Sharing a Ride on the Commodities Roller Coaster: Common Factors in Business Cycles of Emerging Economies

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ABSTRACT

We explore the hypothesis that fluctuations in the price of the commodity goods are an important driver of business cycles in small emerging market economies (EMEs). We document that these economies are, on average, commodity exporters, their aggregate fluctuations are characterized by procyclical and leading commodity prices, and periods of high (low) commodity prices coincide with low (high) interest rates faced by EMEs in world capital markets. We also uncover an important role of common factors in commodity prices, interest rates and output dynamics across EMEs. Guided by these stylized facts, we embed a commodity sector into a dynamic, stochastic, multi-country equilibrium model of EMEs' business cycles where domestic and external -idiosyncratic and common- driving forces coexist. Commodity prices and interest rates follow a common dynamic factor structure. When estimated with EMEs data, the model gives to the common factor in commodity prices a paramount role when accounting for aggregate dynamics. A further amplification mechanism is a "spillover" effect from commodity prices to interest rates. Yet, sometimes, positive commodity price shocks have also cushioned other negative domestic shocks, particularly during the fast recovery from the world financial crisis.

Keywords: Emerging economies, business cycles, commodity prices, common factors, Bayesian estimation, dynamic stochastic equilibrium models.
JEL codes: E32, F41, F44

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1 Introduction

Small emerging market economies (EMEs) are often portrayed as being vulnerable to external forces that amplify their business cycles. But what are the main origins of these external forces? What role do commodity prices play? And how much do these forces matter when it comes to accounting for aggregate fluctuations in EMEs?

A casual look at the macroeconomic performance of EMEs during the past decade suggest a predominant role of these external forces. As depicted in Figure I.1a, the years prior to Lehman's bankruptcy (dotted line) commodity prices expanded well above their trend levels and then abruptly collapsed as the financial crisis unfolded.[2] They bottomed in the first quarter of 2009 and then recovered to trend levels in the following 4 to 6 quarters. From peak to trough there was a total drop of 80 percentage points in the prices of the commodities that these economies export. These dynamics in commodity prices were accompanied by strong movements in both the risk premia on debt issued by these EMEs in international markets and economic activity. In the expansionary years of high commodity prices that preceded the crisis, risk premia was between 100 to 200 basis points (bp) below its trend. The quarter after Lehman it peaked to close to 800 bp only to fall back to trend levels between 3 to 4 quarters after. As for real income, it steadily increased from near trend levels in 2005 to being close to 5 percentage points above trend in the second quarter of 2008 and then abruptly collapsed to four points below trend during two consecutive quarters in 2009. Furthermore, several economic commentators and policy makers have argued that the relatively fast recovery of most small EMEs to the global financial crisis was related to the equally fast and vigorous reversal in commodity prices led, among others, by China's economic activity. And, in more recent times, starting in the second half of 2014, the upward trend in commodity prices ended amid falling oil prices and a sharp slow down in economic activity across several EMEs, and surges in bond spreads that have carried until the time of this writing.

This anecdotal recent historical account of EMEs would suggest that fluctuations in

[2] Figure I.1 depicts the average cyclical dynamics of country-specific indexes of commodity prices for a pool of 13 EMEs between 2005 and 2011. It also reports the (cyclical) credit spreads that these economies faced in international markets using EMBI. Section 2 presents all the details of the data used to construct this Figure, including countries and sources.

the price of the commodity goods that they export -easily comparable to a wild roller coaster ride- may be a key driver of their business cycles. And that such fluctuations are further amplified by variations in the financial conditions that EMEs face in world capital markets. This paper explores this hypothesis formally. It does so, first, by empirically documenting the cyclical properties of these two forces in a pool of 13 EMEs, how they interact over the business cycle, and what role do common factors play in this interaction. It then provides an estimated structural model that quantifies how much do these two forces (and their interaction) matter for aggregate fluctuations in EMEs.

By addressing these issues the paper makes three types of contributions. The first one is empirical as we document the cyclical properties of commodity prices in EMEs. The second contribution is methodological as we build a fully dynamic and stochastic equilibrium model of EMEs' business cycles. The core of the model is built around the small open economy set up first described in the seminal work by Mendoza (1991) and further analyzed by Schmitt-Grohé and Uribe (2003). But we extend it in several novel dimensions. First, we add a commodity endowment sector which takes the price of its goods as given from world markets. It is also cast in a multi-country framework with domestic and external drivers of aggregate fluctuations. External forces are of two kinds: real (commodity prices) and financial (country spreads). We allow for them to have common factors by adding a dynamic latent factor structure on the driving forces that perturb the model away from its steady state. The final contribution is quantitative as we estimate this model with Bayesian methods using data of several EMEs. The multi-country set up allows us to quantify the role played by domestic and external forces, including that of common factors, particularly those associated with commodity prices.

On the empirical front our findings show that, on average, EMEs are commodity exporters. This is a characteristic that differentiates them from advanced economies. We also document that country-specific commodity price indices are strongly procyclical and lead the cycle. In addition, periods of economic expansion (contraction), when commodity prices are high (low), coincide with low (high) interest rates faced by EMEs in world capital markets. Last, but not least, principal components analysis reveals that a considerable share of the variance in commodity prices, both across country specific indexes and types of commodities, is explained by common factors. The latter also play an important role on interest rates and output dynamics.

The estimation of the structural model gives external drivers a paramount role when accounting for aggregate dynamics in EMEs. More than half of the forecast error variance of the output gap originates in external drivers. These external drivers in turn exhibit several characteristics that are novel in the literature of EME's business cycles. The lion's share of these external drivers comes from commodity price shocks, a driving force that has not received much attention in this literature. The bulk of the action from commodity prices is recovered by the model in the form of common shocks across economies. Moreover, for some countries there is a sizeable "spillover" effect from commodity price shocks to the interest rate that they face in external capital markets, which acts as a further amplification mechanism for these shocks. Yet, interestingly, fluctuations in commodity price have not always amplified the business cycle. A historical decomposition of the output gap reveals that, sometimes, they have acted as cushion devices against what the model identifies as domestic forces. This was particularly the case in the fast recovery after the world financial crisis when commodity prices rebounded and helped counter balance negative domestic shocks in many EMEs.

The economics of a commodity price shock in our model are simple. It acts as an income shock that pushes consumer demand for domestic goods, which in turn increases equilibrium wages, labor and capital. Because aggregate investment and consumption are bundles of domestic and foreign goods, the two are further amplified because foreign goods become relatively cheaper (i.e. the real exchange appreciates). Lastly, there is an additional boost to economic activity if the shock lowers interest rates via the reduction in country spreads. The business cycles derived from this shock are not only simple, they produce dynamics that resemble those in EMEs' data, which is why the estimation attaches so much weight to it. Output rises together with consumption and investment, and, because the latter two respond more vigorously, the trade balance falls. Such countercyclical behavior of the trade balance is well known to be a distinctive empirical feature of emerging economies's business cycles. Another intrinsic dynamic to EMEs that the model can reproduce is the fact that expansionary phase is accompanied by an appreciation of the real exchange rate and a fall in the country interest. And because of the common factor in commodity prices the shock can account for the strong comovement across EMEs. Finally, marginal likelihood ratios considerably fall when the model is stripped out from common factors in commodity prices, confirming the preponderant role of this driving force.

This paper can be related to at least three strands of literature. The first and closest to our work is the literature that has used dynamic, equilibrium models to account for business cycles in small open and emerging economies. One set of papers in this literature has explored the role of financial shocks and/or the amplifying effects of frictions, mostly of financial nature, when it comes to accounting for business cycles in EMEs (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Aguiar and Gopinath, 2007; Fernandez-Villaverde, et.al 2011; Chang and Fernández, 2013; and Fernández and Gulan, 2014). Another set of papers has explored the role of terms of trade variations in driving aggregate fluctuations in EMEs (Mendoza, 1995; Kose, 2002; and Lubik and Teo, 2005). This paper is, to the best of our knowledge, the first one to provide a bridge between these two branches of the literature by postulating a link between commodity prices and financial conditions in EMEs and quantifying its relevance when accounting for aggregate fluctuations in these economies within a structural framework. While we do not model this link from first principles we follow both theoretical and historical evidence of this link. Calvo and Mendoza (2000) link volatility in financial conditions for EMEs in world markets to the cyclicality of their terms of trade and other fundamentals in the context of informational frictions where uninformed investors cannot extract information from prices but rather do it from noisy information about specialists´ trades. In a historical context, Eichengreen (1996) documented that during the crash of 1929 the sharp drop in the price of Brazilian coffee led foreign bankers to stop extending loans to Brazilian borrowers. And Min et.al. (2003) found that improved terms of trade are associated with lower yield spreads to the extent that such improvements imply an increase in export earnings and better repayment capacity[3]

[3]Cuadra and Sapriza (2006) link the volatility of terms of trade in EME to spreads in a dynamic model with strategic default model that delivers endogenous default risk, but do not explore the implications for the business cycle. Using FAVAR models, Bastourre et.al. (2012) have also documented a strong negative correlation between commodity prices and emerging market spreads. In the context of the subprime crisis, Caballero et.al. (2008) argued that persistent global imbalances and the volatility in both financial and commodity prices (such as oil) and asset prices that followed the crisis stemmed from a global environment where sound and liquid financial assets are in scarce supply. Morana (2013) has recently found that financial shocks have had a much larger role as drivers of the price of oil, than previously noted in the literature.

