Commodity Prices Shocks and the Balance Sheet Effect in Latin America

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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 firm's external debt dynamics are related to commodity prices. 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 half smaller than in the unrestricted model. We find no evidence on the existence of the balance sheet effect for Chile.

I Introduction

Latin American economies, to different extent, are characterized for being strongly dependent on their natural resources endowment. Their export basket is mainly composed by commodities such as oil, hydrocarbon, minerals and some agricultural raw materials. Although commodities' share on total exports has reduced from the 1970s decade, it remains relatively large compared to other regions (Sinnott et al., 2010).

This commodity dependence implies that Latin American countries are subject to world's commodities prices dynamics, leaving them exposed to their volatility. Being determined by supply and demand interaction, commodities prices tend to be highly variable, which could affect not only the primary sector but its effects spread to the entire economy. As a matter of fact, Mendoza (1995), and more recently, Vegh et al. (2017) state that commodity prices can be

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a potential cause for business cycles in developing economies.

This dependency was specially clear in the middle of the last commodity prices boom, that started in the early 2000*s* and finished approximately in 2014[1], and allowed some Latin American countries to benefite from this boom. In fact, average economic growth in Brazil, Chile, Colombia, Mexico and Peru, in period $2002-2013$ was 4.60%. With the end of the boom came a reduction in average growth rate in this same group: 1.72% between 2014 and 2016.

What can be expected when commodity prices fall? Knowing that commodity-exporting economies tend to attract foreign investment in their primary sector, an effect of volatility in commodity prices is that it may induce variability in nominal exchange rate related to capital flows (Reinhart et al., 2016). Particularly, when commodity prices decrease so does profitability in that sector, which may induce a nominal exchange rate depreciation.

Conventional textbook wisdom highlights the advantages of devaluations, arguing that they stimulate economic growth through an increase in exports and, since imported goods are relatively more expensive, consumers tend substitute them for locally produced goods[2], which also enhances domestic demand. Nevertheless, this is not the whole story and there are other effects of exchange rate increases.

An under-studied impact of depreciations is the one related to balance sheets of companies and governments that possess debt denominated in foreign currency (Céspedes et al., 2004). In this context, depreciation in exchange rates raises the local currency value of companies' total owing balance overnight, forcing them to make higher efforts to meet debt-service payments. This **value effect** implies that investment decisions inside companies might be disturbed, having undesirable effects for the firm, in particular, and the aggregate economic activity overall. As authors explain, the currency mismatch between revenues and liabilities can cause depreciation to be contractionary instead of expansionary, as the conventional wisdom states.

In this sense, balance sheet effects constitute a sort of financial accelerator that can deepen business cycles and increase their volatility. Anytime commodity prices rise, the increased foreign indebtedness may lead to an even higher expansion in output. In contrast, when these prices fall, balance sheet effects might accentuate the bust through the aforementioned investment reductions.

[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.

At the same time, there is another consequence of variability in commodity prices. Considering that interest rate risk premium in commodity-exporting economies may be strongly related to commodity prices, it follows their volatility also affects the borrowing cost (interest rate spread) faced by entrepreneurs in such countries (Malone, 2009). Since a decrease in commodity prices lowers profitability in these sectors and the entire economy is perceived as less attractive, this may end up increasing the interest rate spread, due to a higher default probability: the increased cost of borrowing ultimately hinders new debt acquisition by entrepreneurs. This can be thought of as a **quantity effect.**

Now, bearing all this in mind, it makes sense to explore the effects that commodity prices shocks have on entrepreneurs' balance sheets. It is important to highlight that enterprises do not need to be on the primary sector to be affected by the aforementioned shocks through the nominal exchange rate fluctuations. This issue can be approached following Céspedes et al. (2004), whom develop a theoretical model where risk premium is a function of entrepreneurs' value of investment relative to net worth. Gertler et al. (2007) also constitute a relevant reference to answer our question, since they use a model similar to the one in Céspedes et al. (2004) to explain the Korean crisis.

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

All of the above displays an interesting research question to be answered in this paper. So our main goal is to provide a different, sometimes ignored, cause for business cycles in developing countries. We aim to untangle the linkage between the last commodity prices boom (period $2002 - 2014$) and the existence of balance sheet effects in Latin America and five particular economies: Brazil, Chile, Colombia, Mexico and Peru.

To achieve our goal, we estimate a serie of VAR models, with a conceptual framework provided by Céspedes et al. (2004), using quarterly data of commodity prices, nominal exchange rate, EMBI spreads, external debt and real GDP data. One finding is that balance sheets are important business cycles drivers in the region. Particularly, half of the output contraction is due to firm's debt dynamics. Also, the behavior of Brazil, Colombia, Mexico and Peru is well represented by the region.

[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.

Another finding is that Chilean economy is significantly different from its counterparts and the region. For this economy, real copper price seems not to be a key business cycle driver and balance sheet effect is actually negligible. We believe this result is explained by Chilean 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.

II Commodity Prices, Interest Rates and Balance Sheet Effects

There is a vast economic literature[4] exposing the connection between commodity prices (or terms of trade) and real GDP cycles in EMEs, considering mainly real and commercial channels. Fernández et al. (2017a) model explicitly the transmission mechanisms of commodity prices shocks to the real sector, through their effects on domestic goods demand, using a dynamic stochastic equilibrium model. Two stylized facts found by authors is that commodity prices have a strong comovement with other macroeconomic variables. As a matter of fact, they find that commodity prices are procyclical and leading to output, investment and consumption. Moreover, authors also find that commodity prices are countercyclical to real exchange rates and external risk premium.

The model considers an endowment commodity sector that faces fluctuations on its international price, which it is taken as given by households. The model has four agents: households, firms (domestic good producers), investment good producers and the rest of the world. Foreign and home goods are used as inputs in investment goods production and are also imperfect substitutes in the consumption. Households offer labor services in the labor market and they own commodity endowment, receiving commodity revenues. 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. These two variables are considered exogenous and stochastic, being other business cycle forces. Additionally, authors propose that commodity prices are composed by a latent common factor and idiosyncratic shocks. In the model, the only source of fluctuations in commodity prices is related to shocks to the common factor. Equation 1 presents the log-linearized version of market clearing condition, which allows to

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

decompose 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 increment their capital demand and hence, its rental rate. On the other hand, demand for new investment goods also increases, and so does its price. Altogether, this constitutes a greater expansion in 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. This way, home goods become relative more expensive, which detriments its demand from foreigners.

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

As a final remark regarding to Fernández et al. (2017a) model, 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.

[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.

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

In this context, 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 rates 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 equalize the expected return on 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 the financial contract enforcement. Now, in equilibrium, 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. What is interesting in equation 3 is that, given real income, Y_t, and contemporaneous risk premium, a real devaluation impacts negatively entrepreneur's net worth because it increases the burden of interest payments associated to inherited debt.

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):

$$1+\eta_{t+1} = F\left(\frac{Q_tK_{t+1}}{P_tN_t}\right), \;\; F(1)=1, \;\; F'(\cdot)>0 \tag{4}$$

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 possess debt denominated in foreign currency: whenever exchange rate depreciates, the local currency value increases and so does interest payments. If the firm obtains revenues in local currency, automatically it has to make a higher effort to repay its debt, forcing it to reduce investment and hence, production.

