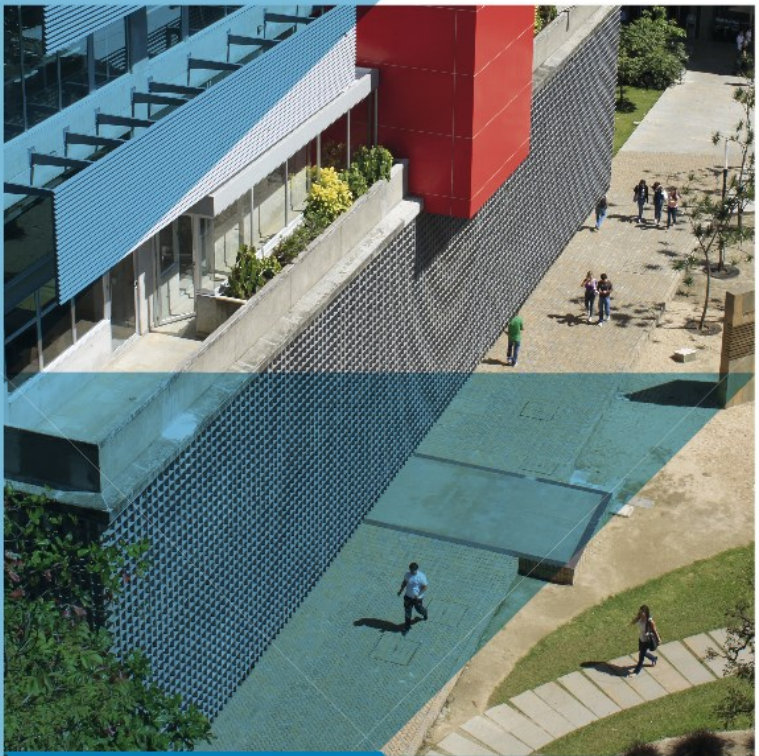

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Abstract

Emerging market economies (EMEs), particularly the commodity exporter ones, are exposed to world's dynamics through different channels. In this paper, we consider the role of (exogenous) commodity prices shocks in explaining business cycles in EMEs, by proposing a financial transmission mechanism: the balance sheet effect. Our hypothesis is that a negative commodity price shock increases the firm's external debt and the cost of the new debt. In consequence, the aggregate investment decreases amplifying the output contraction. To test it, we estimate a series of VAR models using quarterly data on corporate external debt, nominal exchange rate, EMBI+ spreads, the local currency value of external debt to nominal GDP ratio and real GDP, covering the period $2000-2017$. We do this for Latin America and then, we focus on five particular economies: Brazil, Chile, Colombia, Mexico and Peru. We find that balance sheets do matter and they exacerbate the output's contraction when the commodity price shock is negative. We also find that, turning the financial channel off, the real GDP cumulative response in Latin America is smaller than in the unrestricted model. Finally, we find no evidence on the existence of the balance sheet effect for Chile.

Keywords: Emerging Economies, Commodity Prices, International Business Cycles, Balance Sheet Effect, Nominal Exchange Rate.

JEL code: O110, F41, F44, G15.

1 Introduction

Many Latin American economies are strongly dependent on their country's natural resources endowment. Their export basket is mainly composed of commodities such as oil, hydrocarbon, minerals and some agricultural raw materials. Although commodities' share of total exports has reduced since the 1970s, it remains relatively high compared to other regions (see for instance, Gruss (2014) and Sinnott et al. (2010)).

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This commodity dependence exposes Latin American economies to global commodity price dynamics. Being determined by supply and demand interaction, commodities prices exhibit high volatility, which can affect both the primary sector and, indirectly, the entire economy. In fact, Mendoza (1995) and, more recently, Vegh et al. (2017) state that commodity prices can be a potential cause for business cycles in developing economies.

This dependency was especially clear through the last commodity boom, from the early 2000*s* until 2014[1], when many Latin American economies benefited from high commodity prices. In the period from $2002 - 2013$, together with an increase in the commodity prices of more than 300%, annual average economic growth in Brazil, Chile, Colombia, Mexico and Peru was 4.60%. However, the end of the boom coincided with a strong decrease in the economic growth rate in the same group: 1.72% between 2014 and 2016.

What can be expected when commodity prices fall? First, it is clear that the revenues from the primary sector fall, which can affect the aggregate demand through less consumption, investment and taxes. Additionally, given that commodity-exporting economies tend to attract foreign investment in their primary sector, volatility in prices may induce variability in nominal exchange rate related to capital outflows (Reinhart et al., 2016). As a consequence of this shock, the domestic economy experiences a decrease of internal demand, an output contraction and a depreciation of the nominal exchange rate.

Now, conventional textbook wisdom highlights the advantages of devaluations, arguing that they stimulate economic growth via an effect on net exports. This should occur both by making gross exports more competitive (due to a lower-cost currency) and by increasing local demand for domestically-produced goods due to importing goods being relatively more expensive[2]. Nevertheless, this is not the whole story.

An under-studied impact of depreciations is the one related to the balance sheets of companies and governments that possess debt denominated in foreign currency (Céspedes et al., 2004). In this context, exchange rates depreciations raises the local-currency value of companies' debt overnight, thereby increasing their debt-service payments. This **value effect** implies that firm-level investment decisions inside companies might be disturbed, resulting in undesirable effects on the firms, in particular, and on aggregate economic activity overall. As a result, the currency mismatch between revenues and liabilities can cause exchange-rate depreciation to be contractionary, instead of expansionary as the conventional wisdom states.

[1]Regarding to this episode, Gruss (2014) states that "oil prices in current U.S. dollars almost quadrupled between 2003 and 2013 and metal prices tripled, while food prices doubled and prices of agricultural products rose by about 50 percent" (pp. 6)

[2]An important point here to take into account is that all goods are not easily substituted, like capital goods, for instance. This statement is related to consumption goods that are produced nationally.

Concurrently, there is another consequence of variability in commodity prices. The increase in the debt/net worth ratio can be reflected in the increase of the external financial premium, which implies a decrease of the investment. The relationship between commodity prices and interest rates is supported by Malone (2009), who shows that interest rate risk premium in commodity-exporting economies is strongly related to commodity prices. It follows that commodity prices' volatility also affects the borrowing cost (interest rate spread) faced by entrepreneurs in such countries. Since a decrease in commodity prices lowers profitability in these sectors and the entire economy is perceived as less attractive for foreign investors or lenders, they may adjust their expected default rate higher and demand a higher spread over interest rates to hold debt of businesses operating in the economy: this increased cost of borrowing ultimately hinders new debt acquisition by entrepreneurs. This can be thought of as a **quantity effect.**

Viewed in this way, balance-sheet effects constitute a sort of financial accelerator in the sense of Bernanke et al. (1999) that can deepen business cycles due to the contraction of investment caused by financial frictions, and to increase cycles' volatility. As commodity prices rise, the increased capacity for foreign indebtedness may lead to an even higher expansion in output. In contrast, when prices fall, balance-sheet effects may accentuate the bust due to reduced investment.

Bearing all this in mind, it makes sense to explore the effects that commodity prices shocks have on output through the performance of corporate balance sheets. This issue can be approached following the model of Céspedes et al. (2004), where the risk premium is a function of entrepreneurs' value of investment relative to net worth. In a similar way, Gertler et al. (2007) also provide a relevant framework to answer this question, since they use a model similar to the one in Céspedes et al. (2004) to explain the Korean crisis.

Regarding the effects of exchange rate fluctuations on companies' balance sheets, most economic investigations have focused on the micro level[3]. Evidence on the existence of balance sheet effects related to exchange rate depreciation is mixed, although the literature has been able to establish a negative correlation between exchange rates and firms' investment. To the best of our knowledge, little has been done to assess this matter at the macroeconomic level nor to connect it explicitly to commodity-prices fluctuations.

All of the above points to an interesting research question to be answered. Our main goal is to provide evidence of a different, often-ignored, cause of business cycles in developing countries. We aim to untangle the linkage between the last commodity prices boom (from

[3]Bonomo et al. (2003), Benavente et al. (2003), Echeverry et al. (2003), Lobato et al. (2003) and Carranza et al. (2003) carry out these firm size level studies for Brazil, Chile, Colombia, Peru and Mexico, respectively.

2002 − 2014) and the existence of balance sheet effects in Latin America and on five economies in particular: Brazil, Chile, Colombia, Mexico and Peru.

To achieve our goal, we estimate a series of VAR models, using as reference the conceptual framework developed by Céspedes et al. (2004). We use quarterly data of commodity prices, nominal exchange rate, EMBI spreads, external debt and real GDP data in our estimation. One finding is that balance sheets are important business cycles drivers in the region. In particular, we find that half of the output contraction is due to firm's debt dynamics. Also, the behavior of the region is representative of Brazil, Colombia, Mexico and Peru.

Another finding is that Chilean economy is significantly different from its counterparts and the region. For this economy, real copper price does not seem to be a key driver of the business cycle driver and the balance sheet effect is negligible. We believe this is due to Chile's strong institutional structure and, especially, the existence of the Economic and Social Stabilization Fund (ESSF) and fiscal rules.

This paper is organized in five sections, including this introduction. In section 2, we discuss how economic literature approaches commodity prices shocks and business cycles in emerging economies and the balance sheet effect. In section 3, we describe our data and explore some stylized facts for Latin America in general and the five studied countries in particular. Section 4 explains our methodology and presents estimation results. Finally, section 5 concludes.

2 Commodity Prices, Interest Rates and Balance Sheet Effects

There is a vast economic literature[4] linking commodity prices (or, similarly, terms of trade) to real GDP cycles in emerging market economies (EMEs). This literature mainly considers real and commercial channels, finding that commodity prices booms are related to expansions in employment, consumption, investment and output, altogether with improvements in the trade balance. Fernández et al. (2017a) use a dynamic stochastic general equilibrium (DSGE) model to estimate the transmission mechanisms of commodity-prices shocks to the real sector, through their effects on domestic goods demand. The authors find that commodity prices display strong comovement with other macroeconomic variables. In fact, they find that commodity prices are procyclical and leading to output, investment and consumption. Moreover, the authors also find that commodity prices are countercyclical to real exchange rates and the external risk premium.

The model used by Fernández et al. (2017a) considers an endowment commodity sector that faces fluctuations of its international price, which is taken as given by households. The model

[4] See, for example, Fernández et al. (2017b), Shousha (2016), Kose (2002), Tretvoll et al. (2017) and Charnavoki (2010).

has four agents: households, firms (domestic good producers), investment good producers and the rest of the world. Foreign and domestic goods are used as inputs in the production of investment goods and are also imperfect substitutes in household consumption. Households offer labor services in the labor market and they receive commodity revenues due to an ownership stake in the nation's commodity endowment. Firms produce domestic goods using labor and capital inputs.