A second strand of literature that our work relates to has documented the presence of common factors in business cycles across world economies at both global and regional levels (Kose, et.al. 2003; Mumtaz, et.al. 2011). This has largely been investigated, separately, for developed economies (Kose, et.al. 2008; Aruoba, et.al. 2010; Crucini, et.al. 2011; Kose, et.al. 2012; Guerron-Quintana, 2013), and emerging economies (Broda, 2004; Bartosz, 2007; and Akinci, 2013). Within the literature of EMEs special attention has been given to two potential drivers of business cycles: fluctuations in external interest rates (Canova, 2005; Bartosz, 2007; Akinci, 2013) and terms of trade (Broda, 2004; Izquierdo, et.al. 2008).[4] Our contribution to this literature is twofold. We provide further empirical evidence on the existence of common external forces that drive business cycles in EMEs. Then we quantify their role by building a multi-country equilibrium model in which common and idiosyncratic external forces interact while simultaneously allowing the structural estimation to pin down the degree of comovement of these forces along the business cycle.[5]

A final strand of literature related to our work is one that documents the comovement of external forces that impact EMEs simultaneously. On the financial side, perhaps one of the most recent and prominent examples of the way financial forces shape macro dynamics in peripheral countries is the work by Rey (2013) that documents the presence of a global financial cycle that drives capital flows to these economies. Since at least the seminal works of Diaz-Alejandro (1985), Calvo et.al. (1993), and Fernández-Arias (1996) it has been documented how external financial factors, e.g. capital flows, often unrelated to country fundamentals have shaped economic activity in EMEs. More recent studies have also highlighted the critical role in the evolution of borrowing costs faced by emerging economies of exogenous factors, global financial conditions and risk aversion (García-Herrero and Ortiz, 2005; Gonzalez-Rosada and Levy-Yeyati, 2008; Ciarlone, et.al. 2009), the creation of a common, global investor base for EMEs (Levy-Yeyati and Williams, 2012), and U.S interest rate policy (Dailami, et.al. 2008; Edwards, 2010). Regarding the comovement of

[4]Within the group of emerging economies, some particular attention has been given to Latin America (Canova, 2005; Izquierdo, et.al. 2008; Aiolfi, et.al. 2011; Cesa-Bianchi, et.al. 2012).

[5]Miyamoto and Nguyen (2014) investigate the role of different types of common world- and group- specific shocks by structurally estimating a small open economy model on an annual dataset of several developed and developing economies over the XXth century. Justiniano and Preston (2010) demonstrated the need to include correlated disturbances when trying to account for the international business cycles of small open economies.

commodity prices, since at least the work by Pindyck and Rotemberg (1990) it has been documented that prices of unrelated raw commodities have a persistent tendency to move together. More recently, this result has shown to be robust to the use of newer and more sophisticated statistical methods such as FAVAR models (Lombardi, et.al. 2012; Byrne, et.al. 2013) and networks analysis (Gomez, et.al. 2011). Our work contributes to this literature by explicitly incorporating latent common factors in commodity prices and country spreads and measuring their contribution to the business cycle of several EMEs.

The rest of the paper is divided into seven sections including this introduction. Section 2 presents the empirical findings. Section 3 builds the model. Section 4 discusses some of the details of the strategy used for calibrating and taking the model to the data. Section 5 presents the main results of the estimated model and Section 6 reports robustness checks. Concluding remarks are given in Section 7. Further technical details are gathered in a companion online Appendix.

2 Stylized Facts

We document four stylized facts in this section. First, using a comprehensive annual panel dataset of 189 countries, including 61 EMEs, we show that a salient characteristic of EMEs that differentiates them from advanced economies is the large share of commodities in their total exports. Second, country-specific commodity price indices, constructed using another rich quarterly panel dataset of 44 individual commodity prices and average commodity export shares for 60 countries, are strongly procyclical and lead the cycle. Third, we show that periods of economic expansion (contraction), when commodity prices are high (low), tend to coincide with low (high) interest rates faced by EMEs in world capital markets. Last, but not least, we uncover important common factors in commodity prices both across countries and types of commodity goods. We also recover an important role for common factors in the dynamics of interest rate premia and output.

2.1 Commodity Export Shares

The first empirical task that we set out to do is to assess how big is the share of commodity exports in a typical EME. To answer this we assemble a fairly comprehensive (unbalanced) annual panel using the World Bank's Word Development Indicators (WDI) covering 189 countries between the years 1960 and 2013. For each country, the panel contains the share of three broad group of commodities in total exports: agricultural, fuel and metals. We average the sum of these three shares across time to obtain country-specific commodity export shares. Finally we separate countries between 61 EMEs and 128 non-EMEs. The latter is also further subcategorized into 74 advanced and 54 low-income economies[6].

The main descriptive statistics are reported in Table II.1. The table documents the median export share across all groups of countries. We report medians instead of means as the distributions in each of the groups are highly skewed and simple tests reject normality[7]. It also displays Mann-Whitney tests for the equivalence between non-EMEs groups and EMEs, and Kruskal-Wallis for equivalence across all groups. The results in this Table allow us to define a first stylized fact:

- **Stylized Fact 1**: **The share of commodities in total exports in the average EME more than doubles that of advanced economies.** While the median export share in EMEs is 25.7 percent, that in advanced is 11.2 percent. Furthermore, a Mann - Whitney test easily rejects equivalence between the two distributions at 1 percent significance level. It fails to reject such hypothesis, when emerging economies are compared to low-income economies, but continues to accept it when EMEs are compared to non-EMEs, mainly due to the less number of observations for low-income countries relative to those for advanced economies. Finally, Kruskal-Wallis tests easily reject equivalence across these three groups of countries.

[6] The 61 EMEs in our sample are classified as such following a simple criteria: we classify a country as an EME if there exists EMBI data on this country. The only two countries that we exclude from this list are China and India as they clearly do not fall into the category of *small and open* emerging economy that is the focus of our analysis. Advanced and low-income economies are classified following World Bank's classification. See the Appendix for the list of countries and further details.

[7] The Appendix contains kernel density plots as well as more descriptive statistics.

2.2 Cyclicality

The next thing that we explore is the cyclicality of commodity prices. For that purpose we use another quarterly panel dataset of country-specific commodity price indexes for 60 EMEs between 1980.Q1 and 2012.Q3. The indices are constructed by averaging the time series of the international prices of 44 commodity goods using as constant weights the (country-specific) average shares of each of these commodities in total exports between 1999 and 2004.[8] We study the comovement of these indices with output and the risk premium faced by these economies in world capital markets. We use quarterly data on real GDP from IMF's International Financial Statistics, and, following Neumeyer and Perri (2005), we proxy risk premia with EMBIG spreads from Bloomberg.[9] Unfortunately, imposing a minimum range of time series data in these last two variables reduces the sample to 13 EMEs.[10] In order to document the cyclical properties of the data, we use the Hodrick-Prescott filter to extract the cyclical component of the variables. Serial correlations are reported in Figure II.1. When computing these statistics we take simple averages across the 13 countries in the sample and confidence bands denote +/-1.5 standard deviations. Inspecting the two panels in this figure a two more stylized facts can be defined:

- **Stylized Fact 2**: **Country-specific commodity prices in EMEs are procyclical and lead the cycle.** The average contemporaneous correlation between the commodity price index and output is 0.35 as depicted in the upper panel of the Figure. It is slightly below the one found with the (one quarter) lag of the index. The procyclicality and leading property of commodity prices is, to the best of our knowledge, a novel result in the empirical literature of business cycles in emerging economies. It signals that an important (and overlooked) driver

[8]The main source of this dataset is Fernández-Arias and Pérez (2014). More details of this dataset, including the entire list of countries and types of commodity goods, are contained in the Technical Appendix.

[9]Recently, Fernández and Gulan (2014) extended this work and, importantly for our purpose, documented a very high correlation between EMBIG spreads and corporate risk measures that, unfortunately, are not available for many EMEs.

[10]These countries are: Argentina (13.3), Brazil (18), Bulgary (26.4), Chile (69.7), Colombia (28.6), Ecuador (47.8), Malaysia (40.3), Mexico (28.7), Peru (60.5), Russia (65.4), South Africa (26), Ukraine (16.2) and Venezuela (95.5). The numbers in parenthesis are the median commodity export shares as defined in the previous subsection. The median commodity export share in this group is 28.7, only slightly above that of the 60 EMEs studied in the previous subsection. We only selected countries with (i) at least 32 consecutive quarterly observations of EMBI spreads and covering at least until 2012.Q1; (ii) whose median commodity export share is above the median for all 61 EMEs; and (iii) with quarterly time series for real GDP at least from 2000.Q1. See the Appendix for further details.

of aggregate fluctuations in these economies are changes in the international prices of the commodities that these countries export.

- **Stylized Fact 3**: **There is a strong negative comovement between commodity prices and interest rate spreads in EMEs.** The contemporaneous correlation between the variables is -0.35 and the number drops even more with leads of commodity prices, as depicted in the lower panel of figure II.1. Thus, when commodity prices are high (low) along the business cycle the cost of issuing debt for EMEs in foreign capital markets decreases (increases). This stylized fact is also rather novel relative to the literature that has postulated risk premia as an important driving force of aggregate fluctuations in EMEs (Neumeyer and Perri, 2005; Uribe and Yue, 2006; and Fernández and Gulan, 2014). It implies that, along the cycle of these economies there are not only movements in relative prices that reflect intertemporal decisions, namely movements in interest rates, but also relative prices between domestic and foreign goods in the form of movements in the prices of the commodity goods exported.

2.3 Common Factors

A last dimension that we explore empirically is the presence of common factors in commodity prices, risk premia, and income across EMEs. The evidence is presented in the form of time series plots in Figure II.2 and principal components analysis in Table II.2. Inspection of this evidence leads us to define the fourth stylized fact:

- **Stylized Fact 4**: **There is a preponderant role of common factors when accounting for the dynamics of commodity price indices across EMEs. This extends also to the dynamics of risk premia and real income.** A look at the time series dynamics in Figure II.2 reveals the presence of strong comovement across countries in risk premia and, even more markedly, in the country-specific commodity prices. It should be noted that the latter occurs despite the fact that the commodity exporting profiles of the countries in our sample varies substantially.[11] Principal component analysis further

[11] For example, the serial correlation between the commodity price indexes for Colombia and Peru is 0.9 despite the fact that the commodity export patterns of the two countries differ in terms of the type of commodity goods that they export: while the two largest commodity export shares for Colombia are crude oil (53 percent) and coal (15 percent), those of Peru are gold (28 percent) and copper (22 percent). The

corroborates these findings. The first principal component accounts for 69 and 78 percent of the variance in EMBIs and country-specific commodity price indices across the 13 EMEs in our sample. Looking at the first two principal components such numbers increase to 93 and 87 percent, respectively. We also extend the analysis to real GDP in the 13 EMEs, and across the prices of the 44 commodity goods in our sample, which we group into five categories according to the Standard International Trade Classification (SITC, fourth revision)'s one level aggregation.[12][13] The findings, reported in the last two columns of Table II.2, point in the same direction: a robust presence of common factors. The first principal component accounts for 57 and 67 percent of the variance in commodity prices across the five SITC categories and real GDP, respectively. Such numbers increase to 82 and 85 percent, in each of the two variables when one looks at the first two principal components.