[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)

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

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

The financial accelerator mechanism proposed by 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:

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

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

On the production side, entrepreneurs are the key players. To carry out production, they must finance their capital demand through their own net worth of 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 interest rate entrepreneurs must pay. This is the financial accelerator mechanism.

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

Although initially authors consider the case when these bonds are 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 bigger 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 in terms of the output contraction, in contrast to the fixed exchange rate regime. This means that the financial accelerator mechanism is actually more detrimental in currency mismatch contexts.

We have seen that, on the one hand, commodity prices shocks are connected to output cycles but that mainstream economic literature tends to leave the financial channel outside. On the other hand, the balance sheet effect has been studied under frameworks considering interest rates disturbances, leaving commodity prices shocks outside. Given this, we propose that a negative shock in commodity price has the same effects as a positive shock in world 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 cover the risk of unexpected exchange rate fluctuations, which will provide the 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 its instruments is limited.

III Data and Some Stylized Facts

Data

Firstly, we consider Latin America and then, we focuse on Brazil, Chile, Colombia, Mexico and Peru, because these are commodity net exporters (Sinnott et al., 2010). We exclude Ecuador and

Panama because these are dollarized economies and Venezuela because of the political instability that characterizes this economy. Uruguay and Bolivia are excluded for data availability. Central American countries are too small to be considered and, as stated by Sinnott et al. (2010), these are commodity net importer 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 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 from each country's Central Bank. Besides, we construct the local currency value of external debt as the product between nominal exchange rate and dollar debt for each country. EMBI spreads data, used as a risk premium proxy, 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 become 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 in 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 an added Argentina and Paraguay. These seven countries represent an important proportion of the entire Latin American GDP[8]. External debt in dollars is added straightforward for every economy since it is all expressed in the same currency. Now, given that CEPAL reports quarterly national accounts information only in local currency, it was transformed into dollars. We did this transformation multiplying real GDP in a base period ($2011Q4$) by nominal exchange rate in the same period. Then, to actually obtain a GDP in constant base period dollars, we calculated it using growth rates of real GDP in local currency units.

Nominal exchange rate index (in the Latin American case) is computed as a weighted average of country-specific indexes. Here, again, base period was $2011Q4$. 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. Latin Ameri-

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

can EMBI is calculated by JP Morgan, 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 exhibits quarterly GDP growth rates, where Colombia and Chile are remarkably higher than their counterparts and the region. Column 5 shows commodity prices growth, *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%

Stylized Facts

We present some empirical regularities analysis for Brazil, Chile, Colombia, Mexico and Peru compared to Latin American region. Latin American data is constructed aggregating information on output, non-financial private sector external debt, nominal exchange rate and EMBI for our five economies plus Argentina and Paraguay.

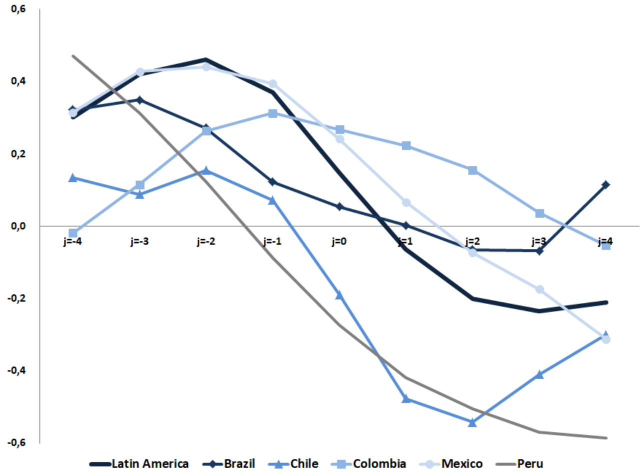
Figure 1 presents the calculated correlation coefficients[9] for our five EMEs and the region. These correspond to the correlation between cyclical components of every variable in period t and the commodity price in period $t + j$ with $j = -4, -3, -2, -1, 0, 1, 2, 3, 4$. Regarding dollar debt (panel a), in Brazil, Colombia and Mexico the commodity-relevant price 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.

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

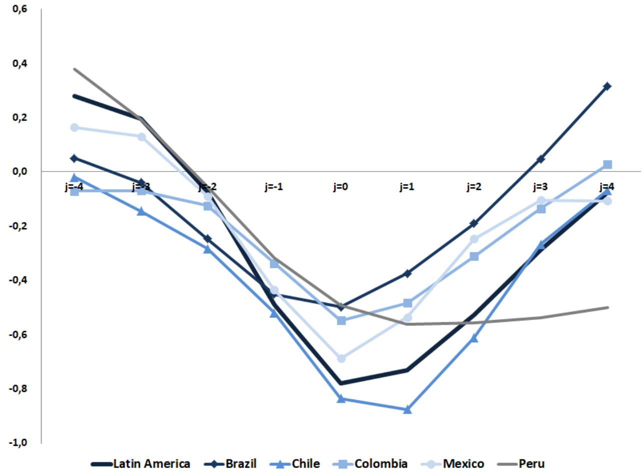
Now, the commodity price is countercyclical and contemporary to LCU debt to GDP ratio (panel b). This is the case in Brazil, Colombia, Mexico and the region. This contrasts with the Chilean and Peruvian case, where this variable is lagged. A strong finding in this paper is the countercyclical and contemporary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

Regarding to EMBI spreads, our risk premium proxy, it is found that commodity price is countercyclical and has a one period lag (panel d). This is true for all economies and the region, excepting 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 idea of the existence of a balance sheet effect caused by commodity price volatility both in the region and the five economies individually.

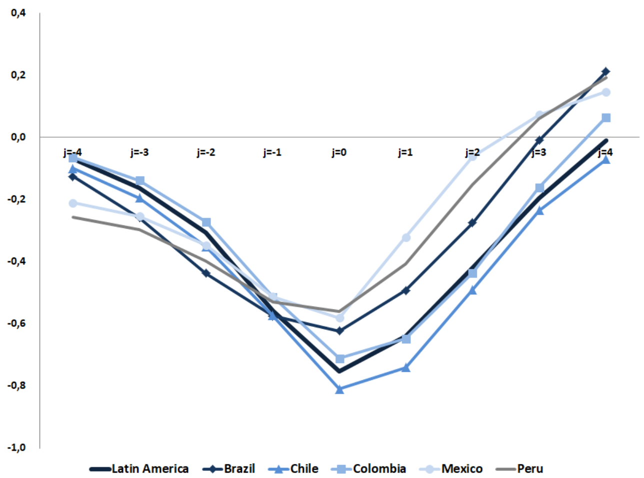
Figure 1: Correlation coefficients - Cyclical components - Latin America and five EMEs