In this framework, households can issue bonds in international financial markets, where they pay a spread over international interest rate. The spread is considered exogenous and stochastic, embodying other business cycle force. Additionally, the authors propose that commodity price movements are explained by a latent common factor and idiosyncratic shocks. In the model, the only source of fluctuations of commodity prices is related to shocks to the common factor. Equation 1 presents the log-linearized version of the market clearing condition, which allows for decomposition of the real GDP response to a positive shock in the commodity price's common factor, as the sum of three effects:

$$y_t = \underbrace{\left(\frac{C^h}{Y}\right) c_t^h}_{Effect\ 1} + \underbrace{\left(\frac{X^h}{Y}\right) x_t^h}_{Effect\ 2} + \underbrace{\left(\frac{C^{h*}}{Y}\right) c_t^{h*}}_{Effect\ 3} \tag{1}$$

where letters without subscript represent steady state levels. Y is output, C^h is home good consumption, X^h is domestic good used in investment good production and C^{h*} is external demand for home goods. Lower-case letters represent log deviations from steady state levels ($x_t = ln(X_t) - ln(X)$). Effect 1 embodies a **domestic demand channel**: the positive commodity income shock leads households to increase their demand. Domestic relative prices increase in response to this to stimulate production.

Effect 2 accounts for changes in new investment goods. On the one hand, to meet the increased domestic demand, firms increase their capital demand and hence, pushes up capital rental rate. On the other hand, demand for new investment goods also increases, and so does their price. Together, this results in an increase in the demand for domestic goods.

Lastly, effect 3 is related to the response of external demand for home goods. Given that the commodity income boom induces an increase in domestic prices, the economy is less competitive in international markets. As a result, home goods become relatively more expensive, which detriments its demand from foreigners.

The net effect of the commodity shock on aggregate output will depend on the strength of the aforementioned effects. In turn, every effect depends on the economy's structural parameters describing firms, households and the behavior of producers of investment goods. Assuming that effect 3 is not large enough to counterbalance effects 1 and 2, the net effect is positive and, in the new equilibrium, the real exchange rate appreciates[5]. Lastly, in the empirical strategy, the authors find that the model correctly replicates patterns exhibited by EME data, particularly those from Brazil, Chile, Colombia and Peru.

As a final remark regarding the model of Fernández et al. (2017a), it is worth noting that interest rates spreads are not explicitly modeled as a function of commodity prices. Furthermore, this model does not consider the external debt dynamics nor the currency mismatch problems that could take place between households' incomes and liabilities. Nevertheless, this paper makes clear the connection between commodity prices and real output in EMEs.

The financial channel or balance sheet effect of debt denominated in foreign currency has been approached in the economic literature as a phenomenon related to external interest rates shocks. Along these lines, Céspedes et al. (2004) develop a theoretical model with financial frictions[6] where debt is dollarized and country risk premium is endogenous. The authors show how devaluations in the exchange rate can be detrimental for economic performance, which contradicts traditional textbook wisdom.

In this context, the authors solve the financial contract problem between domestic entrepreneurs and foreign lenders. In doing so, they make an extension to Bernanke et al. (1999) in an open economy context to find a critical equation that guarantees interest rate parity:

$$\frac{\mathbb{E}_t(R_{t+1}K_{t+1}/S_{t+1})}{Q_tK_{t+1}/S_t} = (1+\rho_{t+1})(1+\eta_{t+1}) \tag{2}$$

Equation 2 equalizes the expected return of the entrepreneur's investment project and the international safe interest rate $(1+\rho_{t+1})$. Entrepreneurs must pay a spread over the international interest rate, η_{t+1} or risk premium, that reflects the informational asymmetries in financial contract enforcement. Now, in equilibrium, the entrepreneur's net worth, denominated in local currency, is[7]:

$$N_t = \delta\left[(1-\Phi_t)\alpha Y_t - (1+\rho_t)E_tD_t\right] \tag{3}$$

where $E_t = S_t/P_t$ is the real exchange rate, δ is the unconsumed proportion of entrepreneur's net worth and $(1-\Phi_t)$ reflects monitoring costs paid in the contract enforcement. It is interesting in equation 3 that, given real income, Y_t, and contemporaneous risk premium, a real devaluation negatively impacts the entrepreneur's net worth because it increases the burden of interest payments associated with inherited debt.

[5]A reasonable conclusion is that, given the economic structure modeled, a fall in commodity prices would cause a depreciation in exchange rates. Besides, the net effect in output would depend on the relative strength of (commercial) effect three in equation 1 with respect to the other effects.

[6]In their model, financial frictions are due to informational or enforcement problems.

[7]This equation holds in nominal terms as well. For details, see equation 12 in Céspedes et al. (2004)

A **key feature** of Céspedes et al. (2004) model is that risk premium is an increasing function of the investment cost-net worth ratio, as shown by Bernanke et al. (1999):

$$1 + \eta_{t+1} = F\left(\frac{Q_t K_{t+1}}{P_t N_t}\right), \;\; F(1) = 1, \;\; F'(\cdot) > 0 \tag{4}$$

The functional form of risk premium, displayed in equation 4, incorporates the balance sheet effects in the model. This effect is related to investment decisions in a firm that possesses debt denominated in a foreign currency: whenever the exchange rate depreciates, the local currency value increases and so do interest payments. If the firm obtains revenues in local currency, it automatically has to make a greater effort to repay its debt, forcing it to reduce investment and hence, production.

In particular, the authors are interested in studying the effects of an unanticipated and temporary increase in the safe international interest rate, ρ_{t+1}, under both flexible and fixed exchange rate regimes. This shock causes an increase in the exchange rate. The authors find that balance sheet effects are relevant and can amplify the effects of foreign disturbances. This magnification is particularly sharp when the economy is financially vulnerable and the conventional effect of exchange-rate depreciation is overshadowed by the financial effect.

A model in the same vein as Céspedes et al. (2004) is that of Gertler et al. (2007), who propose a financial accelerator model–where the exchange rate regime is linked to financial distress– to explain the South Korean crisis of $1997 - 1998$. The authors explain that the Korean crisis was triggered by a reduction in that country's sovereign risk rating by Standard & Poor's. This caused capital flight and a sharp increase in the country risk premium. In turn, to maintain fixed exchange rates, the central bank responded by raising interest rates. This response, combined with higher country risk, ultimately resulted in a deterioration of economic activity.

The financial accelerator mechanism proposed by the authors connects borrower balance sheets to the external risk premium in the financial contract. Agents interacting in the model are: households, firms (entrepreneurs, capital producers and retailers) and a government. As in Fernández et al. (2017a), there are both domestic and foreign goods that are imperfect substitutes. In this model, the country borrowing premium for external debt is a function of net foreign indebtedness, NF_t, and a random shock, Φ_t:

$$\Psi_t = f(NF_t)\Phi_t, \;\; with\; f'(\cdot) > 0 \tag{5}$$

The authors claim that this specification of the borrowing premium is useful because it helps to replicate the apparent cause of Korean crisis. They associate the observed capital flight with an increase in the random variable Φ_t.

On the production side, entrepreneurs are the key players. In order to produce, they must finance their capital demand through their own net worth at the end of period t, N_{t+1}, and nominal bonds, B_{t+1}. In this context, entrepreneurs and lenders solve a financial contract with costly bankruptcy yielding a financial premium, given by:

$$\chi_t(\cdot) = \chi\left(\frac{\frac{B_{t+1}}{P_t}}{N_{t+1}}\right), \ \chi^{'}(\cdot) > 0, \ \chi(0) = 0, \ \chi(\infty) = \infty \tag{6}$$

It is clear from equation 6 that the financial premium faced by entrepreneurs is an increasing function of their leverage ratio: the higher this ratio is, the higher the interest rate that entrepreneurs must pay. This is the financial accelerator mechanism.

Now, how does the shock on country risk premium, i.e., an increase in Φ_t in equation 5 trigger the financial accelerator mechanism and affect output? The massive capital outflow causes the central bank to increase nominal interest rates, in order to protect the fixed exchange rate. Given nominal rigidities in the retail sector, real interest rate also rises, inducing a contraction in output. This is exaggerated by the financial accelerator mechanism: the higher real interest rate generates a reduction in asset prices which, in turn, reduces the entrepreneurs' net worth and, hence, increases their leverage ratio. As stated in equation 6, higher leverage raises entrepreneurs' financial premium, which ultimately leads to a reduction in investment and a sharper output contraction.

Although initially the authors consider the case where these bonds are denominated in domestic currency, they extend their model in order to account for what happens when debt is denominated in foreign currency. One interesting finding is that the contraction in investment after the shock is almost twice as big when the debt is denominated in foreign currency than in the unrestricted case. Furthermore, as in Céspedes et al. (2004), Gertler et al. (2007) find that flexible exchange rates are more desirable than fixed exchange rates in terms of the effect on output. This means that the financial accelerator mechanism is actually more detrimental when a currency mismatch exists.

We have seen that, on the one hand, commodity prices shocks are connected to output cycles, but that the mainstream economic literature tends to leave the financial channel outside their models. On the other hand, the balance sheet effect has been studied under frameworks considering interest rates disturbances, leaving commodity prices shocks as exogenous. Given this, we propose that a negative shock in commodity price has the same effects as a positive shock in world's safe interest rate, as proposed by Céspedes et al. (2004) and a positive shock in the country risk, as in Gertler et al. (2007). Our intuition is that when commodity prices fall, the domestic economy as a whole is less attractive to foreign investors or lenders.

Lastly, an assumption we will make in our analysis, that is also found implicitly in Céspedes et al. (2004) and Gertler et al. (2007), is that entrepreneurs can not use any financial instrument in order to hedge the risk of unexpected exchange rate fluctuations, which will provide a way to connect commodity prices shocks to firm's liabilities. This assumption makes sense in EMEs, where financial markets are incipient and the access to financial instruments is limited.

3 Data and Some Stylized Facts

3.1 Data

First, we will consider Latin America and then we will focus on Brazil, Chile, Colombia, Mexico and Peru, because each is a net commodity exporters. We exclude Ecuador and Panama because these are dollarized economies and Venezuela because of the political instability that characterizes its economy. Uruguay and Bolivia are excluded due to lack of data availability. Central American countries are too small to be considered and, as stated by Sinnott et al. (2010), these are net commodity importing economies.

We gather data from different sources. Real and nominal GDP information is collected from CEPAL database, which provides quarterly data in local currency units. Total non-financial private-sector external debt expressed in U.S. dollars is retrieved from each country's central bank. Although it is possible that we are considering debt originally denominated in currencies different from the U.S. dollar, the largest proportion of external debt in the economies we consider is, in fact, originally denominated in dollars.

Nominal exchange rate data is also taken from each country's central bank. Besides, we construct the local currency value of external debt as the product between the nominal exchange rate and dollar debt for each country. EMBI spread data, used as a proxy for the risk premium, is collected from JP Morgan and converted into quarterly data by computing daily averages. We select these variables because we are interested in studying how commodity prices shocks affect corporate external debt and real GDP cycles, through nominal exchange rate and risk premium.

There are differences in the time period covered: the Brazilian case is examined over the $2001Q4 - 2017Q2$ period, while Chilean covers from $2003Q1$ to $2017Q3$. Colombian and Peruvian cases cover the period $2000Q1 - 2017Q2$ and Mexican data is available from $2002Q1$ to $2017Q2$.

To obtain data for Latin America as a whole, we considered our five countries and add Argentina and Paraguay. These seven countries represent a large proportion of the entire GDP of Latin American[8]. External debt in dollars is simply added for every economy since it is all

[8] Actually, according to World Bank data, these seven economies represent 83% of Latin American and the Caribbean GDP in the period $2000 - 2016$.

expressed in the same currency. Now, given that CEPAL reports quarterly national accounts information only in local currency, national account data was transformed into dollars. We performed this transformation by multiplying real GDP in a base period ($2011Q4$) by the nominal exchange rate in the same period. Then, to obtain a GDP in constant base period dollars, we calculated it using growth rates of real GDP in local currency units.