Taken together, the stylized facts presented in this section allow for a broader and more comprehensive description of the most salient business cycles patterns in EMEs. To the studies that had previously documented the cyclicality of credit spreads[14], we add at least two important facts. We show how this strong cyclicality is present also in the price of commodity goods exported by these economies. And we relate this fact to the presence of common factors across the commodity goods that EMEs export, the spreads they face in external capital markets and their aggregate level of economic activity. The next section builds a dynamic general equilibrium model guided by these stylized facts.

Appendix presents the specific shares of each of the commodities in our sample for all 13 countries in our dataset.

[12] The groups are as follows (distribution of the 44 commodities in parentheses). Group 0: Food and live animals (19 commodities); Group 2: Crude material, inedible, except fuels (15 commodities); Group 3: Mineral fuels, lubricants and related materials (3 commodities); Group 4: Animal and vegetable oils, fats and waxes (5 commodities); Group 9: Commodities and transactions not classified elsewhere in the SITC (1 commodity).

[13] For the sake of space, the Appendix contains time series plots for the price of commodity goods and GDP, as well as information on the SITC aggregation that we use.

[14] See, for instance, the brief literature review in the Introduction.

3 Model

3.1 Set Up

The set up of our model is a multi-country version of the small open economy framework first developed by Mendoza (1991), and further analyzed by Schmitt-Grohé and Uribe (2003). We take four departures from such framework motivated by the stylized facts presented in the previous section. First, we add a country-specific commodity sector that faces fluctuations in the price of the good it sells in international markets. These fluctuations are exogenous as we assume the countries are small players in these markets. The flow of commodity goods is assumed to be an endowment. Second, in addition to commodity goods, we assume that there are foreign and (country-specific) home goods, which are imperfect substitutes. Home goods are produced domestically using capital and labor. Foreign goods are imported from the rest of the world. Third, there is a sector that produces investment goods using home and foreign goods as inputs. As in the standard framework, households in each EME can issue non state-contigent, one-period bonds in international financial markets. Such bonds will pay an exogenous and stochastic premium over the world interest rate that acts as an additional driving force.

The structure with which we model the processes of commodity prices and spreads is what constitutes the fourth departure from the canonical framework. We model them with a dynamic factor structure that incorporates two common factors in addition to idiosyncratic shocks. One factor is associated to commodities and the other one to spreads. The two factors are independent from each other but each one can affect country-specific spreads and commodity prices. While not derived from first principles, this structure is flexible enough to capture the strong comovement across EMEs and the relationship of spreads and commodity prices in the data, as documented in the previous section as well as the studies that we referred to in the Introduction. A complete model of the determination and comovement across these variables is beyond the scope of this paper, because our main goal is to analyze the relation between commodity prices, spreads and business cycles.

There are four agents in each EME considered in the model: households, firms, investment goods producers, and the rest of the world (which does not include the other EMEs in the model).[15] Households consume final goods, defined as a bundle of home and foreign goods; decide how much labor and capital supply to domestic firms; and issue bonds in foreign markets to smooth consumption. They also purchase investment goods to replace depreciated capital and increase the net stock of capital for which they face capital adjustment costs. Besides profits from firms, capital and labor income, they receive income from the commodity sector, which they own. Firms maximize profits, defined as the revenue from selling home goods, net of costs from renting labor and capital from households. Labor costs include working capital costs. Home goods are produced with a standard neoclassical technology and sold either to households, to investment good producers or to the rest of the world. Investment goods producers use a technology that combines home and foreign goods. They later sell these goods to households for capital accumulation purposes. The fourth agent is the rest of the world. It provides funding for households at a stochastic premium over the world interest rate. It also demands home goods for its own consumption as a function of both their relative price and a price elasticity. Finally, it provides (foreign) goods that are imported by households for their own consumption or used as inputs by investment good producers.

Each EME in our model will face seven driving forces. They can be divided as coming from domestic or external sources. A total factor productivity shock will be the only domestic source of business cycles as in Mendoza (1991)'s original work. The remaining six external forces will be the real world interest rate, foreign demand, credit spreads and commodity prices. These last two can further be divided into an idiosyncratic component and a common factor that is shared with the other EMEs in the model. In the following subsections we describe the actions by each of the agents in a representative j^{th} EME in the model. However, we omit the country index to simplify the notation and only use it when common and idiosyncratic variables interact. The full set of equilibrium and optimality conditions are included in the Appendix.

[15] We are thus abstracting from trade linkages across the EMEs in the model, mostly for tractability. While, in principle, trade across EMEs can potentially be relevant for explaining their business cycle comoment, later, in the empirical application of the model, we provide evidence of the relatively low trade linkages among the EMEs chosen to estimate the model. In any case we conjecture that, should trade linkages be added to our framework, the novel role of common factors that our work is highlighting would be further empasized.

3.2 Households

Households' lifetime utility is given by

$$E_t \sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \tag{1}$$

where E_t is the expectation operator with information up to period t, β is the intertemporal discount factor, $U(\cdot)$ is the concave period utility function, L_t is total hours worked, and C_t is consumption goods. We choose a GHH specification for $U(\cdot)$:

$$U(C_t, L_t) = \frac{1}{1-\sigma}\left[C_t - \psi^c \frac{L_t^{1+\gamma_c}}{1+\gamma_c}\right]^{1-\sigma}$$

where σ is the constant relative risk aversion coefficient and γ_c is the inverse of the Frisch elasticity of the labor supply. As it is well known, the key implication of these preferences is that the income effect does not affect the labor supply decision of the household. These preferences have been used extensively in previous works of business cycles of emerging economies (see, among others, Neumeyer and Perri, 2005; Uribe and Yue, 2006).

Households maximize (1) subject to the budget constraint and to the capital accumulation equation. The budget constraint is defined as:

$$\begin{aligned} & P_t^c C_t + P_t^x \left[1 + \eta_H (R_t - 1)\right] X_t + R_{t-1} D_{t-1} \\ = \quad & w_t L_t + r_t^k K_{t-1} + D_t + p_t^{Co} \bar{C}o + \xi_t \end{aligned} \tag{2}$$

where P_t^c is the price of the consumption good, D_t is the stock of international debt at the beginning of each period, w_t is the real wage, R_t is the (gross) external real interest rate, P_t^x is the price of the investment good, p_t^{Co} is the unit price of a constant endowment flow of $\bar{C}o$ quantities of commodity goods, ξ_t are profits from the domestic production sector, r_t^k is the rent of capital and K_t is the stock of that capital. We use the price of the imported goods, P^f, as the numeraire in the model. Hence, the real exchange rate is defined in the model as the inverse of the consumption good's price, $(P_t^c)^{-1}$.

The full revenue from the commodity sector, $p_t^{Co}\bar{C}o$, is then assumed to be handed to households. This modeling approach of the commodity sector is evidently simplistic as we do not incorporate a production sector that uses resources as in Fornero et.al. (2014). Nor do we incorporate a government sector that directly benefits from higher commodity prices (e.g. via higher tax revenues) which later spills over the economy as in Guerra-Salas (2014). We leave these extensions for future research but conjecture that, should we add these elements to our model, the effects of commodity shocks would further increase, reiterating the main hypothesis of the paper[16].

We assume that households borrow a fraction η_H of investment expenditures. This implies that increases in R will affect the accumulation of capital by the traditional channel of raising the user cost of capital, but also by making the purchase of capital goods more expensive to households. The capital accumulation equation is

$$K_t = (1-\delta) K_{t-1} + X_t \left(1 - s_t\left(\frac{X_t}{X_{t-1}}\right)\right) \tag{3}$$

where $s(\cdot)$ is a cost function with the following properties $s_t(1) = s_t'(1) = 0$, and $s_t''(\cdot) > 0$. In particular, we follow Christiano et.al (2010) and assume the following functional form

$$s_t\left(\frac{X_t}{X_{t-1}}\right) = \frac{1}{2}\left(e^{\left(\sqrt{a}\left(\frac{X_t}{X_{t-1}}-1\right)\right)} + e^{\left(-\sqrt{a}\left(\frac{X_t}{X_{t-1}}-1\right)\right)} - 2\right) \tag{4}$$

Consumption is assumed to be a bundle of domestic and imported goods as follows

$$C_t = \left[(1-\alpha_c)^{\frac{1}{\eta_c}}\left(C_t^h\right)^{\frac{\eta_c-1}{\eta_c}} + \alpha_c^{\frac{1}{\eta_c}}\left(C_t^f\right)^{\frac{\eta_c-1}{\eta_c}}\right]^{\frac{\eta_c}{\eta_c-1}} \tag{5}$$

where C^h and C^f denote domestic and imported consumption goods, η_c is the elasticity of substitution between the two and $\alpha_c \in (0,1)$ is the share of imported goods in total consumption.

[16] There is, however, the possibility that governments conduct fiscal policy to optimally manage the commodity price shock. Agenor (2015) has recently invetigated this idea, although within a setting of low-income economies.

3.3 Production

Firms in the domestic sector maximize profits subject to a standard neoclassical production technology that uses capital and labor. Following Neumeyer and Perri (2005), among others, we assume that domestic firms have to borrow a fraction η_F of the wage bill to produce so the total cost of labor is a function of both the real wage and the interest rate. This generates a supply side channel trough which shocks to the interest rate are transmitted to the domestic economy. Formally, the optimization problem for domestic firms is

$$\max E_t \sum_{j=0}^{\infty} \beta^t \frac{\lambda_{t+j}}{\lambda_t} \xi_{t+j}$$

subject to a production technology:

$$Y_t = z_t K_{t-1}^{\alpha} L_t^{1-\alpha} \tag{6}$$

where profits are $\xi_t = p_t^h Y_t - w_t \left[1 + \eta_F \left(R_t - 1\right)\right] L_t - r_t^k K_{t-1}$, Y_t denotes domestic output, z_t is the productivity shock and p_t^h is the price of domestic goods in terms of the numeraire. Since profits are in the end passed on to households we use λ_t, the marginal utility of consumption, to discount future dividends.