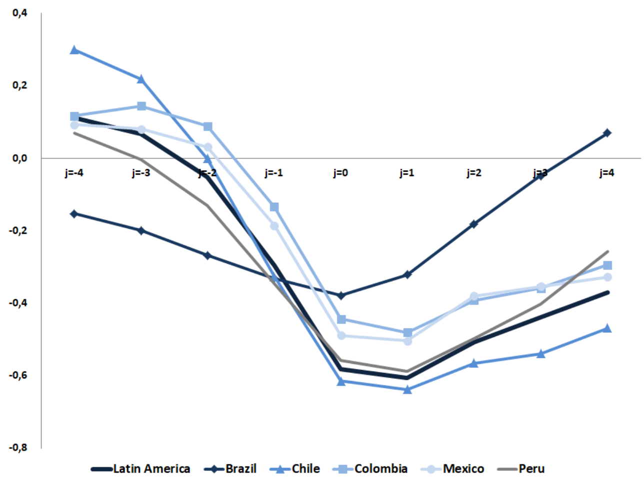
(a) External Debt (USD)



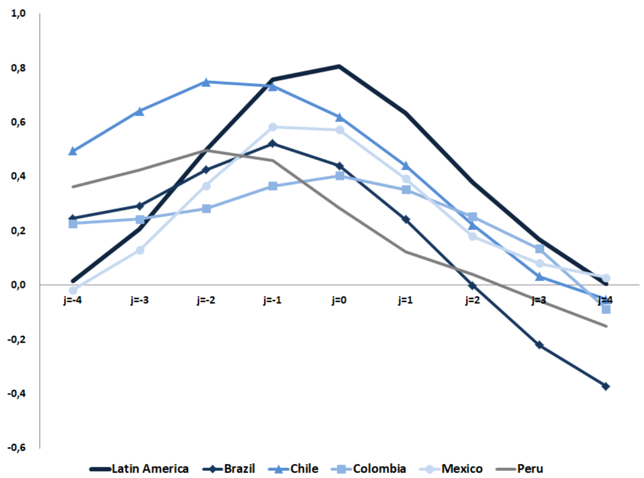
(b) LCU External Debt to GDP ratio



(c) Nominal Exchange Rate



(d) EMBI



(e) Real GDP

IV Methodology and Estimation Results

In 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 smooth parameter[10]. 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: commodity prices index, nominal exchange rate, EMBI, 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 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[11]. IRF and FEVD are presented only for Latin America and Chile. Brazil, Colombia, Mexico and Peru emulate the qualitative behavior of the region, while Chile is noticeably different.

Latin America

The Latin America model is estimated with two lags. Figure 2 presents the impulse response function to a one standard deviation negative shock in commodity price index cyclical component. 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. This 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. In 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[12] These calculations are presented in table 2.

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

[11]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 influencial paper.

[12]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

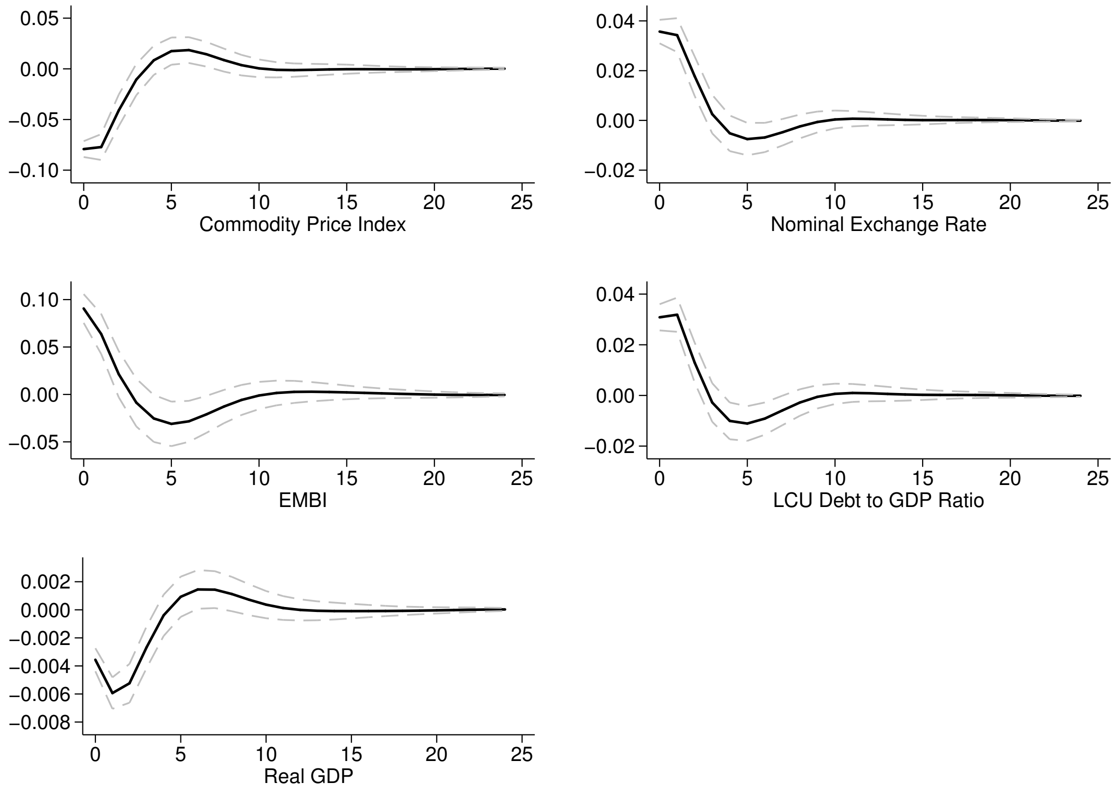
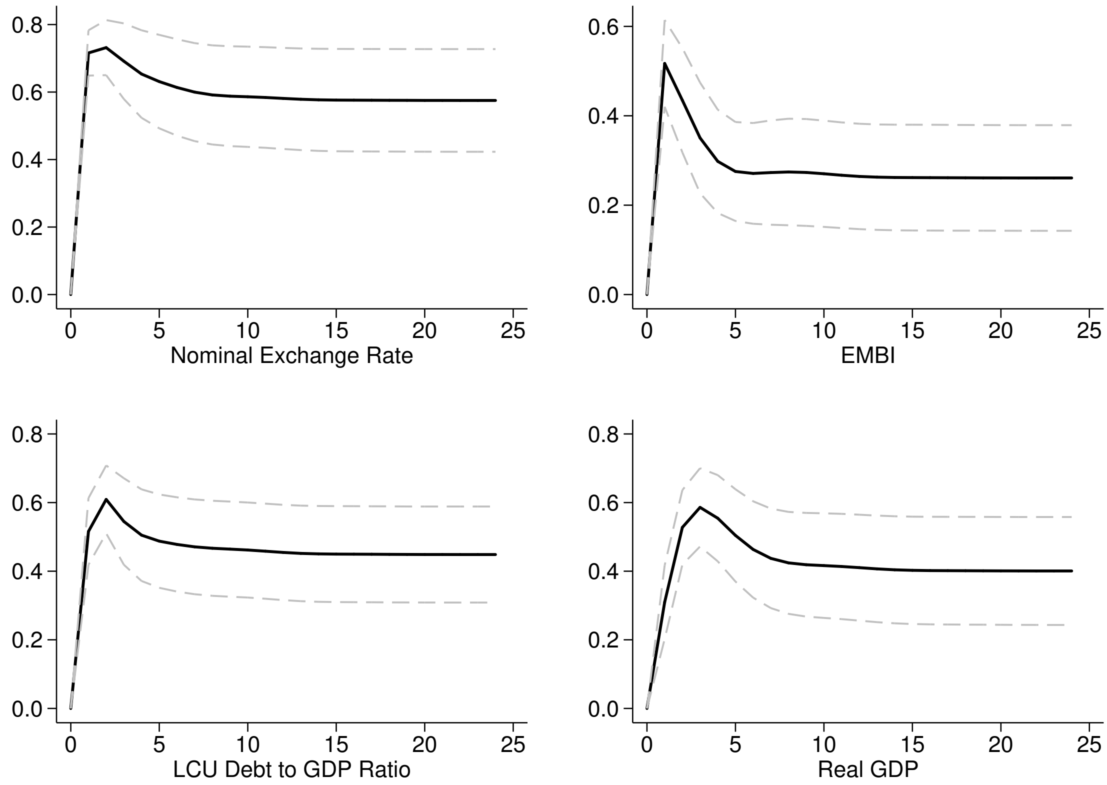


Table 2: Cumulative responses - Impulse Response Function to a 2.5 standard deviation negative shock in commodity price index.