The nominal exchange rate index (in the Latin American case) is computed as a weighted average of country-specific indexes. Here, again, the base period is $2011Q4$. The weights are calculated as the participation of each country in the group of seven. The same procedure was used to compute the LCU external debt to GDP ratio from every economy's ratio data. The Latin American EMBI is calculated by JP Morgan, and we have this information in the period $2000Q1 - 2017Q1$.

Finally, some descriptive statistics are displayed in Table 1. It is noticeable that Chile has the highest LCU-debt-to-GDP ratio and, at the same time, the lowest EMBI+ spreads. Column 4 in Table 1 displays quarterly GDP growth rates, which shows that Colombia and Chile are markedly higher than their counterparts and the region. Column 5 shows commodity prices growth, and *min* and *max* statistics allow us to observe their volatility.

Table 1: Descriptive Statistics - Latin America and five EMEs

Country	**LCU Debt to GDP ratio**	**EMBI+ (bp)**	**Real GDP Growth**	**Commodity Price Growth**		
	Mean	**Mean**	**Mean**	**Mean**	**Min**	**Max**
Latin America	31.64%	496.8898	0.62%	0.95%	-51.94%	16.62%
Brazil	23.44%	435.732	0.59%	1.52%	-21.30%	27.94%
Chile	95.81%	149.9758	0.93%	1.14%	-65.09%	37.02%
Colombia	30.44%	319.1614	0.95%	0.22%	-67.93%	32.06%
Mexico	28.90%	210.9567	0.49%	0.22%	-67.93%	32.06%
Perú	40.44%	287.1461	0.59%	1.52%	-21.30%	27.94%

3.2 Stylized Facts

We present some empirical regularities analysis for Brazil, Chile, Colombia, Mexico and Peru compared to the Latin American region as a whole. Figure 1 presents the calculated correlation coefficients[9] for our five EMEs and the region. These correspond to the correlation between cyclical components of every variable in period t and the **commodity price** in period $t + j$ with $j = -4, -3, -2, -1, 0, 1, 2, 3, 4$. Regarding dollar debt (panel a), in Brazil, Colombia and Mexico,

[9] The statistical significance of these coefficients is tested, yielding that all of them are statistically different from zero.

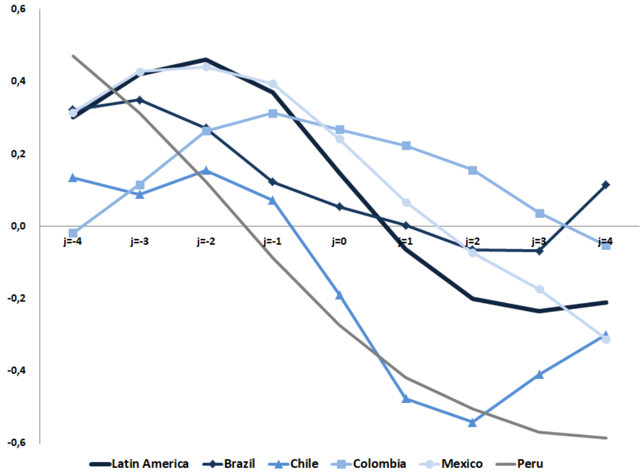
the commodity-relevant price[10] shows a procyclical and leading movement with respect to this variable. This means that dollar debt reacts in the same direction, and after, commodity price changes. Furthermore, these economies exhibit the same behavior as Latin America. Chile and Peru behave differently from their counterparts and the region, since the commodity price is countercyclical and lagged with respect to debt in USD, meaning that dollar debt moves before and in the opposite direction of commodity price change.

The commodity price variable is countercyclical and contemporary to the LCU-debt-to-GDP ratio (Panel b). In the case of Brazil, Colombia, Mexico and the region. This contrasts with the Chilean and Peruvian case, where this variable is lagged. A strong finding in this paper is the countercyclical and contemporary relation between the nominal exchange rate and commodity price (Panel c). This is found both for the region as a whole and for each of the five economies studied. Considering that dollar debt is procyclical and the nominal exchange rate is countercyclical, LCU debt dynamics would initially depend on whether the quantity effect is greater than the value effect explained above. Since LCU debt turns out to be countercyclical, it allows us to conclude, at least preliminarily, that the value effect dominates.

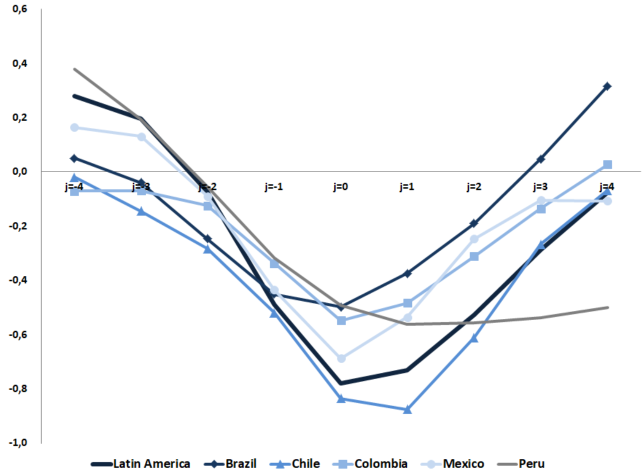
Regarding EMBI spreads (our risk premium proxy), we find that commodity price is countercyclical and has a one period lag (Panel d). This is true for all economies and the region, except for Brazil, where it is contemporary. Finally, it is also clear from Panel e in Figure 1 that commodity price is procyclical to GDP and contemporary for Colombia and the region, while it is leading in the other economies. This exploratory and preliminary analysis supports the existence of a balance sheet effect caused by commodity price volatility both in the region and the five economies individually.

[10]In the cases of Brazil and Peru, we construct a commodity-price index using: i) soybeans, iron, sugar, oil and poultry meat and ii) copper, gold, oil and zinc, respectively. For Chile, we only take into account the copper price, while in Colombia and Mexico, we use oil price.

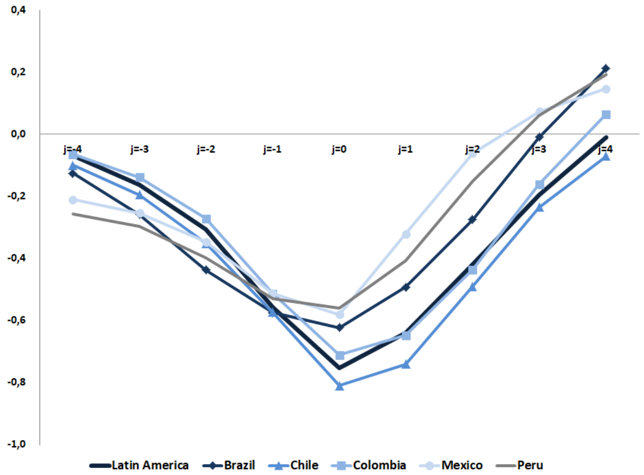
Figure 1: Correlation coefficients - Cyclical components - Latin America and five EMEs



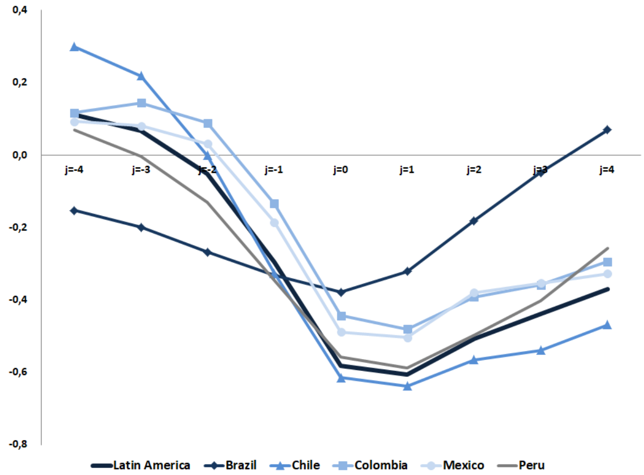
(a) External Debt (USD)



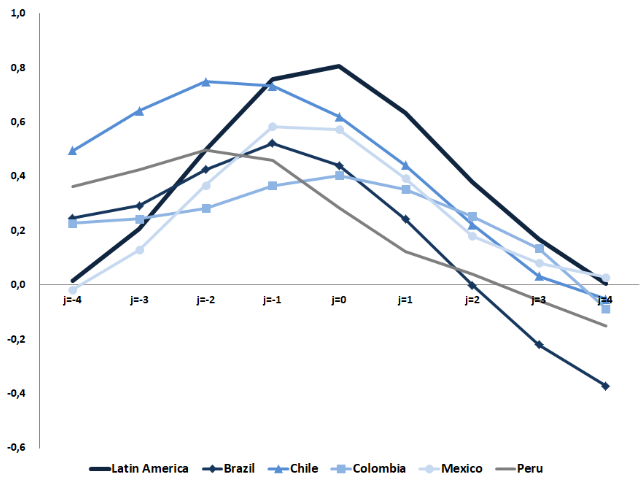
(b) LCU External Debt to GDP ratio



(c) Nominal Exchange Rate



(d) EMBI



(e) Real GDP

4 Methodology and Estimation Results

For our empirical strategy, we use the cyclical component of the log of every variable. We extract the cycle using Hodrick-Prescott filter with 1600 as the smoothing parameter[11]. This allows us to obtain percentage deviations from steady state in impulse response function analysis derived from our model.

We estimate a VAR(p) model for each economy, with five variables: a commodity-price index, the nominal exchange rate, the EMBI spread, LCU external-debt-to-GDP ratio and real GDP. In general, the equation to estimate is as follows:

$$Y_t = \beta Dummy(2008Q4) + \sum_{i=1}^{p} A_i Y_{t-i} + \epsilon_t \tag{7}$$

where Y_t is a $5x1$ vector with the endogenous variables ordered as above. A dummy variable for period 2008Q4 is also included, in order to control for the financial crisis. In constructing Impulse Response Functions (IRF) and Forecast Error Variance Decomposition (FEVD), we use 70% confidence intervals[12]. IRF and FEVD are presented only for Latin America and Chile. Brazil, Colombia, Mexico and Peru exhibit the qualitative behavior of the region, while Chile is noticeably different.

4.1 Latin America

The Latin America model is estimated with two lags. Figure 2 presents the impulse response function resulting from a one standard deviation negative shock in the commodity price index cyclical component[13]. It is clear that when the commodity price reduces, nominal exchange rate, EMBI spreads and LCU debt to GDP ratio increase, reflecting the countercyclical relations found before. In contrast, real GDP exhibits the expected procyclical behavior. These effects are statistically significant for around three periods (quarters).

At first sight, the magnitude of the responses might look negligible but it is worth noting that these are quarterly responses. In order to obtain a clearer response, we aggregate the quarterly changes to get the annual (cumulative) response. For this exercise, we alter the magnitude of the shock in order to capture the variation in commodity price index from boom to bust, as shown in figure 6 in Appendix A[14] These calculations are presented in Table 2.

[11]We used alternatives cycle measures, yielding no significant differences with respect to the Hodrick-Prescott filter.

[12]In VAR model applications, it is usual to find confidence intervals of up to 68%. This practice became popular since Sims and Zha (1999) published their very influential paper.

[13]Diagnostic tests were performed in each model and results are available for the interested reader.