3.4 Investment

Investment is produced with imported and domestically produced goods. The production technology for new investment goods is given by:

$$X_t = \left[(1-\alpha_x)^{\frac{1}{\eta_x}} \left(X_t^h\right)^{\frac{\eta_x - 1}{\eta_x}} + \alpha_x^{\frac{1}{\eta_c}} \left(X_t^f\right)^{\frac{\eta_x - 1}{\eta_x}} \right]^{\frac{\eta_x}{\eta_x - 1}} \tag{7}$$

where X^h and X^f are domestic and imported goods used by the investment sector, η_x is the elasticity of substitution and $\alpha_x \in (0,1)$ measures the share of imported goods over total investment.

3.5 Market Clearing

External demand for home goods is simply modeled as

$$C_{j,t}^{h*} = \left(p_{j,t}^{h}\right)^{-\epsilon_{j,e}} Y_t^* \tag{8}$$

where Y_t^* denotes the level of aggregate demand in the rest of the world that we take as an exogenous process, and $\epsilon_{j,e}$ is the parameter that governs the price elasticity of foreign demand. The equation that describes market clearing in the home goods market is:

$$Y_t = C_t^h + X_t^h + C_t^{h*} \tag{9}$$

3.6 Driving Forces

The strong comovement of commodity prices and risk premia across EMEs documented in the stylized facts is modeled with a dynamic factor structure. Following Geweke and Zhu (1996) and Jungbacker and Koopman (2008) we postulate two latent factors that evolve according to AR(1) processes:

$$f_t^{Co} = \phi_{Co} f_{t-1}^{Co} + \sigma^{f^{Co}} \varepsilon_t^{f^{Co}}, \qquad \varepsilon_t^{f^{Co}} \sim N(0,1) \tag{10}$$

$$f_t^{R} = \phi_{R} f_{t-1}^{R} + \sigma^{f^{R}} \varepsilon_t^{f^{R}}, \qquad \varepsilon_t^{f^{R}} \sim N(0,1) \tag{11}$$

where f_t^R and f_t^{Co} are the common factors associated to spreads and commodity prices, respectively, across the EMEs in the model. These two factors affect the (country-specific) processes of commodity prices and spreads as follows. The commodity price, $p_{j,t}^{Co}$, is related to the two common factors as:

$$p_{j,t}^{Co} = \omega_j^R f_t^R + f_t^{Co} + \varepsilon_{j,t}^{Co} \tag{12}$$

where ω_j^R is the loading factor associated to f_t^R for the j^{th} economy, capturing the interaction between the commodity prices and (common) fluctuations in spreads. As it is standard in the aforementioned literature, we normalize the loading factor associated to f_t^{Co} to tell factors apart from factor loadings. $\varepsilon_{j,t}^{Co}$ is an idiosyncratic shock that is assumed to behave as an AR(1) process

$$\varepsilon_{j,t}^{Co} = \rho^{Co}\varepsilon_{j,t-1}^{Co} + \sigma_j^{Co}\nu_{j,t}^{Co}, \qquad \nu_{j,t}^{Co} \sim N(0,1) \tag{13}$$

which accounts for movements in $p_{j,t}^{Co}$ that are independent from either of the two common factors. Hence, the stronger and more persistence are the fluctuations in f_t^{Co} the more will the model assign movements in $p_{j,t}^{Co}$ to common factors across all EMEs considered.

As in Neumeyer and Perri (2005), we assume that a large mass of international investors is willing to lend to the j^{th} EME any amount at a country-specific interest rate, R_{jt}, and that these loans are risky assets because there can be default on payments to foreigners. This assumption creates two sources of volatility in R_{jt}. On one hand, real interest rates may change as the perceived default risk changes in economy j. On the other, even if default risk stays constant, interest rate can change because the preference of international investors for risk changes over time. We capture these two sources of interest rate volatility by decomposing the interest rate faced by every EME as

$$R_{jt} = R_t^* S_{jt} \tag{14}$$

where R_t^* is assumed to be the world interest rate, which is not specific to any economy, and S_{jt} captures the country spread over R_t^*. We model the evolution of the external interest rate as an AR(1) process

$$\ln R_t^* = \rho_{R^*} \ln R_{t-1}^* + \sigma^{R^*}\varepsilon_t^{R^*}, \qquad \varepsilon_t^{R^*} \sim N(0,1) \tag{15}$$

where shocks $\varepsilon_t^{R^*}$ capture changes in the risk appetite of foreign investors. As it is usually done in the literature, default decisions are modeled assuming that private domestic lenders always pay their obligation in full but that in each period there is a probability that the local government will confiscate all the interest payments going from local borrowers to foreign lenders. Fluctuations in the perceived confiscation probability by investors are assumed to obey to two forces. On one hand, domestic factors may drive the business cycle, thereby driving country risk. On the other, exogenous factors, either idiosyncratic or common across

EMEs may also drive country risk. We capture the two alternatives jointly by assuming that S_{jt} is defined as

$$S_{jt} = z^R_{jt} \left\{ \exp \left[\Omega_{j,u}(D_{j,t} - \overline{D}_j) \right] - 1 \right\} \tag{16}$$

where the term $\exp \left[\Omega_{j,u}(D_{j,t} - \overline{D}_j) \right]$ is a debt elastic interest rate mechanism whose role is not only limited to inducing stationarity in the debt process, as in Schmitt-Grohé and Uribe (2003), but to capture the role of domestic factors which, through financial frictions, affect the evolution of spreads as in García-Cicco et.al. (2010). We follow the latter work and, in our subsequent empirical implementation, we estimate the parameter $\Omega_{j,u}$ which governs the strength of this mechanism. The novelty in (16) relative to the existing literature comes from the exogenous term in the country risk spread, z^R_{jt}, which is assumed to be potentially affected by the two common factors in a similar way as in (12)[17]:

$$z^R_{j,t} = f^R_t + \omega^{Co}_j f^{Co}_t + \varepsilon^R_{j,t} \tag{17}$$

where ω^{Co}_j is the (country-specific) loading factor associated to f^{Co}_t capturing the interaction between the risk premia and (common) fluctuations in commodity prices. As before, we normalize the loading factor associated to f^R_t. $\varepsilon^R_{j,t}$ is an idiosyncratic shock that is assumed to behave as an AR(1) process

$$\varepsilon^R_{j,t} = \rho^{z^R} \varepsilon^R_{j,t-1} + \sigma^R_j \nu^R_{j,t}, \qquad \nu^R_{j,t} \sim N(0,1) \tag{18}$$

that accounts for movements in risk premia that are independent from either of the two common factors and domestic factors embedded in the debt elastic component. The parameter ω^{Co}_j governs the semi-elasticity by which (common) changes in commodity prices affect (country-specific) spreads. It is meant to capture in a reduced form the idea postulated by earlier theoretical and historical studies (e.g. Calvo and Mendoza, 2000; and Eichengreen, 1996) where imperfect information in capital markets drives foreign investors to link country

[17] A caveat to our framework to bear in mind is that we do not explicitly model non linearities in the driving forces, most notably in the spreads, as done by Fernandez-Villaverde et.al. (2011), or in commodity prices, as in García-Cicco et.al (2012). Doing so would render the empirical application of our framework highly untractable.

fundamentals in EMEs, like commodity prices, to risk premia.[18]

The remaining two driving forces are the world's foreign demand and the country-specific technology which we characterize as AR(1) processes[19]

$$\ln Y_t^* = \rho_{Y^*} \ln Y_{t-1}^* + \sigma^{Y^*} \varepsilon_t^{Y^*}, \qquad \varepsilon_t^{Y^*} \sim N(0,1) \tag{19}$$

$$\ln z_{j,t} = \left(1 - \rho_{j,z}\right) \ln \bar{z}_j + \rho_{j,z} \ln z_{j,t-1} + \sigma_j^z \varepsilon_{j,t}^z, \qquad \varepsilon_{j,t}^z \sim N(0,1) \tag{20}$$

3.7 Equilibrium

Given initial conditions $K_{j,0}$ and $D_{j,0}$, and exogenous state-contingent sequences of idiosyncratic and common shocks $\{\varepsilon_t^{R^*}, \nu_{j,t}^R, \nu_{j,t}^{Co}, \varepsilon_{j,t}^z, \varepsilon_t^{Y^*}, \varepsilon_t^{f^R}, \varepsilon_t^{f^{Co}}\}$ in economy j, an equilibrium is a set of state-contingent allocations[20]

$$\{C_{j,t}, L_{j,t}, D_{j,t}, X_{j,t}, K_{j,t}, h_t^I, D_{t+1}, \xi_{j,t}, C_{j,t}^h, C_{j,t}^f, Y_{j,t}, C_{j,t}^{h*}\}_{t=0}^{\infty}$$

and prices

$$\{P_{j,t}^c, P_{j,t}^x, R_{j,t}^*, w_{j,t}, r_{j,t}^k, Q_{j,t}^x, \lambda_{j,t}\}_{t=0}^{\infty}$$

such that, for all j's EMEs in the sample, given the laws of motion of shocks:

1. The allocations solve the consumer's problem given prices and the laws of motion for the capital stocks.

2. The allocations solve the firm's problem given prices.

3. Markets clear for capital, labor and home goods.

[18] We do not model spreads from first principles as in Mendoza and Yue (2012) or Fernández and Gulan (2015). Instead we model risk premia in a reduced form where domestic conditions can translate into higher spreads as in Neumeyer and Perri (2005), Garcia-Cicco et.al. (2010) or Chang and Fernández (2013). A more complete model of the determination of fluctuations in country risk and their interaction with commodity prices is beyond the scope of this paper because our main goal is to analyze the extent to which this interaction matters for business cycles.

[19] Strictly speaking, the processes for R^* and Y^* can also be considered as two additional common factors. We prefer not to label them as such because they will be considered as observable processes in the estimation of the model, unlike f^{Co} and f^R which will be treated as latent variables.