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 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 in 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 nominal exchange rate is due to commodity price shocks. This proportion is approximately 30% for EMBI spread. Regarding to LCU Debt to GDP ratio and real GDP errors, it is clear that commodity price shocks explain roughly 40% of them.

According to these results, we conclude that commodity prices shocks do play an important role explaining the dynamics of the economic variables included, both in the region and the five EMEs, excepting Chile. It is particularly interesting that external debt do 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. The idea is to have a sort of 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 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 deepen 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 associated to the underlying financial accelerator. The intuition is that 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. Here, again, we can 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 can not 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 balance sheet effect does exist and it plays an important role deepening business cycles associated to commodity prices 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 IV[13]. Since we are considering shocks of the same magnitude, these results are comparable. Brazil appears to be the most vulnerable economy to commodity prices disturbances: it has the highest increases on exchange rate and risk premium, while having the deepest GDP contraction. Disconcert-

[13]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.

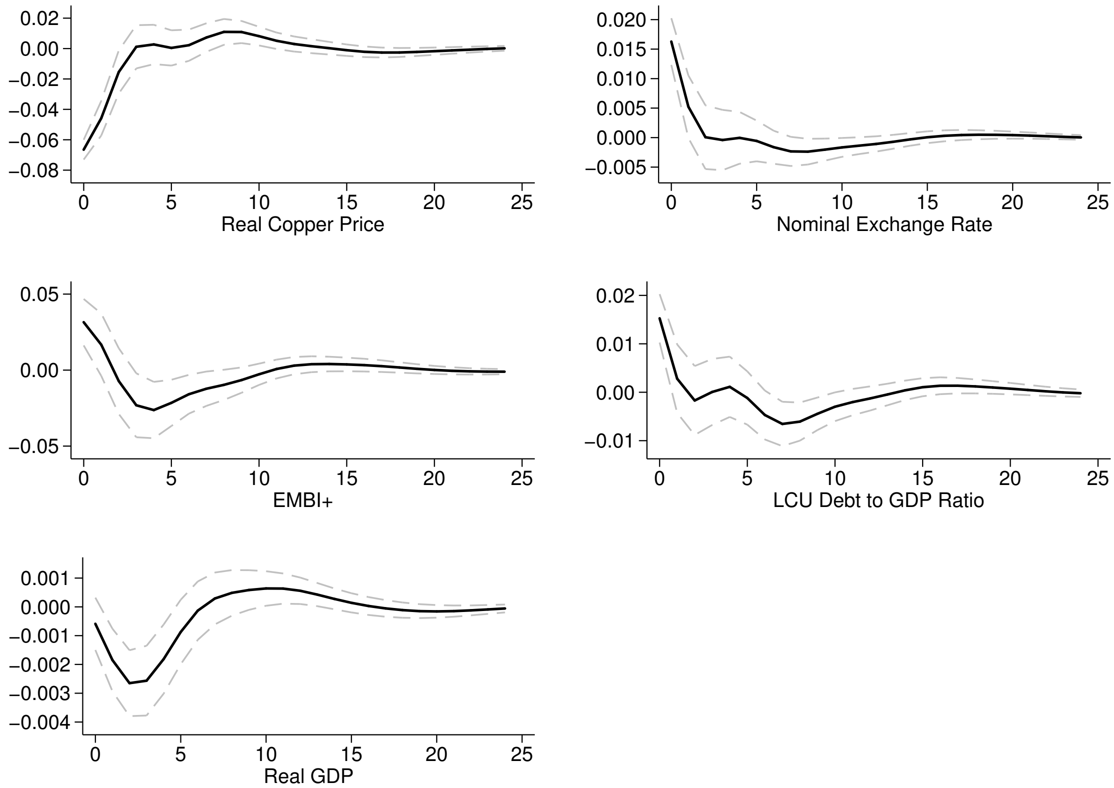
Table 4: Cumulative responses and Forecast Error Variance Decomposition - A one standard deviation negative shock in country-specific commodity price.

		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%

Chile

In the Chilean case, we run the model using real copper price, deflated using US consumer price index. In this case, we estimate equation 7 with $p = 2$. The impulse response function to a negative one standard deviation shock in real copper price is displayed in figure 4. Qualitative behavior of endogenous variables is the same as in the region. Significance of these responses covers, at best, four quarters after the shock. For instance, the effect in nominal exchange rate, EMBI+ 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 in Appendix A, the last copper price fall, between periods 2014*Q*3 and 2016*Q*1 was not so prominent. In fact, from boom to bust, the copper price variated 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 nominal exchange rate, EMBI+ 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 attributable to the institutional structure characterizing this economy, that have allowed it to accomplish a good credibility and reputation in the international markets. Besides, the existence of the economic and social stabilization fund (ESSF) may help to cushion the economy from the effects of copper price volatility and hence, soften business cycles caused by it. In fact, as explained by Solimano and Calderón (2017), the role of the fund in dampening the effects of international copper price volatility on Chilean economy, also brings stability to fiscal budget and policy.