[14]Boom was observed in 2014Q2, corresponding to a positive deviation from its long run trend of 19.35% and bust in 2016Q1, where it was -30.81%. This corresponds to a fall of approximately 50.34% in the eight periods covered.

Figure 2: Impulse Response Function - One standard deviation shock in commodity price index - 70% confidence intervals

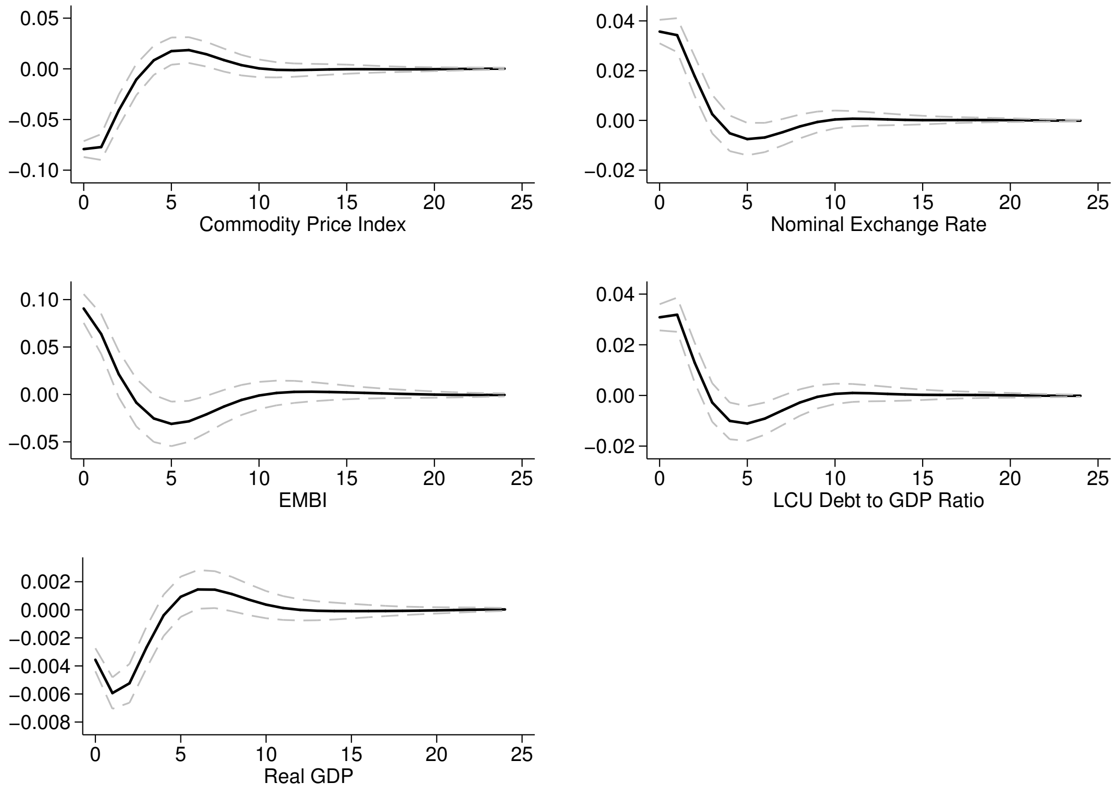
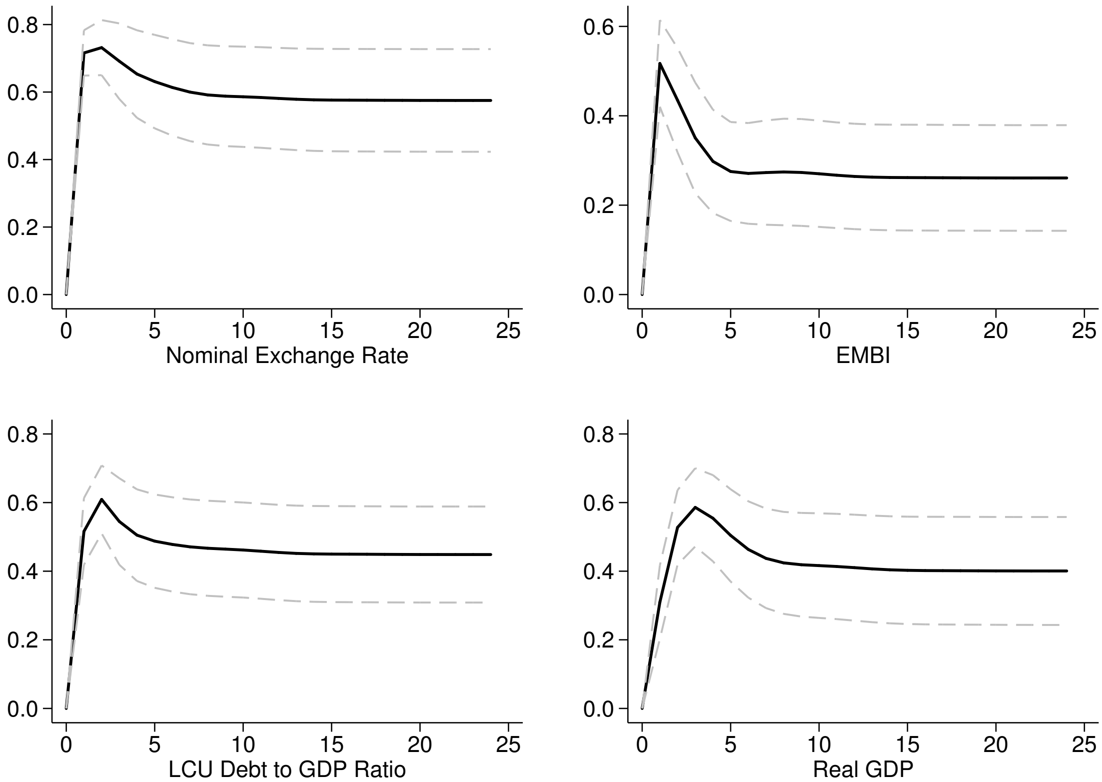


Table 2: Cumulative responses - Impulse Response Function to a 2.5 standard deviation negative shock in commodity price index.

Step	**Nominal Exchange Rate**	**EMBI Spread**	**LCU Debt to GDP Ratio**	**Real GDP**
0	0.0893	0.2265	0.0771	-0.0089
1	0.0857	0.1592	0.0797	-0.0148
2	0.0444	0.0534	0.0324	-0.0131
3	0.0064	-0.0215	-0.0070	-0.0067
Cumulative response	21.93%	38.57%	18.92%	-4.35%

Table 2 shows that when the commodity price index falls in almost 20% in a period, the cumulative significant response in real GDP would be approximately 4.4% three periods after the shock. The effect on the nominal exchange rate and LCU-debt-to-GDP ratio are significant until two quarters after the shock, yielding cumulative changes of 22% and 19%, respectively. EMBI spread is significant only a period after the impulse, with a cumulative response of 38.6%.

Figure 3: Forecast Error Variance Decomposition - 70% confidence intervals



Finally, forecast error variance decomposition (FEVD) from this model is presented in Figure 3. Based on this, one can conclude that around 60% of forecast error variance of the nominal exchange rate is due to commodity price shocks. This proportion is approximately 30% for EMBI spread. Regarding LCU-debt-to-GDP ratio and real GDP errors, we find that commodity price shocks explain roughly 40% of them.

According to these results, we conclude that commodity prices shocks do play an important role in explaining the dynamics of the economic variables included, both in the region and the five EMEs, except for Chile. It is particularly interesting that external debt does react to changes in commodity prices. But, is this evidence enough to conclude that the balance sheet effect actually exists? To answer this question, we estimate a VAR model restricting the external debt to not respond to commodity prices shocks. This provides a counterfactual exercise that allows us to obtain the responses that would take place if the financial mechanism were not relevant.

Table 3 displays the cumulative responses of the unrestricted model and the restricted model. We compare significant cumulative responses in both models. In terms of the nominal exchange rate, depreciation is 10% higher in the unrestricted model. It implies that, since entrepreneurs make debt service payments in dollars, their demand for foreign currency exacerbates the exchange rate depreciation originally caused by commodity price fall.

Regarding EMBI spread, the unrestricted model again generates a higher response than the restricted. This might be related to the underlying financial accelerator. The intuition is that a commodity price fall induces a first increase in EMBI spreads because economy is less attractive for foreign lenders but, since entrepreneurs' net worth is negatively affected by the initial shock, it provokes a further increase in risk premium.

Table 3: Impulse response function comparison: Unrestricted model vs. Restricted model - Negative shock in commodity price index of 20%

Step	**Unrestricted model**			**Restricted model**		
	Nominal Exchange Rate	**EMBI Spread**	**Real GDP**	**Nominal Exchange Rate**	**EMBI Spread**	**Real GDP**
0	0.0902	0.2288	-0.0090	0.0989	0.2580	-0.0065
1	0.0866	0.1608	-0.0150	0.0228	-0.0013	-0.0100
2	0.0448	0.0539	-0.0132	-0.0003	-0.0133	-0.0055
3	0.0064	-0.0217	-0.0068	0.0048	0.0101	-0.0013
Cumulative response	22.16%	38.96%	-4.40%	12.14%	25.80%	-2.20%
Significant periods	0-2	0-1	0-3	0-2	0	0-2

Lastly, the GDP contraction is higher in the unrestricted model. We again attribute this finding to the financial accelerator. First, the fall in commodity price reduces commodity exports and, ceteris paribus, aggregate demand. Then, given the increase in debt service payments, firms cannot easily carry out investment projects. The increased risk premium hinders new debt acquisition to finance investment. Thus, the financial accelerator causes a further contraction in aggregate demand and, hence, in real GDP. Based on these results, we conclude that the balance sheet effect exists, and that it plays an important role deepening business cycles associated with commodity price disturbances in EMEs.

Finally, cumulative responses in impulse response functions and forecast error variance decomposition for Brazil, Colombia, Mexico and Peru are displayed in Table 4.1[15]. Since we are considering shocks of the same magnitude, these results are comparable. Brazil appears to be the most vulnerable economy to commodity-price disturbances: it has the highest increases in exchange rate and risk premium, while having the deepest GDP contraction. Disconcert-

[15]Impulse Response Function and Forecast Error Variance Decomposition from the estimated model for each economy are presented in Appendix B.

ingly, unlike its counterparts, in the Peruvian case, EMBI spread and LCU-debt-to-GDP ratio are countercyclical to commodity prices.