[20] The set of equilibrium allocations and prices that characterize the solution of the model is found by applying a first-order Taylor approximation to the set of equilibrium conditions. The log-linearized system is then solved using perturbation methods in DYNARE. The Appendix presents the list of stationary equations as well as further technical details of the solution.

4 Taking the Model to the Data: Preliminaries

This section explains how we take the model to the data from a subsample of the EMEs presented in Section 2. We first provide further details on the subset of countries chosen to estimate the model. Then we provide some preliminaries for the Bayesian estimation of the model such as the priors and observables used, and the calibration of the steady state of the model. Taking the model to the data helps to illustrate an application of the theoretical framework built in the previous section. It also allows to quantify, through the lens of such theory, the relative role of common/idiosyncratic or external/domestic forces that drive business cycles in EMEs. The results of this application will be summarized in Section 5.

4.1 A Representative Group of EMEs

From the pool of 13 countries studied in Section 2, we pick a sample of four EMEs to estimate the model: Brazil, Chile, Colombia and Peru. We do so mainly for two reasons. First, we want to have a reduced number of countries for tractability, while still keeping a pool that is large enough to pin down the common factors in the model. Second, as will be shown below, the calibration of the model´s steady state presents some further data requirements that are binding for several of the 13 countries studied in Section 2. We believe that this pool of four economies is representative of the type of economies modeled in our theoretical framework. The four countries are all well known commodity exporters, with a median commodity export share of 35.4.[21] In addition, as depicted in Figure II.1, in this reduced group of countries commodity prices continue to be procyclical, lead the cycle and negatively commove with spreads[22].

There is also strong evidence in favor of common factors affecting the macro dynamics in these four countries. The first principal component explains 84, 82 and 68 percent of the

[21] Specific commodity export shares are: Brazil (17.9); Chile (69.7); Colombia (28.6); and Peru (60.5).

[22] The Appendix presents evidence of the cyclical movement in commodity prices and spreads for these four countries before and after the Great Recession, along the lines of Figure I.1. It is shown how, like in the bigger pool of 13 EMEs, these four countries experienced higher (lower) than trend values in commodity prices (spreads) in the period before the Lehman, and those trends reversed completely afterwards. Interestingly, the magnitude of the deviations in these two driving forces was slightly lower in both the expansion and the contraction phases. And so was that of output.

variance in spreads, commodity prices, and real output, respectively (see Appendix). Such numbers are even more supportive of the kind of common factors embedded in our model given that commodity exporting profiles are fairly heterogenous and trade linkages are small across these four economies. Table IV.1 reports the average commodity export shares for these four countries. Brazil's largest shares are soybeans and iron; Chile's top two are copper and fish; Colombia's two are oil and coal; and in Peru they are gold and copper. This little overlap between the commodities that these four countries export implies that the common factor in commodities does not come mechanically from these countries exporting the same type of commodity goods. The Appendix presents data on the low trade linkages between the four economies and their other trading partners. For example, Brazil's exports to Chile, Colombia and Peru are, respectively, 0.2, 0.1, and 0.1 percent of output. In contrast, trade with its main trading partners is nearly twenty times that share (10.1 percent). Similar order of magnitudes are observed for the other three countries.[23]

4.2 Details of the Estimation

A subset of the parameters in the model is estimated using Bayesian techniques. The remaining ones are calibrated to match long run ratios of the data and/or taken from previous studies. Our choice between which parameters to estimate or calibrate is guided by the research questions of our work and the information content (or lack thereof) of the data regarding certain parameters. Since our main focus is the business cycle, we estimate the parameters that govern the short run dynamics of the model. Namely, the persistence of the seven driving forces $\{\phi_{Co}, \phi_R, \rho_j^{Co}, \rho_j^{z^R}, \rho_{R^*}, \rho_Y, \rho_{z,j}\}$ and the standard deviation of their shocks $\{\sigma^{f^{Co}}, \sigma^{f^R}, \sigma_j^{Co}, \sigma_j^R, \sigma^{R^*}, \sigma^{Y^*}, \sigma_j^{zy}\}$. We also estimate the parameters that govern how common factors affect country-specific commodity prices and credit spreads $\{\omega_j^{Co}, \omega_j^R\}$, and those that determine the country premium, the cost of adjusting the capital stock, and the borrowing needs of households and firms $\{\Omega_{j,u}, a_j, \eta_{jH}, \eta_{jF}\}$.

The parameters that we calibrate are summarized in Table IV.2, and Table IV.3

[23] There is, however, one disadvantage in picking this subsample of four economies. The fact that all countries belong to the same geographical region implies that common factors could not be further separated into regional or global. This, however, is not the central goal of our empirical application.

presents the long-run ratios from the data used to calibrate some of them. We assume that, across all households in the economies considered, the risk aversion coefficient, σ, equals 2 and the Frisch elasticity, $1/\gamma_c$, equals to 1.72, in line with what is usually found in the business cycle literature. We assume an annual depreciation rate of capital, δ, of 10 percent across all countries, and calibrate the share of capital in the production function, α, to match the consumption and investment ratios to GDP in each country. Following Galí and Monacelli (2008) we set the price elasticity of exports, $\epsilon_{j,e}$, and the elasticities of substitution in the consumption and investment bundles to 0.99. The assumption that the price elasticities are close to one allows us to calibrate the parameters α_c and α_x so that the steady state of the model reproduces the average import shares of consumption and investment goods in the data. The parameters $\overline{D}$ and $\bar{Co}$ are calibrated so as to match the long run shares of external debt and commodity exports. The share of non-commodity exports to GDP adjusts to satisfy the balance of payments identity. We assume that the steady state (gross annual) real world interest rate, $\overline{R^{*}}$, is 1.01 and we calibrate $\overline{z^{R}}$ to match the long-run value of the country risk premium for each economy. The discount factor, β, for each economy is pinned down as the inverse of the country's real interest rate. We calibrate the scale parameter in the labor supply, ψ^{c}, so that labor in the steady state is set to 0.3. Finally, we normalize to 1 the steady state levels of productivity and foreign demand, $\bar{z}_j$ and $\overline{Y^{*}}$.

The estimation uses as observables 26 quarterly time series that are mapped onto the model's counterpart through measurement equations. Out of these, 24 are country-specific as we use data on real aggregate consumption, income, investment, the trade balance to GDP ratio, the (quarterly) EMBIG spread and the commodity price indices constructed in Section 2, for each of the four economies in our subsample. The last two observables are the 3-month real Libor rate, and the United States's real GDP, as proxies for the world interest rate and foreign aggregate demand, respectively. We add measurement errors in consumption, investment and the trade balance share as they are they are the only variables that do not have a shock directly linked to them. The model is estimated on a balanced panel that covers the period 1999.Q2 to 2011.Q4. In the measurement equations the data are expressed in log-deviations from the Hodrick-Prescott trend and are measured in percent. Interest rates and EMBI are measured in logs of gross rates. We follow Kohli (2004), Kehoe and Ruhl (2008), and Adler and Magud (2012) by using real income instead of real GDP in the set of observables because the latter may mute the income effects that changes in terms of trade could produce. Real income is measured as nominal GDP deflated by the consumer price index as suggested in this literature.

We use fairly agnostic priors for the Bayesian estimation. We use a Beta distribution with mean 0.5 and standard deviation 0.15 for the autoregressive coefficients in all driving forces implying a prior highest density region at 90 percent probability between 0.25 and 0.74. The same prior distribution is used for η_{jF} and η_{jH} which measure the proportion of the wage and investment bills that need to be financed by firms and households. The prior distribution for $\Omega_{j,U}$ is Gamma with mean 0.05 and standard deviation 0.025, implying that the elasticity of the country risk premium to the debt level lies between 0.016 and 0.081 with a 90 percent probability. This allows to account for relatively high values of this parameter found in previous studies, e.g., García-Cicco et.al (2010). Smaller values are, nonetheless, also commonly used in the literature and our prior specification does not rule out that possibility. Finally, we choose a rather conservative approach and center the prior distribution for ω_j^{Co} and ω_j^R around zero using a normal distribution with standard deviation 0.015. In this case, the 90 percent bounds of the prior higher density region are $(-0.025, 0.025)$.

5 Estimation Results

This section presents the main results of the Bayesian estimation of the multi-country model presented in Section 3 with data from Brazil, Chile, Colombia and Peru. We divide the results into three subsections. First we present posterior distributions of the estimated parameters along with the two latent common factors that we back out from the estimation. Then we analyze the relative importance of the various driving forces in the business cycle of these economies. Finally, we inspect the main mechanisms behind the estimated model.

There are several novel findings. First and foremost, external drivers, mainly in the form of fluctuations in commodity prices, play a paramount role when accounting for aggregate cyclical dynamics in the four emerging economies considered. Close to 3/4 of the unconditional forecast error variance in output originates in these fluctuations. Moreover, the bulk of the action from commodity prices is recovered through large fluctuations in the common factor across economies. When inspecting the mechanism in place after these shocks we show that they reproduce business cycles akin to those in the data, and that if they are removed, the performance of the model decreases considerably. A further amplification mechanism for commodity price shocks works through their negative comovement with country spreads. Yet positive commodity price shocks have sometimes acted as cushion devices against what the model identifies as domestic forces. This was particularly the case in the fast recovery after the world financial crisis.

5.1 Posterior Results and Common Factors

Posterior distributions of the estimated parameters are reported in Tables V.1a-b.[24] Overall the posterior densities are considerably different from the loose priors that we choose, implying that the data contain information on the estimated parameters. In terms of the parameters associated to the driving forces, the most salient result comes from the highly persistent and volatile commodity shock processes estimated. The AR(1) coefficient in the common factor of commodity prices, ϕ_{Co}, has a posterior mean of 0.92, the largest of all the driving forces estimated. Moreover, shocks to this common factor display an estimated standard deviation, $\sigma^{f^{Co}}$, of 5.23 percent, at least an order of magnitude larger than those of the other global shocks. The AR(1) parameters associated to the idiosyncratic components in commodity prices, ρ_j^{Co}, are also persistent although less than that of the common factor. The standard deviation of this shock is lower for Brazil and Peru, but not for Chile and Colombia. The presence of commodity prices reduces both the persistence of the (country-specific) productivity processes and the size of their shocks relative to previous business cycle studies. The posterior mean estimates of ρ_z range between 0.5 in Peru to 0.7 for Brazil.