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

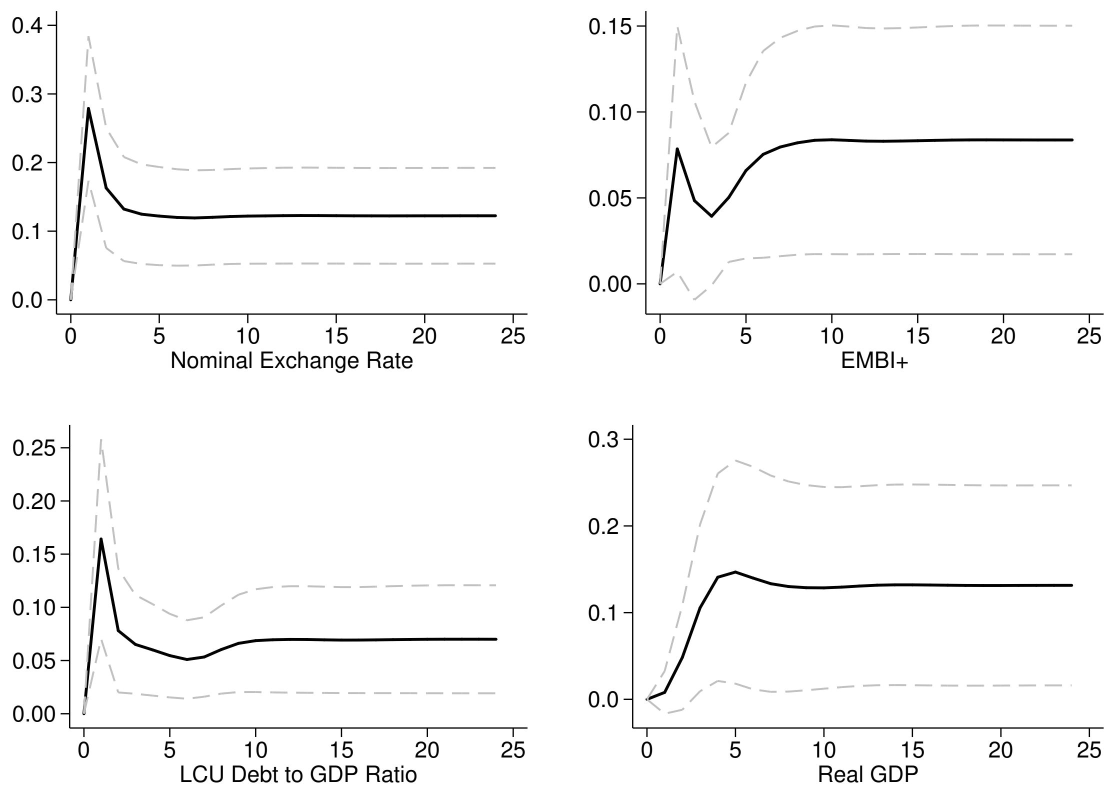


Figure 5 exhibits the forecast error variance decomposition for the Chilean case. According to it, around 10% in nominal exchange rate and real GDP error variance is associated with copper price shocks. The fraction of the error variance of both EMBI+ and LCU debt to GDP ratio explained by copper price innovations is below 10%. These are, again, timid 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.

V Conclusions

Emerging market economies, particularly the commodity exporter ones, are exposed to world's 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 behind 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. This effect is approached in economic literature as being related to 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 hence, production when depreciation in exchange rate takes place.

Our hypothesis is that firm's 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 balance sheet effect acts a sort of financial accelerator that, when commodity prices are high exaggerates output's expansion (through the increased investment), but when commodity's conditions are adverse, deepenes output's contraction.

To test our hypothesis, we estimate a series of VAR models using data from Latin America and then, we focus on five particular economies: Brazil, Chile, Colombia, Mexico and Peru. We use corporate external debt, nominal exchange rate, 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 emulate the observed qualitative behavior in the region. All variables comove as expected with commodity-relevant price measures, i.e., nominal exchange rate, EMBI spread and the debt ratio are countercyclical, while real GDP is procyclical. Chile constitutes a remarkable exception from its counterparts, where 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 try to answer how would the variables in the system respond 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 and they exacerbate the output's 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 half smaller than in the unrestricted model. Nominal exchange rate and EMBI spread are approximately 10% and 13% smaller, respectively. Again, Chile exhibits a different behavior from the region.

An implicit assumption we make in our paper is that companies do not cover from 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