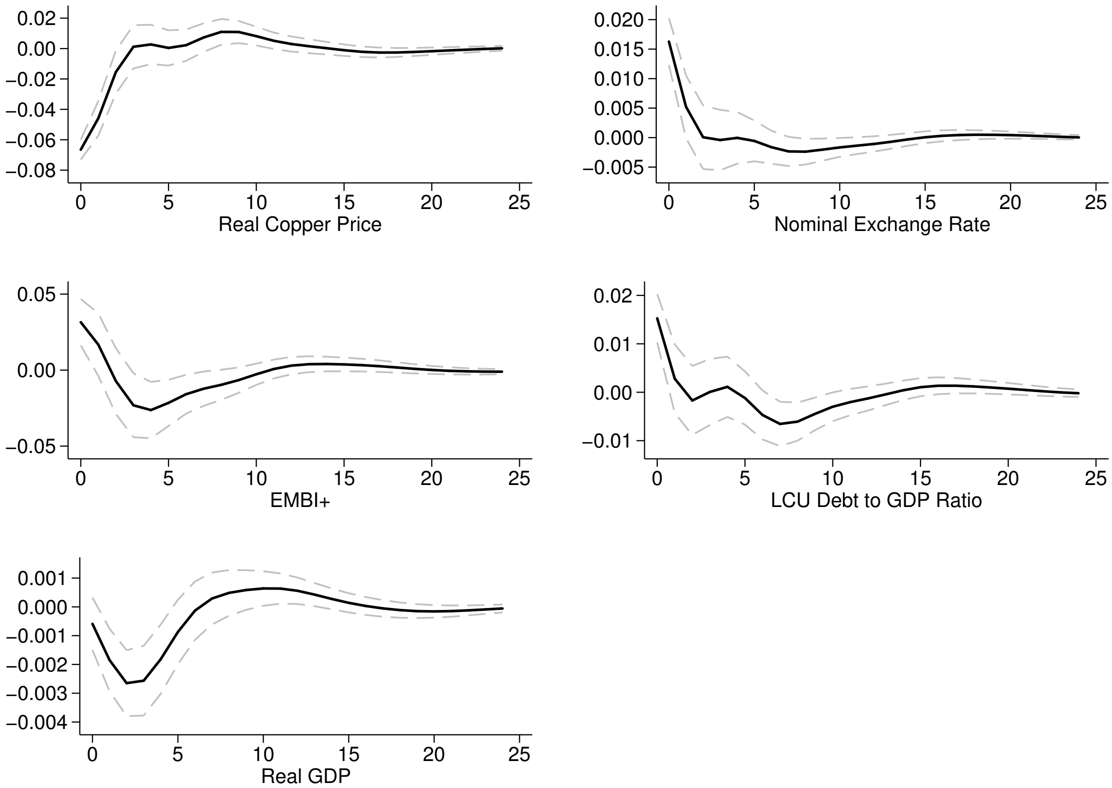
Table 4: Cumulative responses and Forecast Error Variance Decomposition - A one standard deviation negative shock in country-specific commodity price.

		Brazil	**Colombia**	**Mexico**	**Peru**
Nominal Exchange Rate	**Cumulative Response**	13.86%	8.13%	8.76%	3.19%
	FEVD	33.01%	25.37%	49.68%	24.60%
EMBI Spread	**Cumulative Response**	13.92%	13.45%	5.19%	-16.04%
	FEVD	10.84%	13.43%	14.76%	8.45%
LCU Debt to GDP Ratio	**Cumulative Response**	9.06%	6.27%	4.64%	-15.24%
	FEVD	20.91%	20.23%	34.26%	19.41%
Real GDP	**Cumulative Response**	-1.04%	-1.02%	-0.86%	-0.69%
	FEVD	17.59%	10.76%	14.34%	9.06%

4.2 The Chilean case

In the Chilean case, we run the model on inflation-adjusted copper price, which is deflated using US consumer price index. We estimate Equation 7 with $p = 2$. The impulse response function to a negative one standard deviation shock in the real copper price is displayed in Figure 4. Qualitative behavior of endogenous variables is the same as in the region. Significance of these responses persists, at most, four quarters after the shock. For instance, the effect on the nominal exchange rate, EMBI+ spreads and LCU-debt-to-GDP ratio is only significant on impact, after that, we can not reject the null hypothesis of the response being different from zero. Real GDP response is significant from period 1 to 4.

Figure 4: Impulse Response Function - One standard deviation shock in real copper price - 70% confidence intervals



As can be seen in Figure 8 of Appendix A, the last copper price fall, between 2014*Q*3 and 2016*Q*1 was not so extreme. In fact, from boom to bust, the copper price varied 23.48%, which in average represents a variation of 3.35% per quarter. Given this, cumulative responses are calculated using a one standard deviation shock.

Table 5: Cumulative responses - Impulse Response Function to a one standard deviation negative shock in real copper price.

Step	**Nominal Exchange Rate**	**EMBI Spread**	**LCU Debt to GDP Ratio**	**Real GDP**
0	0.0163	0.0315	0.0153	-0.0006
1	0.0052	0.0168	0.0028	-0.0018
2	0.0001	-0.0072	-0.0017	-0.0026
3	-0.0004	-0.0231	0.0001	-0.0026
4	0.0000	-0.0263	0.0011	-0.0018
Cumulative response	1.63%	3.15%	1.53%	-0.89%

Table 5 displays the results of the cumulative response analysis. Since the nominal exchange rate, EMBI+ spreads and LCU-debt-to-GDP ratio are only significant on impact, the responses are, as can be seen in the third row of the table, 1.63%, 3.15% and 1.53%, respectively. In the case of GDP, the cumulative response, corresponding to periods 1 to 4 after the shock is -0.89%. The Chilean case is remarkably different from its counterparts and the region. This can be attributed to the institutional structure characterizing this economy, which have allowed it to establish credibility and a good reputation in the international markets. Besides, the existence of the economic and social stabilization fund (ESSF) may help cushion the economy from the effects of copper price volatility and, hence, soften the business cycles caused by it. In fact, as explained by Solimano and Calderón (2017), by dampening the effects of international copper price volatility on the Chilean economy, the fund also helps stabilize fiscal budgets and policy.

Figure 5: Forecast Error Variance Decomposition - 70% confidence intervals

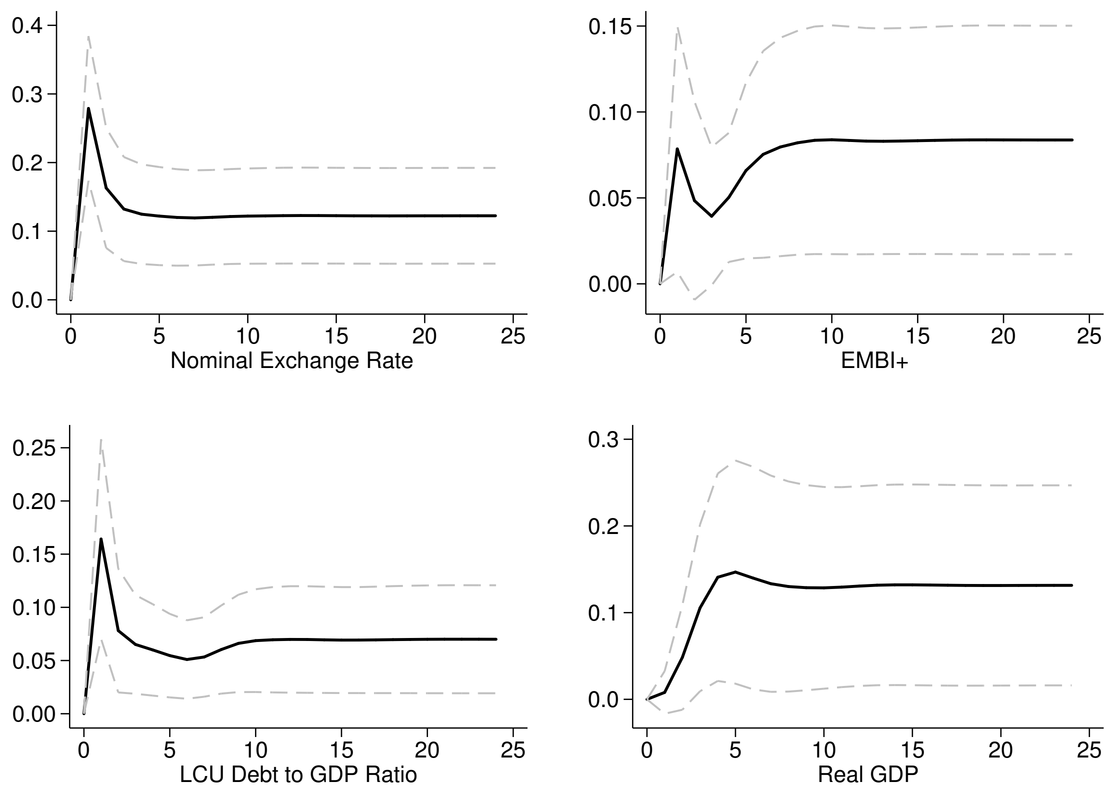


Figure 5 exhibits the forecast error variance decomposition for the Chilean case. According to this analysis, around 10% of nominal exchange rate and real GDP error variance is explained by copper price shocks. The fraction of the error variance of both EMBI+ spreads and LCU-debt-to-GDP ratio explained by copper price variation is less than 10%. These are, again, low numbers revealing that copper price may not have a relevant role in the explanation of Chilean business cycles. Moreover, it is important to note that Chile has the highest LCU-debt-to-GDP ratio and, in spite of that, we find no evidence of this deepening business cycles.

5 Conclusions

Emerging market economies, particularly the commodity exporter, are exposed to global dynamics through different channels. In this paper, we considered the role of (exogenous) commodity prices shocks in explaining business cycles in EMEs. Mainstream economic literature relates the commodity prices disturbances to business cycles through the traditional commercial channel, leaving aside the potential role played by financial variables.

We go further this approach by proposing a financial transmission mechanism of commodity prices shocks: the balance sheet effect. The existing economic literature usually approaches this effect via international interest rates shocks, without taking into account the commodity prices. We aim to connect the latter to the balance sheets of firms that possess debt denominated in foreign currency. In this context, there is a currency mismatch between firm's revenues and liabilities, hindering investment and production when depreciation in exchange rate takes place.

Our hypothesis is that firms' external debt dynamics are related to an exogenous macroeconomic variable: commodity price. An increase in this variable reduces both nominal exchange rate and risk premium, facilitating external debt acquisition by domestic firms. But, whenever commodity prices fall, the opposite happens and hinders firm's investment. In this sense, we propose that the balance sheet effect acts as a financial accelerator that: when commodity prices are high, it amplifies economic expansions (through the increased investment), but when commodity-price conditions are adverse, it deepens output contraction.

To test our hypothesis, we estimated a series of VAR models using data from Latin America and in five individual economies: Brazil, Chile, Colombia, Mexico and Peru. We use corporate external debt, nominal exchange rates, EMBI+ spreads and real GDP data. Besides, we construct the local currency value of external-debt-to-nominal-GDP ratio.

Our estimations allow us to conclude that Brazil, Colombia, Mexico and Peru exhibit the observed qualitative behavior in the region. All variables comove as expected with commodity-relevant price measures, i.e., nominal exchange rate, EMBI spreads and the debt ratio are countercyclical, while real GDP is procyclical. Chile constitutes a remarkable exception, as we found no evidence of copper price disturbances being a business cycle driver. We attribute these findings to Chile's ESSF and other institutional arrangements, such as fiscal policy rules. Moreover, in the Chilean case, the fact that this economy has the highest external-debt-to-GDP ratio seems not to be relevant.

To account for the magnitude of the balance sheet effect, we estimated the same VAR model as before but constraining the impact of the debt ratio on the other variables, and vice versa, to be zero. By doing so, we attempt to answer how the variables in the system would have responded if the financial channel were not important.

Comparing impulse response functions and cumulative responses for the region and the economies (excepting Chile), we find that balance sheets do matter in that they exacerbate the output contraction when the commodity price shock is negative. We find that, turning the financial channel off, the real GDP cumulative response in Latin America is smaller by half than in the unrestricted model. Responses on nominal exchange rates and EMBI spreads are approximately 10% and 13% smaller, respectively. Again, Chile exhibits different behavior from the region.