Another salient result comes from the estimated coefficient that captures the semi-elasticity between the common factor in commodity prices and country spreads, ω^{Co}. Its posterior distribution moves far away to the left of the prior centered around zero. The

[24] The Appendix reports prior and posterior plots, including those of the measurement errors used in the estimation which we do not report for the sake of space.

posterior means are: -0.020 in Brazil; -0.009 in Chile; -0.015 in Colombia; and -0.011 in Peru. These numbers imply that, following a one standard deviation increase in f^{Co} (an increase of 7.2 percent), credit spreads decrease by 71, 29, 51, and 36 basis points in each of the four countries, respectively. This provides support for the works mentioned earlier that established a causal effect going from commodity prices to risk spreads in emerging economies either theoretically (Calvo and Mendoza, 2000) or historically (Eichengreen, 1996). On the other hand, the estimation is not picking a link that goes in the opposite direction: the posterior distribution for ω^R, the parameter capturing how the common factor in spreads affects commodity prices, is no different than our agnostic prior centered around zero.

The data is also informative on the parameters that govern the interest debt elasticity, Ω_{ju}. The posterior means lie far to the left of the prior in all countries and close to zero: 0.001 in Brazil and Chile; 0.004 in Colombia, and 0.002 in Peru. This implies a rather modest channel through which domestic debt dynamics affect interest rates. At first hand, these results may seem at odds with those in García-Cicco et.al (2010) who find estimated coefficients for this parameter that are much larger and related it to financial frictions shaping their model's response to aggregate disturbances. We think, however, that our model is also recovering financial frictions to the extent that spreads react to fundamentals in the form of commodity price shocks. Moreover, we are identifying another form of financial friction embedded in the working capital channel (absent in the latter study). Indeed the posterior estimates of η_{jF} and η_{jH} lie well above zero.

Lastly, Figure V.1 highlights the common factors that we back out from the estimation. The upper panel plots the common factor in commodity prices, f^{Co}. It displays large fluctuations, particularly in the second half of the sample. The increase in the years preceding the financial crisis, was followed by a sharp fall during the crisis and then a vigorous recovery within the next two years. Only to fall once more in the last year and a half of the estimated period. The lower panel plots the common factor in spreads, f^R, which displays two clear spikes, one in the early 2000s that followed the "Lula effect" after the presidential election in Brazil, and another one during the world financial crisis.

5.2 Business Cycle Drivers

We now use the estimated model to document the main business cycle drivers. Our first tool to accomplish this is the forecast error variance decomposition (FEVD) of output across the four countries and at various forecast horizons, summarized in Table V.2. The upper left panel of the table presents the contribution of each of the seven structural shocks and each of the countries unconditionally, while the other three panels report at alternative forecast horizons of one, four, and twelve quarters. The most important result in the first panel is the overwhelming preponderance of the common factor shock in commodity prices, $\sigma^{f^{Co}}$, which takes on more than half of the model's implied unconditional FEVD. The largest share is that of Peru with 73.3 percent, followed by Brazil (73.1), Colombia (60.6), and Chile (57.5). In the latter country, the idiosyncratic shock to commodity prices also plays a role with a share of 31.2, followed by Colombia (9.5), Peru (6.0), and Brazil (1.7). Thus, summing the common and idiosyncratic shocks, roughly 3/4 of the unconditional forecast error variance in output originates in fluctuations of commodity prices. This share is far higher than the one coming from the second shock in order of importance, which is the domestic productivity shock, which accounts for 21.2 of the variance in Colombia, followed by Peru (19.6), Brazil (12.0), and Colombia (11.2). The remaining four external shocks to foreign demand, the world interest rate and spreads (idiosyncratic and common) account for no more than 12 percent of output's unconditional FEVD.

The reason why the two commodity price shocks account for the lion's share of the unconditional FEVD is related to their large standard deviation and strong persistence, as documented earlier in Table V.1. When the FEVD is computed with only one quarter forecast horizon (upper right panel in Table V.2) the share of output's FEVD accounted by commodity price shocks decreases considerably, between 1/5 and 1/2. The domestic productivity shock accounts for the highest share, while the contribution of the remaining four shocks continue to be very small.

In order to gauge when, historically, have commodity price shocks contributed the most to business cycles in the four countries considered, we decompose the observed time series of output into the structural shocks of the model. The results, reported in Figure V.2, group the seven shocks into three groups: (i) *Domestic Shocks* captures domestic productivity shocks, ε^z; (ii) *Commodity Shocks* includes the common factor and country-specific shocks to commodity prices ($\varepsilon^{f^{Co}}$, ν_j^{Co}); and (iii) *Other Shocks* which puts together the four remaining shocks ($\varepsilon^{f^R}, \nu_j^R, \varepsilon^{Y^*}, \varepsilon^{R^*}$).[25] A common feature across the four decompositions is the preponderant role of commodity shocks. This is more marked within the two years that preceded the world financial crisis, which abruptly turned negative during the 2009 recession. As mentioned before (and reported in the alternative historical decompositions in the Appendix) the lion's share of these global shocks belongs to the common factor in commodity prices. Remarkably, these shocks turned positive in the recovery of the 2009 recession, and helped counter balance the negative domestic shocks that the model identifies for this period in most countries.

Table V.3 presents further evidence by running various counterfactual experiments on the historical decompositions. Starting from the second row, the table reports the standard deviation (S.D) of output predicted by the model if one or several shocks are counterfactually turned off. The numbers are reported as percentage of the observed S.D reported in the first row of the table. One of the most salient findings in Table V.3 is that the counterfactual S.D. falls considerably relative to observed one when the two commodity price shocks (common and idiosyncratic) are turned off. In Chile, for instance, the counterfactual S.D is 71.4 percent of the observed one. And the numbers are also considerable for Peru (78.1), Colombia (80.1), and, to a lesser extent, Brazil (97.1). Remarkably, these numbers are quite similar to the case where all six external shocks are turned off, reiterating that commodity shocks have taken most of the action coming from the external driving forces in the model. On the other hand, turning off the domestic productivity shock brings a considerable reduction of the S.D in output in Peru (36.2), Brazil (57.7), and Colombia (67.0). The other two experiments where we remove the two spread shocks (common and idiosyncratic) or the external demand and interest rate shocks do not make the counterfactual S.D fall much. In fact, in the latter the counterfactual numbers are *larger* than those observed in the data, implying that some of the other shocks helped reduce the volatility generated by these shocks.

[25] Evidently, this is only one of many ways in which one can group the shocks. The online Appendix presents various alternatives to this.

5.3 Inspecting the Mechanism

Why does the estimation of the model attribute such a paramount role to commodity price shocks, particularly those that are common across economies? To answer this we inspect the main mechanism at play behind this shock. Our inspection begins with the impulse response function (IRF) following a one S.D shock to the common factor in commodity prices, $\varepsilon^{f^{Co}}$. Figure V.3 presents IRFs for the variables in the model as deviations from steady state levels, for each of the four countries. A first thing to note is that this shock generates substantial and persistent deviations of output from its steady state. In Chile output increases close to 2 percent on impact and is still above steady state by 0.6 percent after 40 quarters. In Brazil, on impact, the deviation is close to 1 percent while in Colombia and Peru it is half of a percentage point, and quite persistent too. Hence, this shock allows the model to account both for the observed comovement of economic activity across EMEs and the procyclicality in commodity prices that were documented in Section 2.

Another remarkable aspect of the IRFs in Figure V.3 is that, within countries, the propagation mechanism of a commodity price shock generates dynamics that resemble "normal" business cycles in a typical emerging economy. Since investment and consumption also respond vigorously along with the expansion in output, the trade balance behaves countercyclically (on impact or with a lag), which is a well known empirical feature of emerging economies's business cycles. Another intrinsic dynamic to EMEs depicted by in these IRFs is that the expansionary phase is accompanied by an appreciation of the real exchange rate and a fall in the country interest. The latter occurs simultaneously, which further allows the model to account for the comovement in interest rates documented also in Section 2.

Table V.4 presents further evidence on the model's good performance by focusing on three key moments that were studied in Section 2: the contemporaneous correlation between output and spread, $corr\left(Y, z^R\right)$; output and commodity prices, $corr\left(Y, p^{Co}\right)$; and spread and commodity prices, $corr\left(z^R, p^{Co}\right)$. Qualitatively, the model does a good job in reproducing the procyclicality of commodity prices, the countercyclicality of spreads, and the negative comovement between these two variables. Quantitatively, the model is particularly good when accounting for the comovement of commodity prices and output in Chile, Colombia and Peru. Although it also overestimates some of the other moments. Still, one should keep in mind that the estimation was not designed to match these specific moments.

There are several channels behind the large real effects generated by a commodity price shock. Because it is an income shock, an increase in commodity prices pushes consumer demand for both external and domestic goods as the two are not perfectly substitutable. This pushes up the relative price of domestic goods so domestic producers react optimally by increasing their production, raising their demand for capital and labor, in turn pushing the rental price of capital and wages up. Under the type of preferences assumed, the increase in wages raises labor supply by households despite the rise in consumption. Thus equilibrium wages and labor expand. Investment and consumption move further away from their steady state because foreign goods are relatively cheaper, i.e. the real exchange rate appreciates.

A further amplification channel operates through the reduction in country spreads triggered by the commodity price shock. This reduction materializes in additional labor demand. We test how large this channel is by comparing the benchmark IRF of output against a counterfactual case where, *ceteris paribus*, we turn off the correlation between commodity prices and spreads (i.e. $\omega^{Co} = 0$). The results, reported in Figure V.4, show that the amplification is considerable in Brazil, Colombia and Peru.

The final tool that we use to inspect the key mechanism in the model is the comparison between our benchmark set up and reduced versions of it where we remove, sequentially, the main elements of its core set up. Table V.5 reports the FEVD decomposition of output in four alternative reduced versions of the benchmark model. The first version (upper left corner of the table) is the simplest version where we remove three elements from the benchmark case: commodity shocks (common or idiosyncratic), common spread shocks; and working capital requirements. The second reduced model (upper right panel) puts back the presence of working capital requirements. The third model (lower left panel) further reintroduces a common factor in spreads. Lastly, the fourth model (lower right panel) reintroduces commodity shocks but only of idiosyncratic nature, and differs only from our benchmark set up in not incorporating a common factor shock in commodity prices. The most remarkable result in this table is that the lion's share of the FEVD in the most simplified version is the domestic productivity shock, and this holds also in the second and third versions. It is only when commodity price shocks are added in the fourth case that the dominant role of technology shocks decreases. This is even further reduced when the common factor in commodity prices is included, as in the benchmark case, and absorbs most of the variance decomposition.