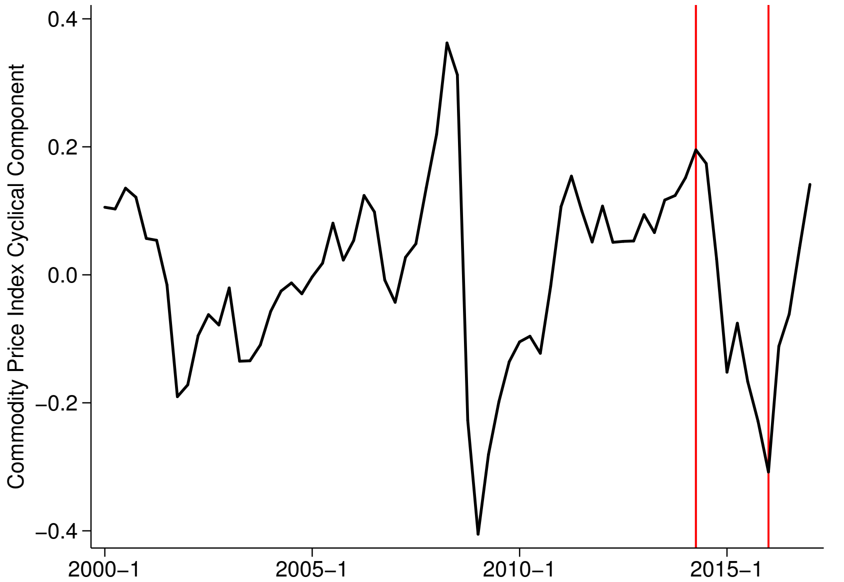


Figure 7: Commodity Price Index - Brazil

Figure 8: Real Copper Price - Chile

Figure 9: Real Oil Price - Colombia and Mexico

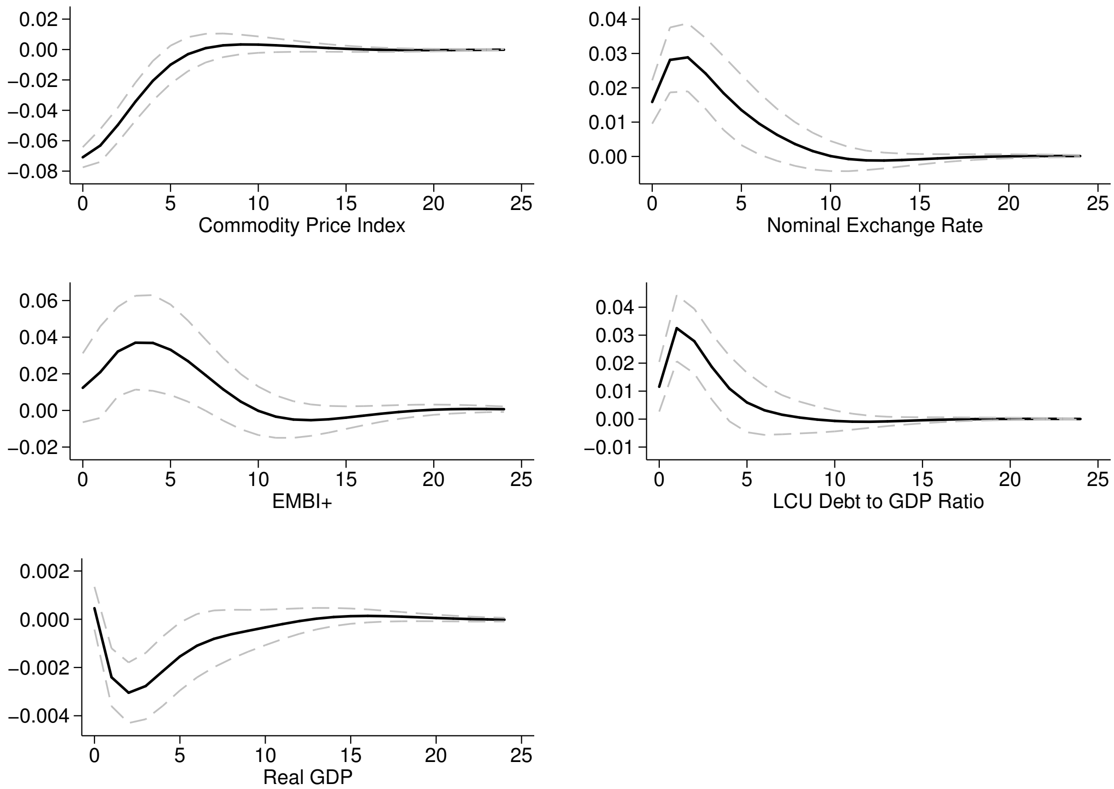
Figure 10: Commodity Price Index - Peru

Appendix B: IRF and FEVD

I Impulse Response Functions

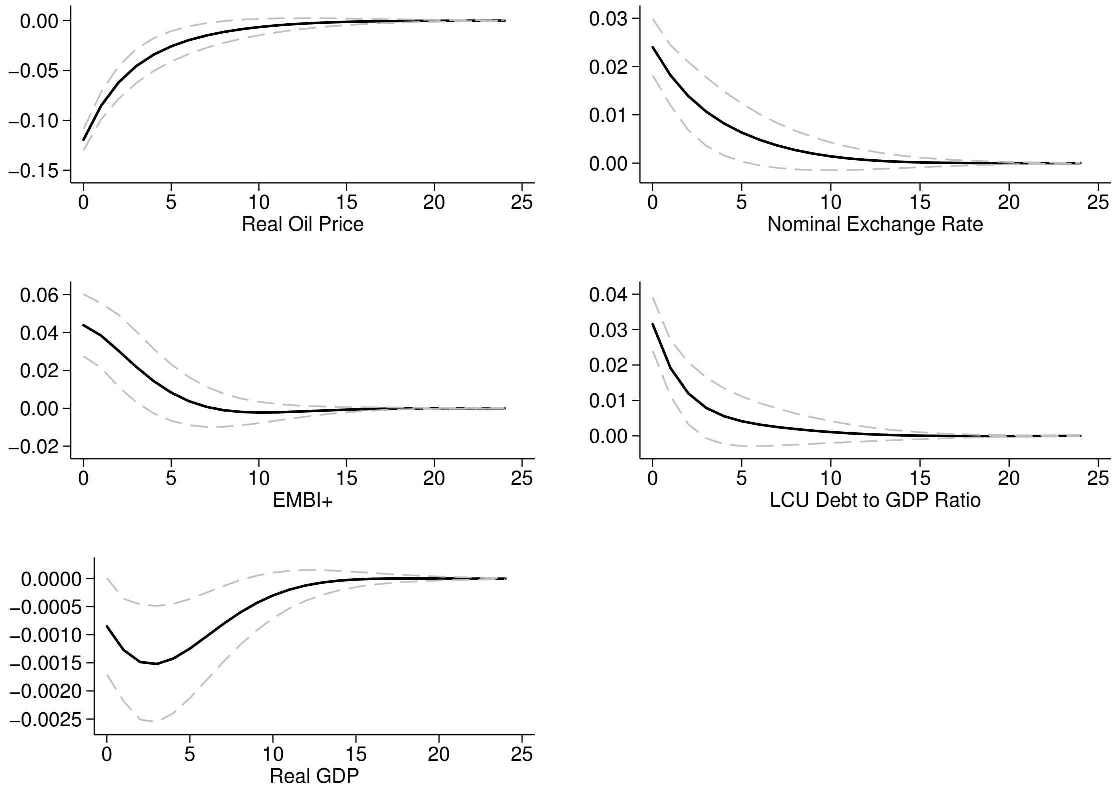
I.1 Brazil

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