An implicit assumption we make in our paper is that companies do not hedge exchange-rate risk. This is a limitation that could be overcome in future works. It would also be important to propose a theoretical model that consideres the effects of commodity prices in EMEs through both the traditional and financial channels. Furthermore, Structural VAR models could be useful to capture contemporaneous relations between variables, which are also observed in the stylized facts.

Appendix A

Figure 6: Commodity Price Index - Latin America

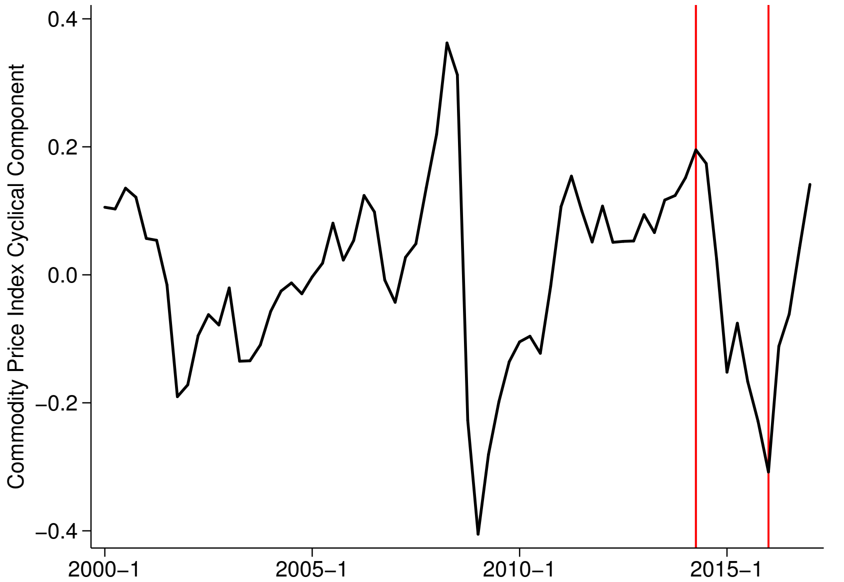


Figure 7: Commodity Price Index - Brazil

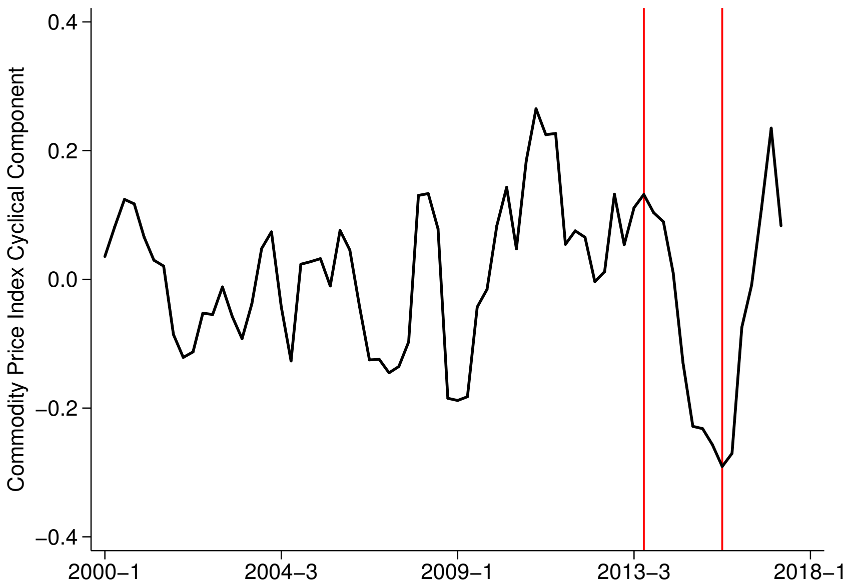


Figure 8: Real Copper Price - Chile

Figure 9: Real Oil Price - Colombia and Mexico

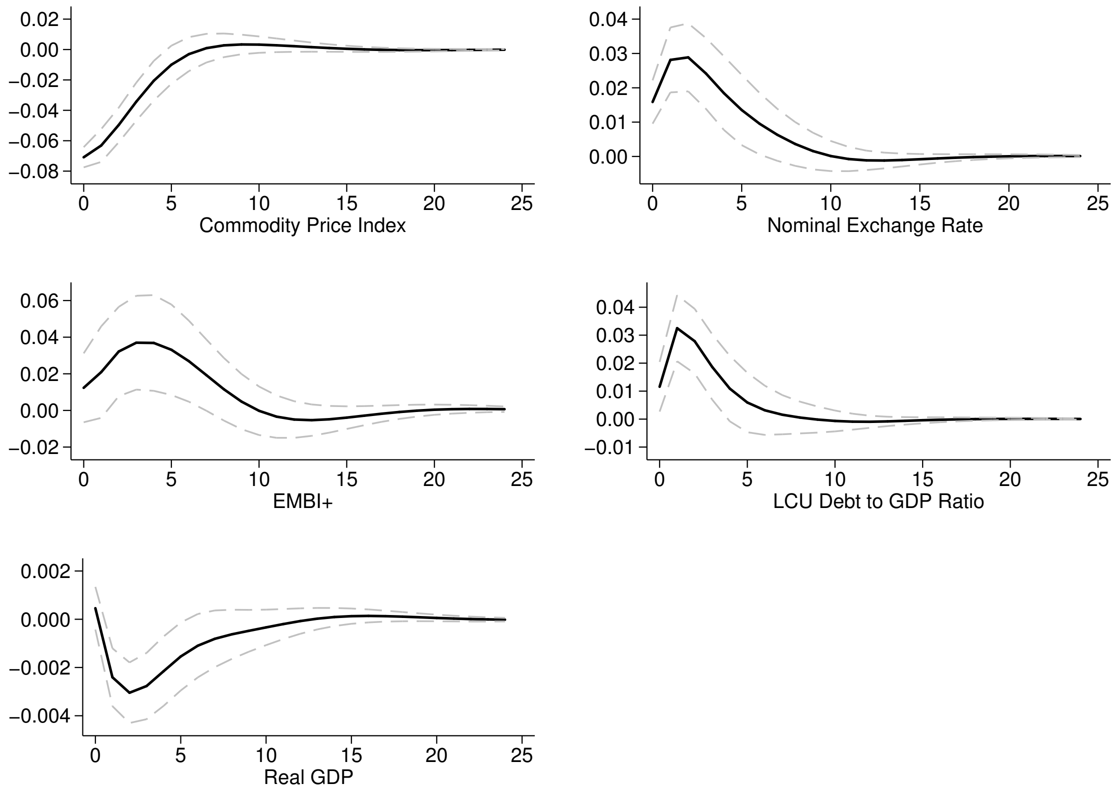
Figure 10: Commodity Price Index - Peru

Appendix B: IRF and FEVD

5.1 Impulse Response Functions

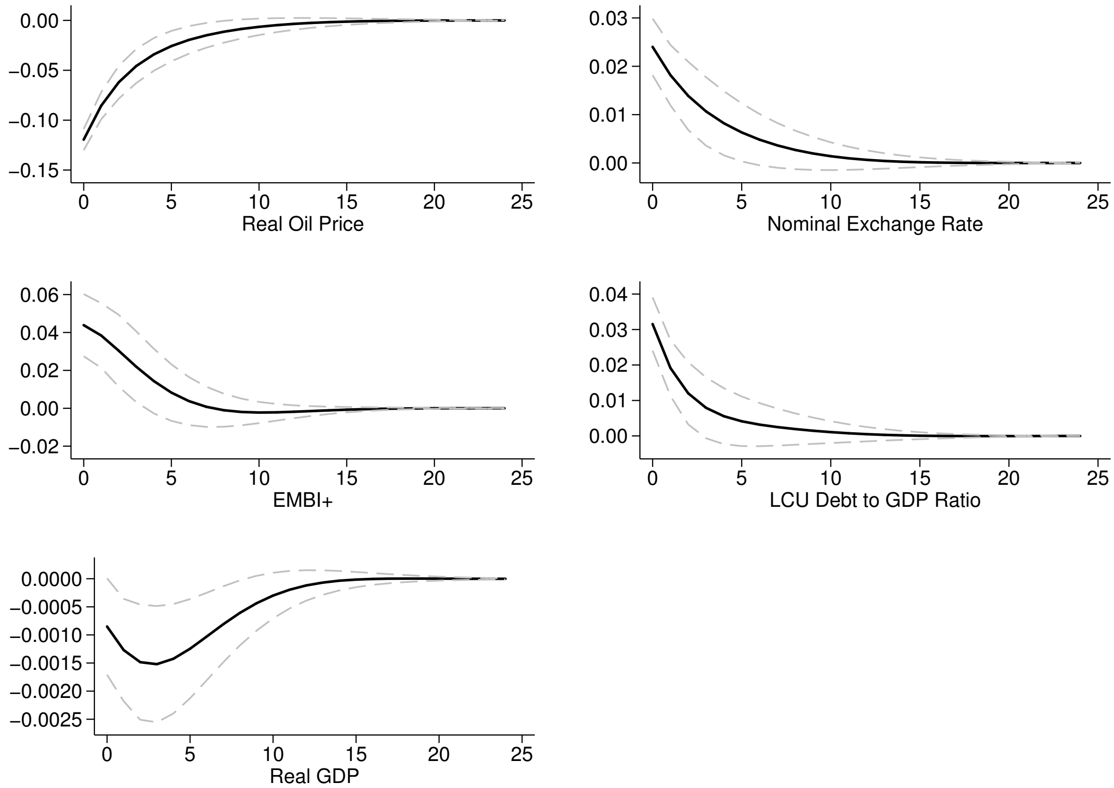
5.1.1 Brazil

Figure 11: Impulse Response Function - One standard deviation shock in commodity price index - 70% confidence intervals



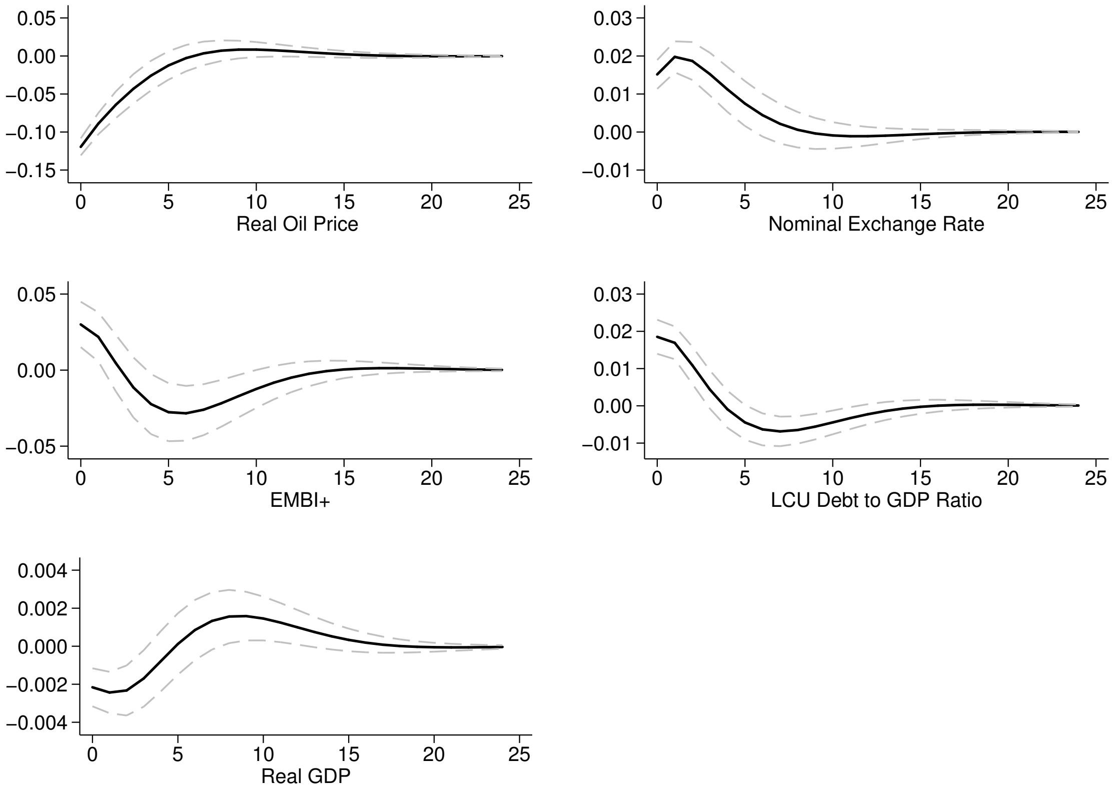
5.1.2 Colombia

Figure 12: Impulse Response Function - One standard deviation shock in real oil price - 70% confidence intervals