A similar picture emerges when one inspects the results from the marginal likelihood (ML) of the alternative models. The ML of the simplest model (3226) is lower than that of the benchmark model (3279, see bottom of Table V.1b). This relatively poor performance of the simplest model continues to be the case in the second and third models when working capital and common spread shocks are added (3221 and 3213, respectively). In the fourth model, when commodity shocks are added in the form of idiosyncratic perturbations, the ML improves considerably (3258). Still, this number continues to be lower than the one in our benchmark case when the common factor in commodity shocks is added.[26]

6 Robustness and Extensions

This section evaluates the robustness of our benchmark results. As reiterated in the last section, these results hinge on a crucial element in the benchmark model: the dynamic factor structure in commodity prices and spreads. Given this, we now see how do these results change under alternative specifications of this structure. In particular, we consider three alternatives. In the first one we allow for a more densely parameterized autoregressive process in the two common factors. Formally, we substitute Eqs. (10) and (11) for AR(2) processes

$$f_t^{Co} = \phi_{Co}^1 f_{t-1}^{Co} + \phi_{Co}^2 f_{t-2}^{Co} + \sigma^{f^{Co}} \varepsilon_t^{f^{Co}}, \qquad \varepsilon_t^{f^{Co}} \sim N(0,1) \tag{21}$$

$$f_t^{R} = \phi_{R}^1 f_{t-1}^{R} + \phi_{R}^2 f_{t-2}^{R} + \sigma^{f^{R}} \varepsilon_t^{f^{R}}, \qquad \varepsilon_t^{f^{R}} \sim N(0,1) \tag{22}$$

This allows us to capture potentially richer dynamics in the common factor dynamics. Second, we consider lagged effects of the two common factors on the observed country-specific

[26] In the alternative models 1 to 3, where commodity shocks are absent, we estimate a separate and independent AR(1) process for commodity prices. This allows the estimation of all models to have the same set of observables as the benchmark model, thereby rendering the comparison of ML valid across models.

dynamics of commodity prices and spreads. Formally, Eqs. (12) and (17) are substituted by

$$p_{j,t}^{Co} = \omega_{j,1}^{R} f_t^R + f_t^{Co} + \omega_{j,2}^{R} f_{t-1}^{R} + \omega_j^{R,Co} f_{t-1}^{Co} + \varepsilon_{j,t}^{Co} \tag{23}$$

$$z_{j,t}^{R} = f_t^R + \omega_{j,1}^{Co} f_t^{Co} + \omega_j^{Co,R} f_{t-1}^{R} + \omega_{j,2}^{Co} f_{t-1}^{Co} + \varepsilon_{j,t}^{R} \tag{24}$$

This allows us to account for richer interlinkages between current and past common factors and observed commodity prices and spreads. The last robustness jointly models the two previous cases. The results of these three variations to the dynamic factor structure in terms of the FEVD of the model are presented in Table VI.1. The results are quantitatively very robust in the sense that the shock to the common factor of commodity prices continues to be the one responsible for the largest share of the variance in output.

7 Concluding Remarks

This paper has shed light onto the nature and relative importance of external forces of aggregate fluctuations in emerging market economies. It has involved both a careful study of the stylized facts in the data and an attempt to structurally identify these external forces by estimating a dynamic, stochastic equilibrium model. We have found support for the view that these external forces are relevant and that their sources can be mostly traced back to exogenous changes in the prices of the commodity goods that these economies export. A salient characteristic of these movements -often comparable to a wild roller coaster ride- is that they share a common factor. The latter cannot be solely attributed to these economies exporting similar commodity goods. Indeed, the common factor arises also because there is a marked tendency for the price of different commodity goods to move in tandem. Furthermore, the real effects generated by the fluctuations in the prices of these commodity goods can be amplified by the fact that they are often accompanied by movements in interest rates in opposite directions. Lastly, while most often movements in these relative prices have amplified the business cycle of EMEs, there are instances where they have served as cushion devices against other forces. This was the case during the recovery after the world financial crisis when a rapid reversal of commodity prices helped to counter balance negative shocks of domestic and external sources.

The simplicity of the theoretical framework with which we have looked into the data has served us well for the kind of question that we set out to answer. However, its simplicity has also left aside important issues that are worth exploring in subsequent work. One important topic left aside is to try to uncover the role of government in the mechanism through which changes in commodity prices affect the real economy. The public sector may play a role in amplifying these external shocks to the extent that it is often the main stakeholder in the commodity producing firms of these economies. Also it is worth exploring the type of optimal fiscal and monetary policies that may be implemented to counteract the effect of these shocks.

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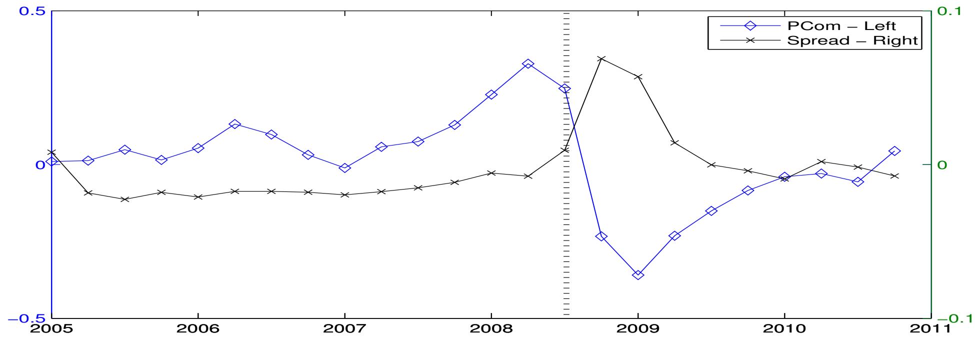
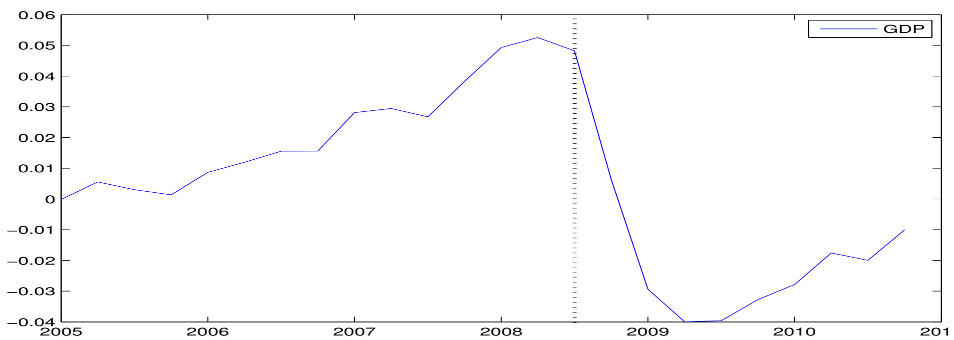
Figures and Tables

Figure I.1. The Great Recession in Emerging Economies



(a)



(b)

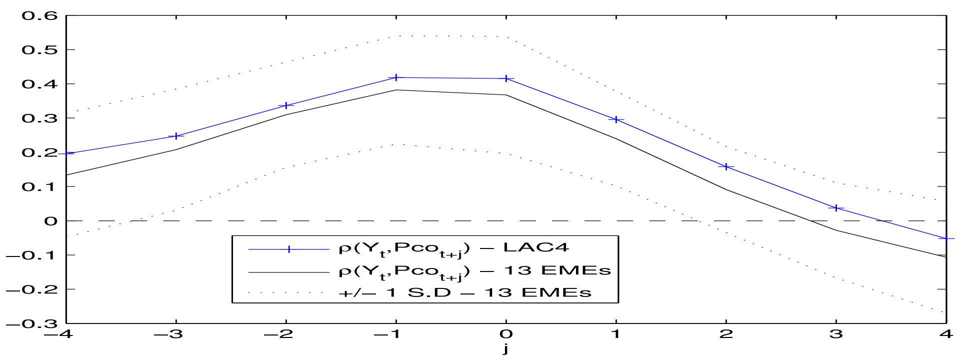
Note: The upper panel reports the cyclical average dynamics of the country-specific commodity indices (left axis) and EMBI spreads (right axis) for a pool of 13 EMEs between 2005 and 2011. The lower panel plots the average real GDP cycle in the same group of EMEs. The dotted line represents the quarter when Lehman bankruptcy was declared. Cyclical components were obtained with a Hodrick-Prescott filter (lambda of 1600). See Section 2 for the list of countries included and the Appendix for the sources and a description of the construction of the indices.

Table II.1. Commodity Export Shares

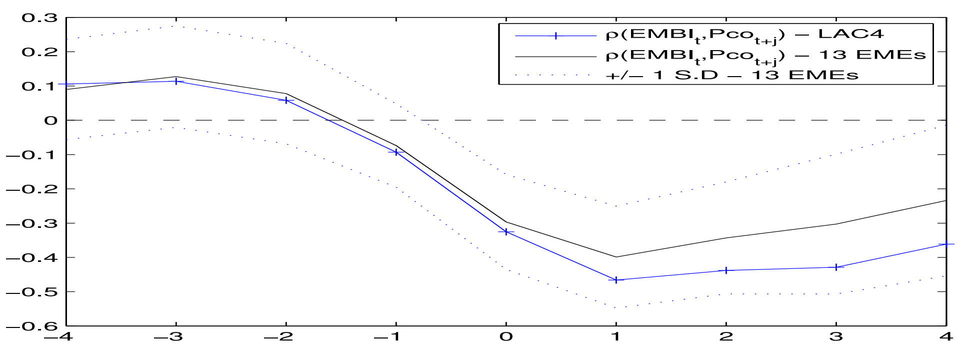
	All Countries	Advanced	Emerging	Low Income	Non-Emerging
Median	19.3	11.2	25.7	26.5	14
Mann-Whitney Test (against Emerging)		3.046 (0.0023)		-0.689 (0.4906)	-2.309 (0.0209)
Kruskall-Wallis Test			8.048 -0.0179		
No. of Countries	189	74	61	54	128
No. of observations (annual)	5514	2296	2205	1013	3309

Note: The first row reports the median commodity export share across various groups of countries (in percentages). Second and third rows report Mann-Whitney and Kruskal – Wallis tests statistics (p-values in parenthesis). Mann-Whitney tests are computed always relative to emerging economies. The Kruskal – Wallis test reports the results using three groups: advanced, emerging and low income. Data come from WDI in the form of an unbalanced annual panel of three kinds of commodity exports (agricultural, fuels, and metals). EMEs are classified as such if data on EMBI exist. Advanced and low-income are categorized according to World Bank's WDI indicators. The Appendix contains further information on the countries in each group and a description of the dataset.