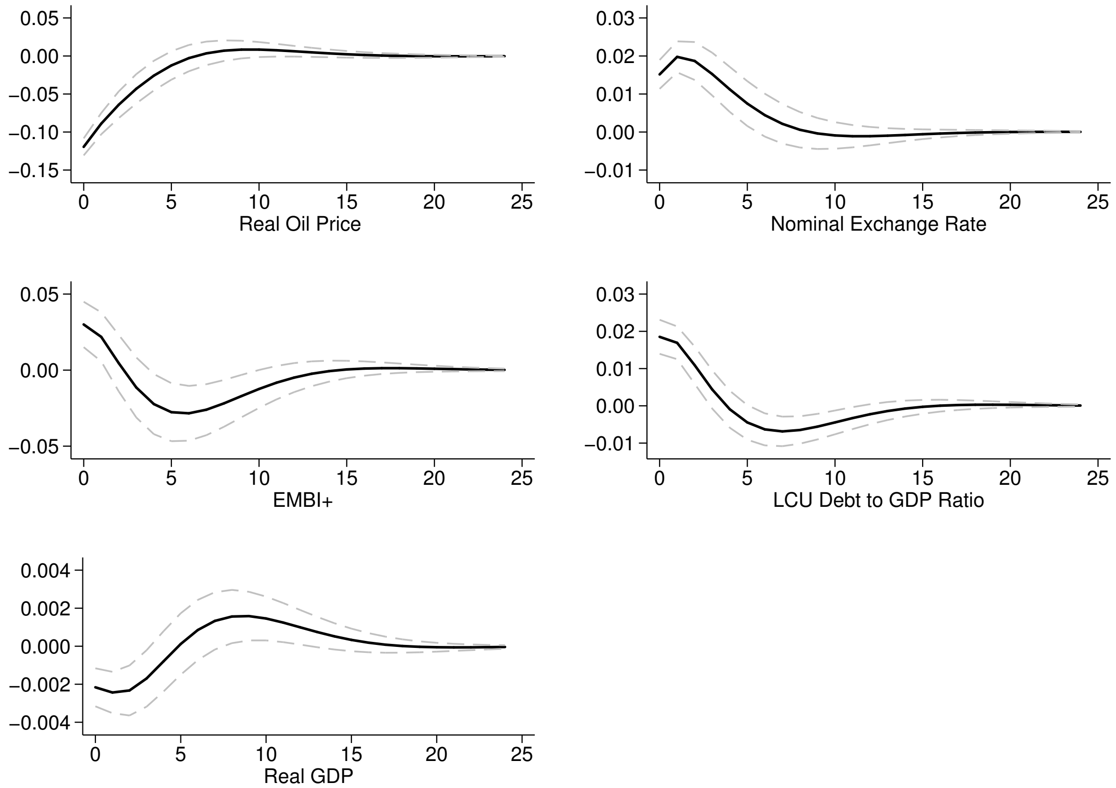
I.2 Colombia

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



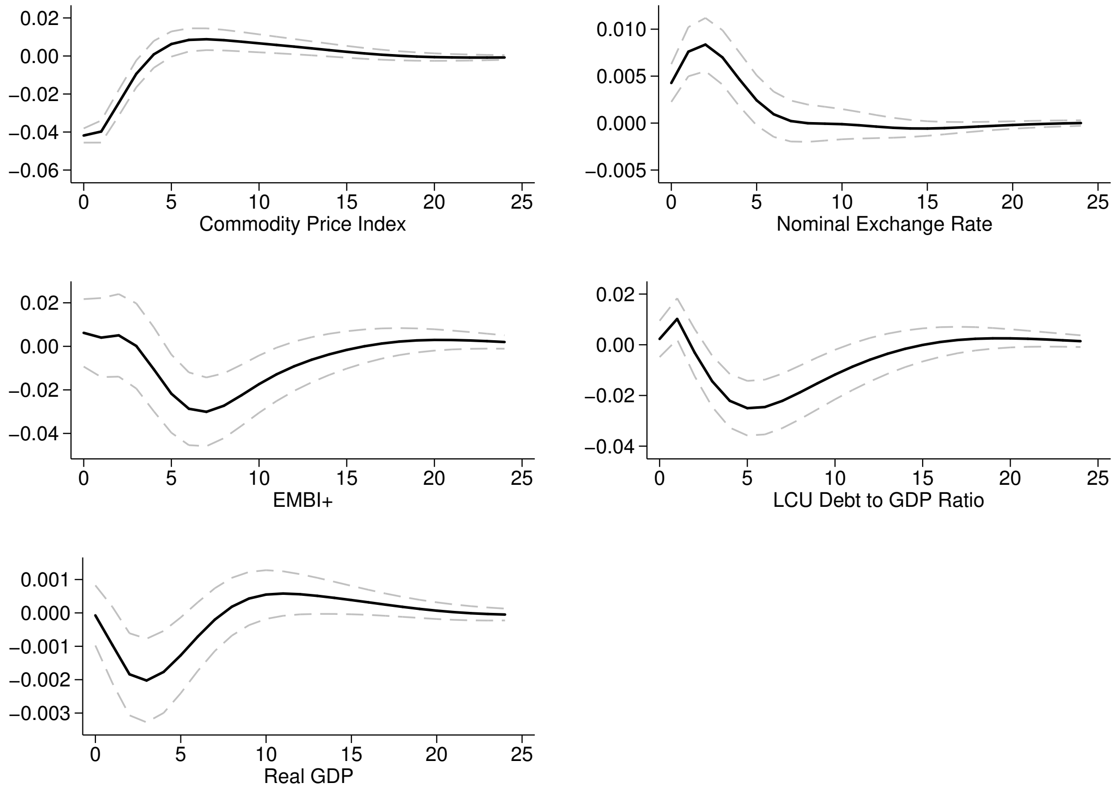
I.3 Mexico

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



I.4 Peru

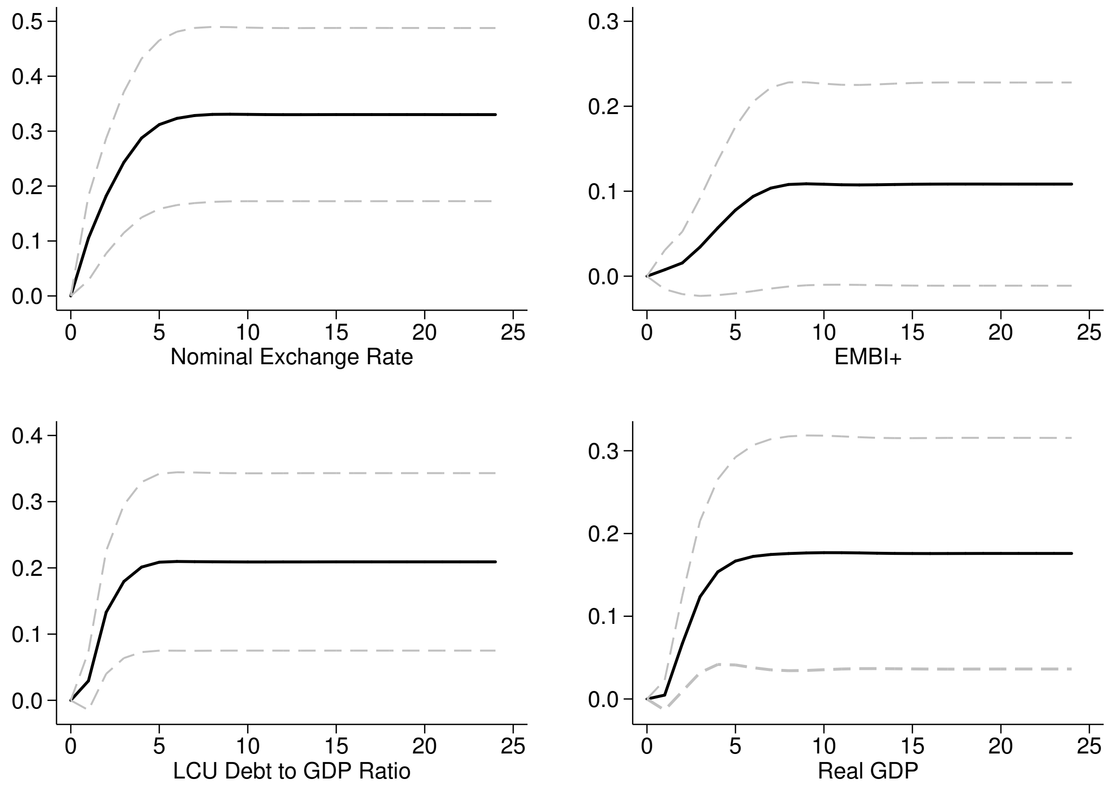
Figure 14: Impulse Response Function - One standard deviation shock in commodity price index - 70% confidence intervals