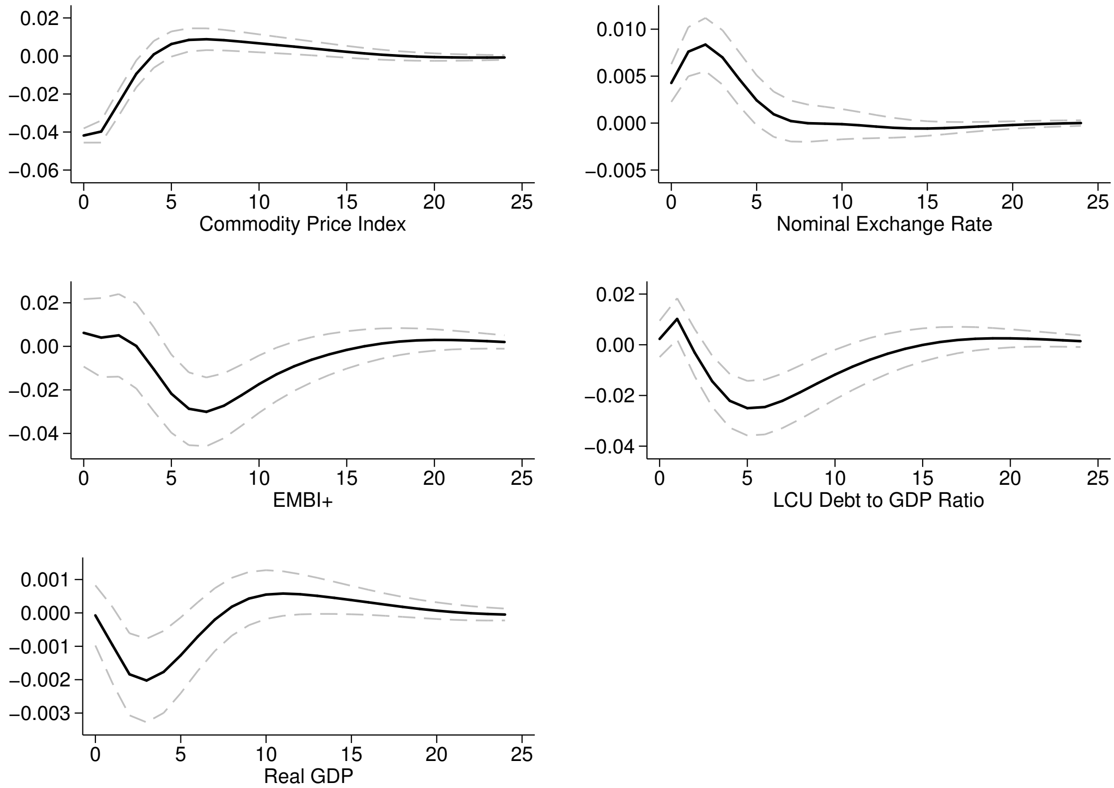
5.1.3 Mexico

Figure 13: Impulse Response Function - One standard deviation shock in real oil price - 70% confidence intervals



5.1.4 Peru

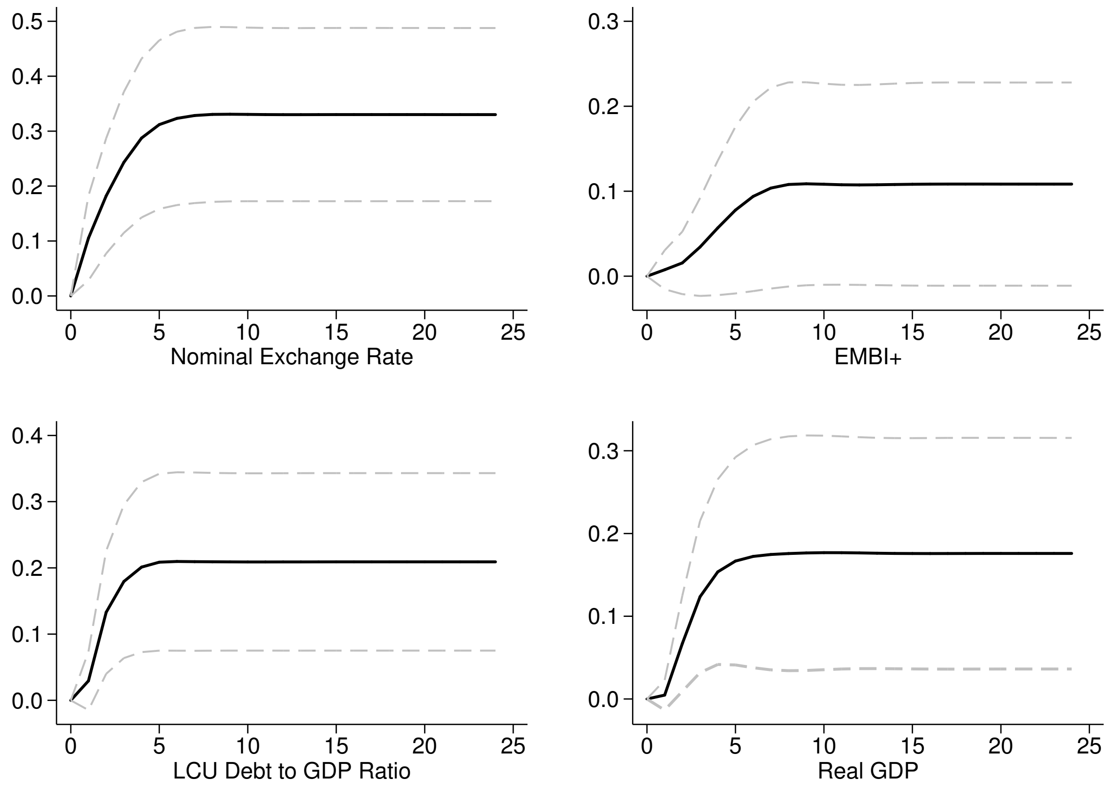
Figure 14: Impulse Response Function - One standard deviation shock in commodity price index - 70% confidence intervals



