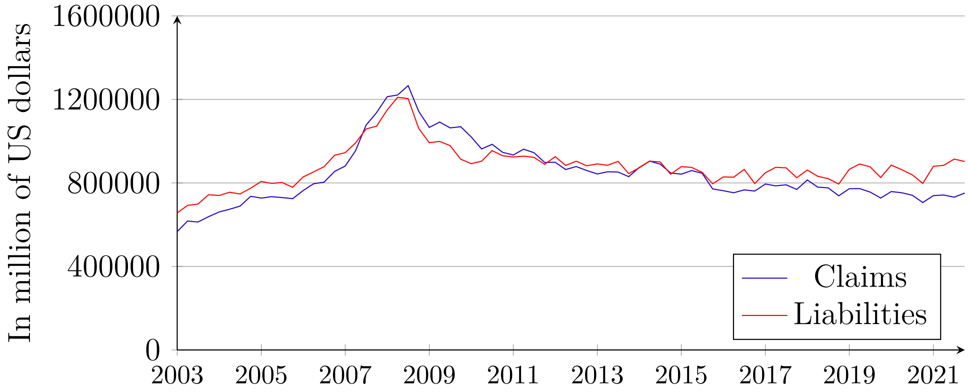
Austria



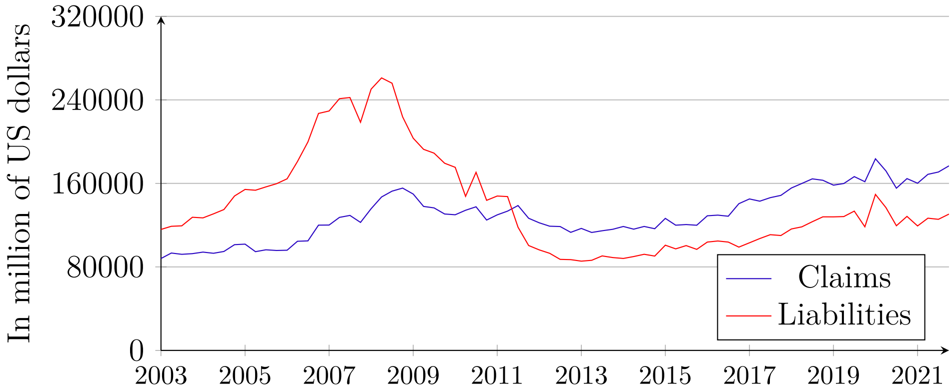
Belgium



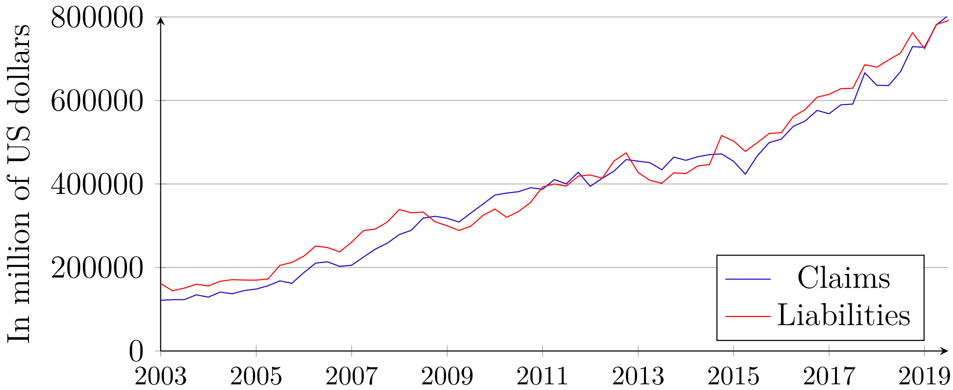
France



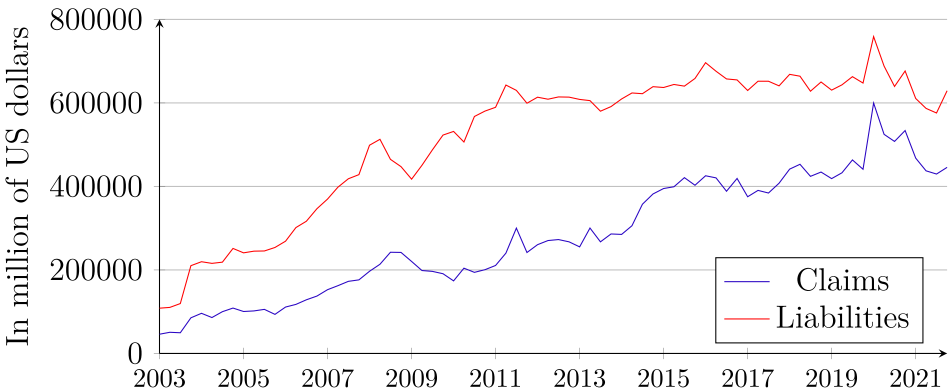
Germany



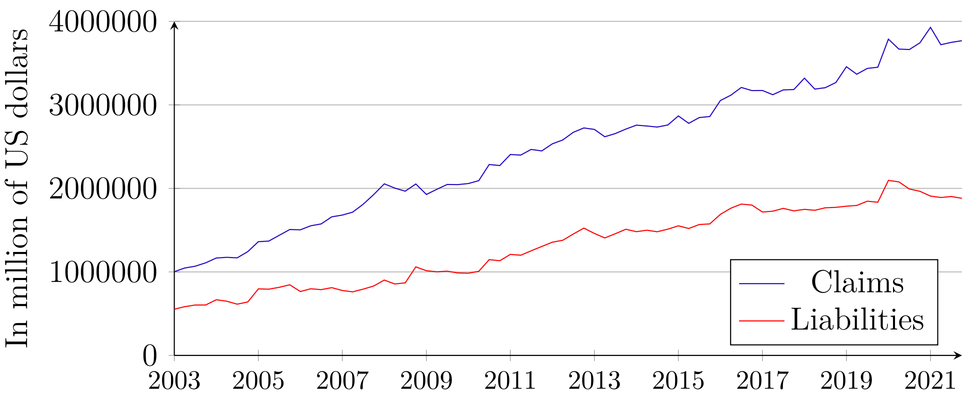
Italy



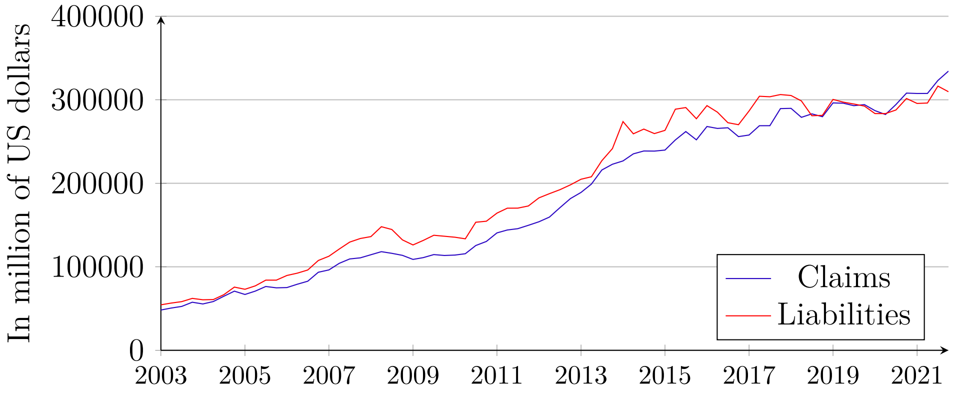
Canada



Australia



Japan



400000
300000
200000
100000
0
In million of US dollars
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
Claims
Liabilities

Turkey