II Forecast Error Variance Decomposition

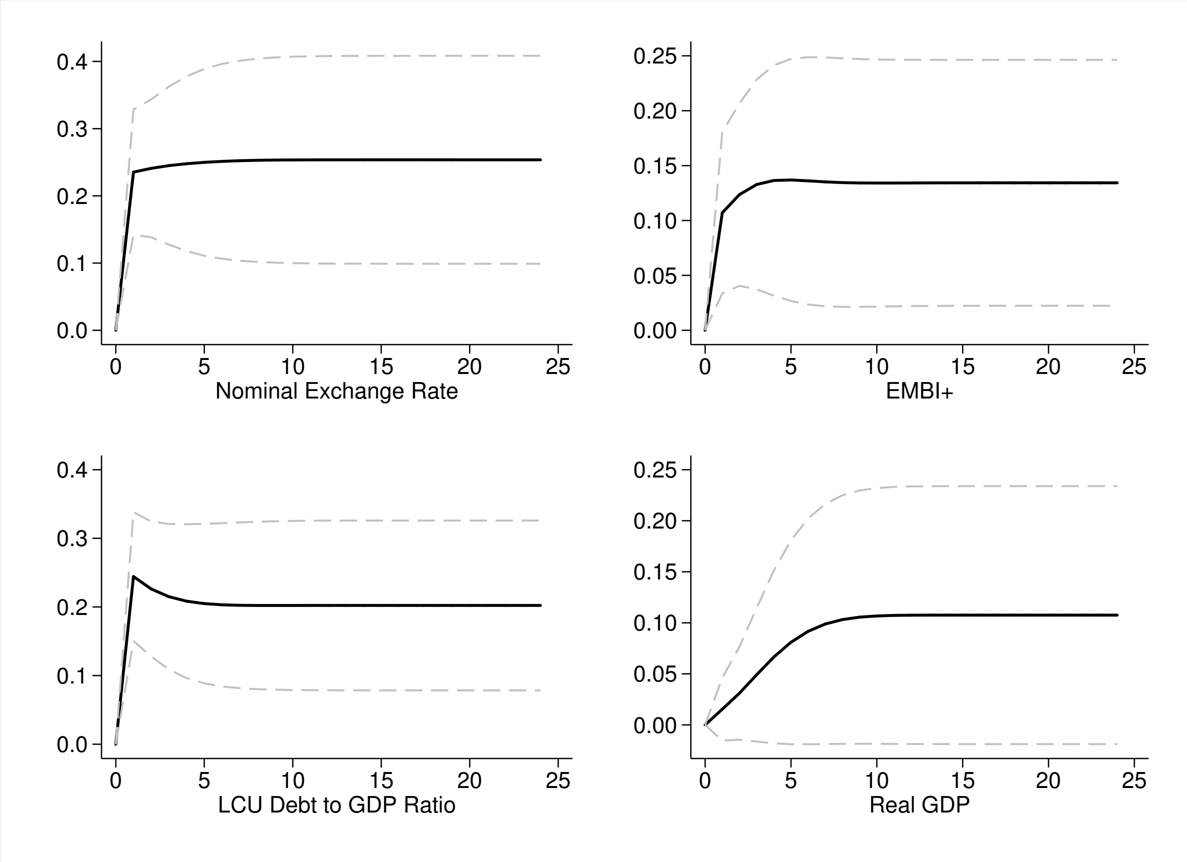
II.1 Brazil

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



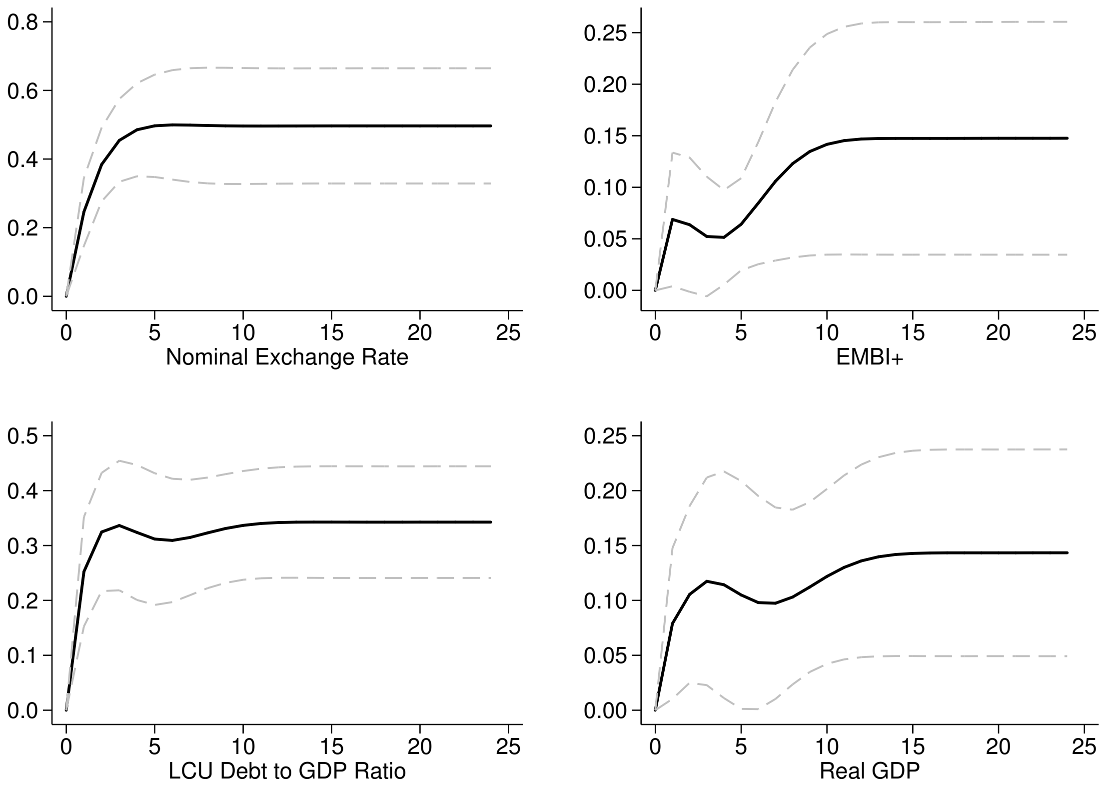
II.2 Colombia

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



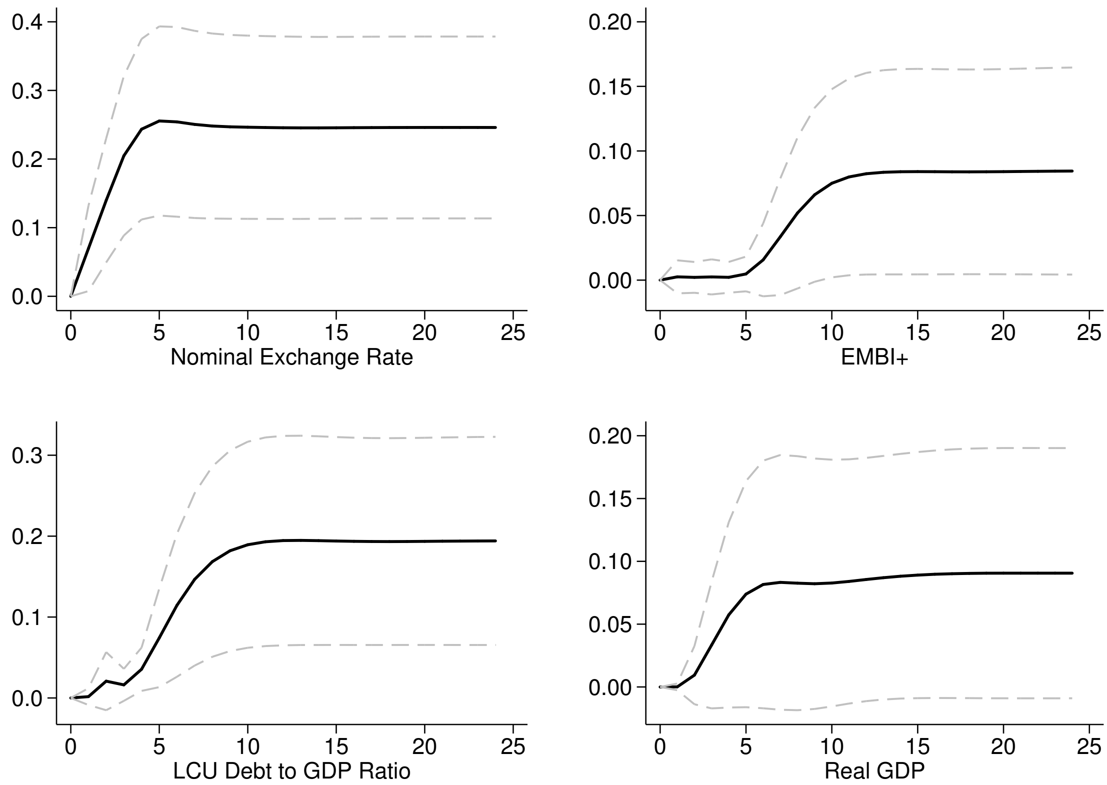
II.3 Mexico

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



II.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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