5.2 Forecast Error Variance Decomposition

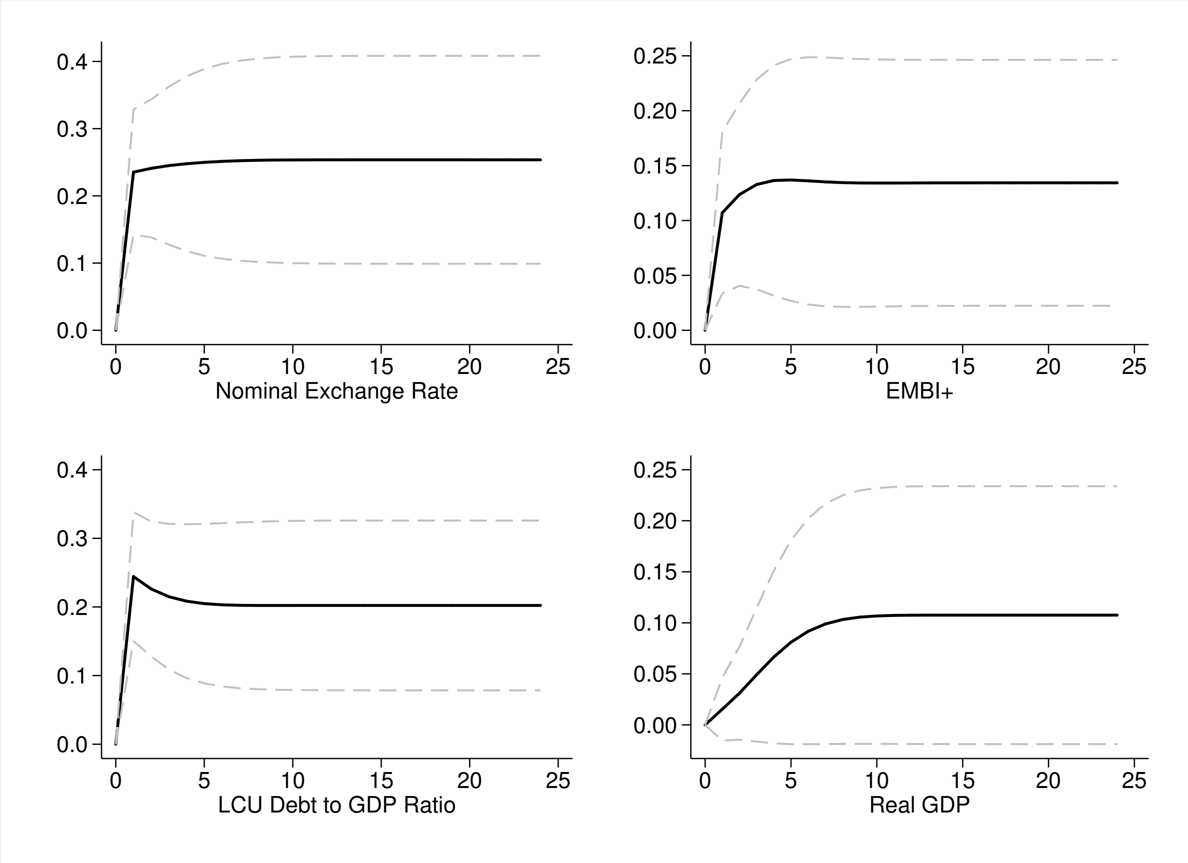
5.2.1 Brazil

Figure 15: Forecast Error Variance Decomposition - 70% confidence intervals



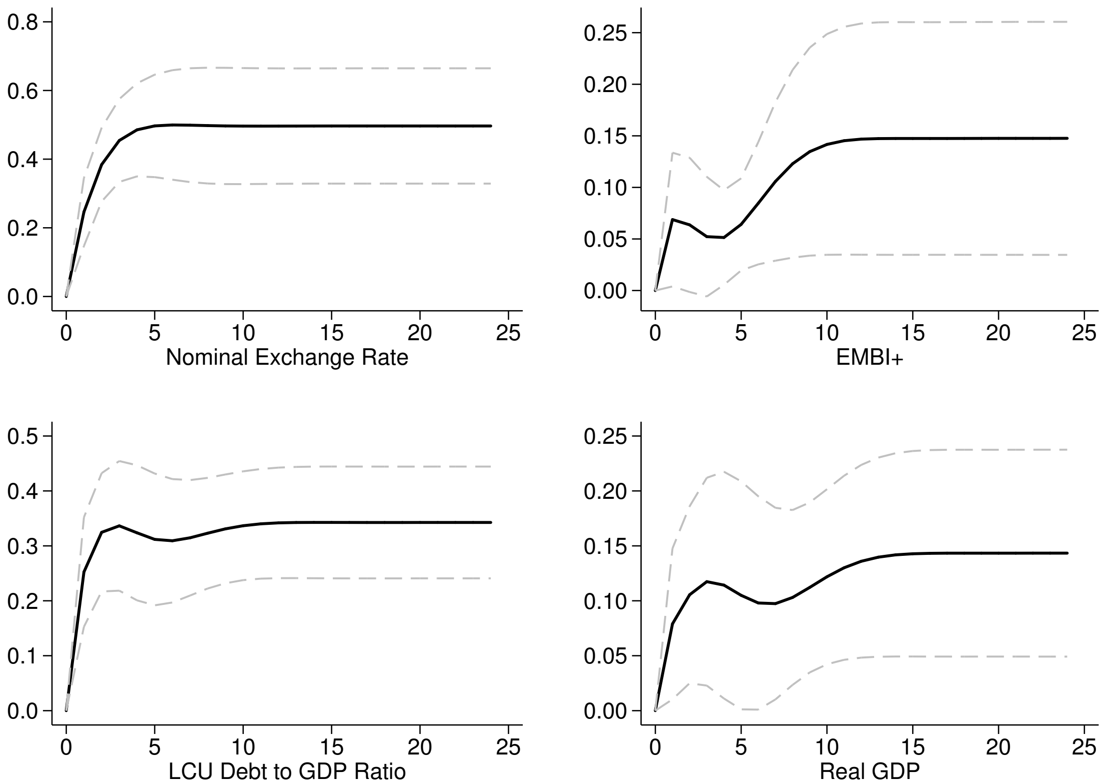
5.2.2 Colombia

Figure 16: Forecast Error Variance Decomposition - 70% confidence intervals



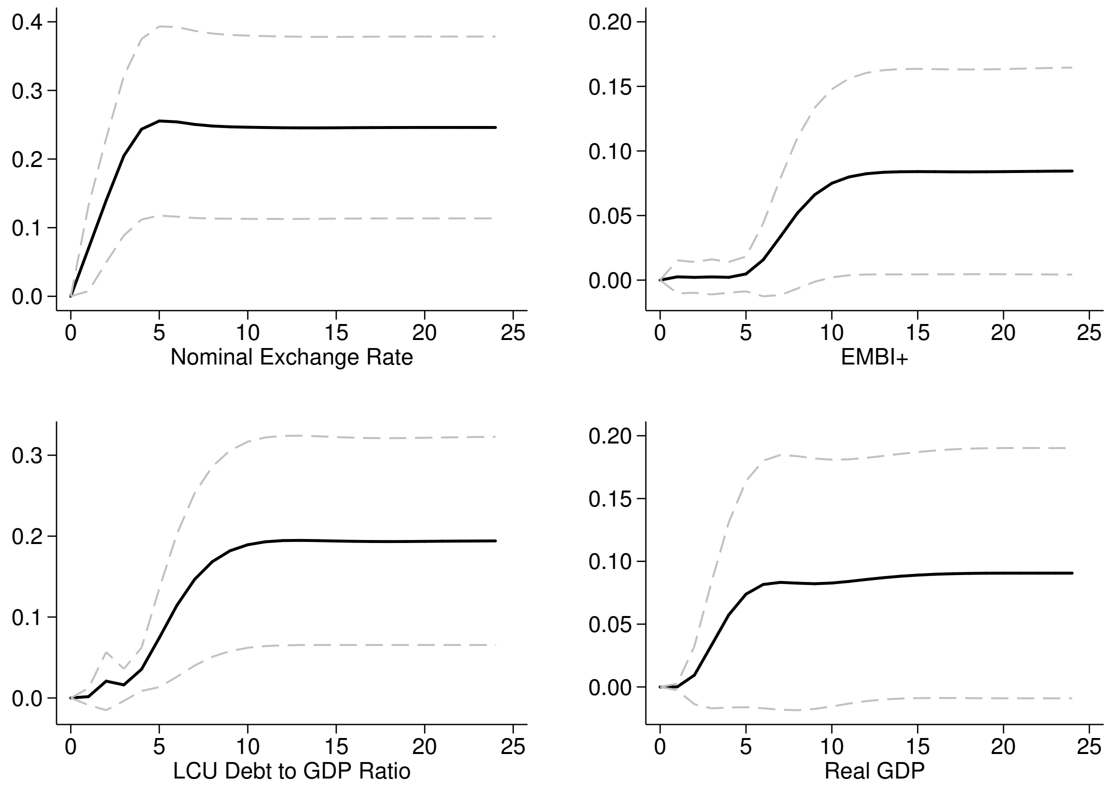
5.2.3 Mexico

Figure 17: Forecast Error Variance Decomposition - 70% confidence intervals



5.2.4 Peru

Figure 18: Forecast Error Variance Decomposition - 70% confidence intervals



Appendix C: Estimated Balance Sheet Effects

Brazil

Table 6: Impulse response function comparison: Unrestricted model vs. Restricted model - Negative shock in commodity price index of 20%

Step	Unrestricted model			Restricted model		
	Nominal Exchange Rate	EMBI Spread	Real GDP	Nominal Exchange Rate	EMBI Spread	Real GDP
0	0.0448	0.0349	0.0013	0.0729	0.0930	0.0016
1	0.0794	0.0591	-0.0068	0.0418	-0.0321	-0.0080
2	0.0815	0.0908	-0.0086	0.0217	0.0041	-0.0089
3	0.0682	0.1044	-0.0078	0.0215	0.0625	-0.0052
4	0.0521	0.1040	-0.0061	0.0246	0.0868	-0.0022
5	0.0382	0.0935	-0.0044	0.0208	0.0770	-0.0010
6	0.0270	0.0759	-0.0031	0.0123	0.0535	-0.0009
Cumulative response	39.11%	46.87%	-3.36%	21.56%	37.29%	-2.22%
Significant periods	0-6	2-6	1-5	0-6	0, 3-6	1-3

Chile

Table 7: Impulse response function comparison: Unrestricted model vs. Restricted model - Negative shock in real copper price of 20%

Step	Unrestricted model			Restricted model		
	Nominal Exchange Rate	EMBI Spread	Real GDP	Nominal Exchange Rate	EMBI Spread	Real GDP
0	0.0490	0.0969	-0.0018	0.0637	0.1026	-0.0041
1	0.0153	0.0569	-0.0057	0.0152	0.0572	-0.0050
2	0.0001	-0.0138	-0.0082	0.0020	-0.0009	-0.0065
3	-0.0008	-0.0626	-0.0080	-0.0008	-0.0465	-0.0060
4	0.0006	-0.0741	-0.0058	0.0001	-0.0618	-0.0042
5	-0.0009	-0.0620	-0.0030	0.0016	-0.0525	-0.0022
6	-0.0041	-0.0465	-0.0007	0.0024	-0.0333	-0.0008
7	-0.0063	-0.0363	0.0006	0.0024	-0.0164	-0.0001
Cumulative response	4.90%	-12.19%	-2.78%	7.89%	-3.43%	-2.80%
Significant periods	0	0, 4-7	1-4	0-1	0-1,3-6	0-5

Colombia

Table 8: Impulse response function comparison: Unrestricted model vs. Restricted model - Negative shock in real oil price of 20%

Step	Unrestricted model			Restricted model		
	Nominal Exchange Rate	EMBI Spread	Real GDP	Nominal Exchange Rate	EMBI Spread	Real GDP
0	0.0402	0.0734	-0.0014	0.0487	0.0888	-0.0014
1	0.0304	0.0643	-0.0021	0.0249	0.0543	-0.0022
2	0.0232	0.0508	-0.0025	0.0127	0.0312	-0.0024
3	0.0179	0.0367	-0.0025	0.0063	0.0151	-0.0022
4	0.0138	0.0240	-0.0024	0.0028	0.0040	-0.0018
5	0.0106	0.0139	-0.0021	0.0010	-0.0028	-0.0014
6	0.0081	0.0063	-0.0017	0.0000	-0.0064	-0.0010
7	0.0061	0.0013	-0.0014	-0.0004	-0.0077	-0.0007
8	0.0045	-0.0017	-0.0010	-0.0006	-0.0075	-0.0004
Cumulative response	13.61%	22.51%	-1.71%	9.25%	17.44%	-1.11%
Significant periods	0-5	0-3	1-8	0-3	0-2	1-6

Mexico

Table 9: Impulse response function comparison: Unrestricted model vs. Restricted model - Negative shock in real oil price of 20%

Step	Unrestricted model			Restricted model		
	Nominal Exchange Rate	EMBI Spread	Real GDP	Nominal Exchange Rate	EMBI Spread	Real GDP
0	0.0254	0.0502	-0.0036	0.0303	0.0600	-0.0046
1	0.0331	0.0366	-0.0041	0.0259	0.0182	-0.0033
2	0.0313	0.0077	-0.0039	0.0202	-0.0096	-0.0021
3	0.0255	-0.0191	-0.0028	0.0151	-0.0256	-0.0011
4	0.0188	-0.0374	-0.0013	0.0110	-0.0328	-0.0002
5	0.0125	-0.0463	0.0002	0.0080	-0.0343	0.0005
6	0.0074	-0.0475	0.0014	0.0059	-0.0324	0.0010
7	0.0036	-0.0435	0.0022	0.0044	-0.0288	0.0012
8	0.0010	-0.0366	0.0026	0.0034	-0.0246	0.0013
9	-0.0006	-0.0285	0.0027	0.0027	-0.0206	0.0013
Cumulative response	14.65%	-15.29%	-1.44%	12.07%	-13.92%	-1.01%
Significant periods	0-5	0-1, 4-9	0-3	0-7	0, 3-9	0-2

Peru

Table 10: Impulse response function comparison: Unrestricted model vs. Restricted model - Negative shock in commodity price index of 20%

Step	Unrestricted model			Restricted model		
	Nominal Exchange Rate	EMBI Spread	Real GDP	Nominal Exchange Rate	EMBI Spread	Real GDP
0	0.0464	0.0112	0.0023	0.0843	0.0740	0.0027
1	0.0815	0.0212	-0.0056	0.0478	-0.0477	-0.0075
2	0.0850	0.0321	-0.0081	0.0281	-0.0226	-0.0084
3	0.0735	0.0391	-0.0088	0.0261	0.0078	-0.0063
4	0.0586	0.0394	-0.0079	0.0248	0.0149	-0.0038
5	0.0453	0.0335	-0.0063	0.0188	0.0073	-0.0019
6	0.0338	0.0231	-0.0045	0.0110	-0.0009	-0.0007
Cumulative response	42.41%	NA	-4.12%	24.09%	7.40%	-2.59%
Significant periods	0-6	None	1-6	0-6	0	1-4

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