Figure II.1. Cyclical Correlations



(a)



(b)

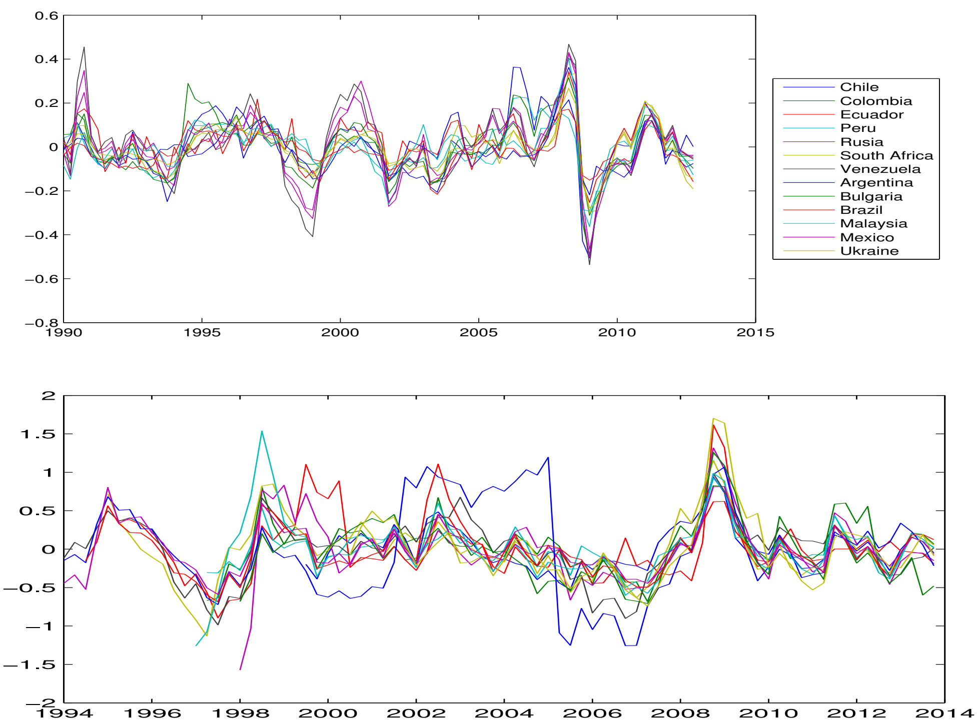
Note: Panel (a) reports the average correlation between real GDP in period t and country-specific commodity price indices in t+j with j=-4,. . . ,4, across 13 EMEs. Panel (b) reports the average correlation between EMBI spreads in period t and commodity price indexes in t+j across the same group of countries. Dotted lines report plus/minus one S.D. bands. Starred lines report the results for a smaller sub-group of EMEs in Latin America (Brazil, Chile, Colombia, and Peru). All statistics are computed with the cyclical components obtained using a Hodrick-Prescott filter (lambda of 1600). See the text for a complete list of countries. The appendix contains the exact range of quarterly time series used for each country.

Table II.2. Principal Component Analysis

Share of the variance explained by the first j principal components in:				
First **j** Principal Components	Country EMBI Spreads	Country Commodity Price Indices	SITC-one digit Commodity Goods	Real GDP
j =1	0.69	0.78	0.57	0.67
j =2	0.93	0.87	0.82	0.85
j =3	0.96	0.92	0.95	0.90

Note: The first row denotes the share of the variance explained by the first principal component in EMBI spreads (col. 1), commodity price indices (col. 2), commodity goods (col. 3), and real GDP (col. 4). The second and third rows denote the share of the variance explained by the first two and three principal components. For the case of Cols. 1, 2 and 4, the numbers refer to the pool of 13 EMEs studied in Figure II.1. Numbers in Col. 3 refer to an aggregation of the 44 commodity goods into 5 SITC categories (the Appendix contains further details of this aggregation). Each column was computed on a balanced panel of quarterly observations in the following ranges: 2000.Q3-2013.Q4 (Col. 1); 1990.Q1-2012.Q4 (Col. 2); 1991.Q1-2012.Q4 (Col. 3); 2000.Q1-2010.Q4 (Col. 4). All statistics are computed with the cyclical components obtained using a Hodrick-Prescott filter (lambda of 1600).

Figure II.2. Spreads and Commodity Price in Emerging Economies



Note: Upper panel (lower panel) reports the time series for the cyclical components of country-specific commodity price indices (EMBI spreads) across 13 EMEs. Cyclical components are computed as relative deviations from a Hodrick-Prescott trend (lambda of 1600). The appendix contains the exact range of quarterly time series used for each country, and further details on the data. The legend of the upper plot applies to the lower plot.

Table IV.1 Main Commodity Exports – LAC4

	Brazil	**Chile**	**Colombia**	**Peru**
Chicken	5.9	0.3	0.0	0.0
Fish	0.3	**12.4**	0.8	1.1
Bananas	0.1	0.0	6.6	0.0.1
Sugar	9	0.0	3	0.3
Coffee	8.5	0.1	**15**	4.4
Soybean Meal	9.3	0.0	0.1	0.0
Fish Meal	0.0	3.1	0.0	**15.5**
Soybeans	**12.5**	0.0	0.0	0.0
Soft Sawn	1.2	5.4	0.0	0.0
Iron	**16.5**	1.4	0.0	1.6
Copper	0.6	**69.6**	0.1	**21.9**
Aluminum	7.6	0.1	0.5	0.0
Zinc	0.2	0.1	0.0	11.1
Coal	0.0	0.0	**15.4**	0.0
Gold	1.7	2.7	2.1	**28**
Crude Oil	8.6	2.1	**52.8**	8.7
Others	17.9	2.8	3.7	7.2
Total	**100**	**100**	**100**	**100**

Note: The rows denote the share of total exports for 17 commodity goods in the four countries (columns) analyzed. Shares are averages between 1999 and 2004. See Appendix for further details of the sources.

Table IV.2. Calibrated Parameters

Parameters		Brazil	Chile	Colombia	Peru
	Calibrated parameters common to all countries				
$\overline{R^{\star}}$	Steady state external interest rate	1.01	1.01	1.01	1.01
γ_c	Inverse of labor supply elasticity	0.58	0.58	0.58	0.58
σ	Constant relative risk aversion coefficient	2.00	2.00	2.00	2.00
η_c	Elasticity of substitution - consumption bundle	0.99	0.99	0.99	0.99
η_x	Elasticity of substitution - investment bundle	0.99	0.99	0.99	0.99
δ	Capital depreciation rate (%)	10.00	10.00	10.00	10.00
ϵ_e	Price elasticity of exports	0.99	0.99	0.99	0.99
$\overline{Y}^{*}_{t}$	Steady state aggregate demand of ROW	1.00	1.00	1.00	1.00
$\bar{z}$	Steady state productivity level	1.00	1.00	1.00	1.00
	Calibrated parameters to match long run relations				
$\bar{D}$	Steady state level of external debt	31.72	3.99	10.38	12.48
ψ^c	Scale parameter in labor supply	5.39	14.71	6.94	10.22
α_c	Import share in consumption bundle	0.13	0.30	0.12	0.04
α_x	Import share in investment bundle	0.04	0.40	0.40	0.67
α	Capital share in production	0.32	0.39	0.34	0.37
$\overline{p^{Co}}$	Steady state level of commodity price	1.01	3.47	0.41	1.51
$100\left(1-\overline{z^R}\right)$	Steady state level of risk premium (%)	5.39	1.45	3.9	3.56
β	Discount factor	$\frac{1}{\overline{R^{\star}_t z^R_t}}$	$\frac{1}{\overline{R^{\star}_t z^R_t}}$	$\frac{1}{\overline{R^{\star}_t z^R_t}}$	$\frac{1}{\overline{R^{\star}_t z^R_t}}$

Note: World interest rate $\overline{R^{\star}}$, country spread $\overline{z^R}$ and the depreciation rate δ are presented in annual terms. ROW stands for rest of the world.

Table IV.3. Long Run Relations

Long run relations (%)	Brazil		Chile		Colombia		Peru	
	Model	Obs	Model	Obs	Model	Obs	Model	Obs
consumption / GDP	78.08	82.11	76.66	72.67	77.06	82.00	76.64	77.67
investment / GDP	17.74	17.74	23.16	23.16	21.00	21.00	22.22	22.22
Imports / GDP	10.79	11.31	32.54	31.33	17.65	19.00	18.06	18.11
Exports / GDP	14.96	11.45	32.72	35.49	19.59	16.00	19.21	18.19
Imported Invest / Invest	3.58	3.58	40.00	40.00	40.00	40.00	66.84	66.84
Home Invest / Invest	96.42	96.42	60.00	60.00	60.00	60.00	33.16	33.16
Imported cons / cons	13.00	13.00	30.36	30.36	12.00	12.00	4.19	4.19
Home cons / cons	87.00	87.00	69.64	69.64	88.00	88.00	95.81	95.81
Commodities exports / GDP	8.49	8.49	26.19	26.19	6.40	6.40	12.27	12.27
External real interest rate	6.44	6.44	2.46	2.46	4.94	4.94	4.60	4.60
External debt / GDP	66.39	66.39	7.54	7.54	40.00	40.00	25.31	25.31

Note: The long-run values are equal to the numbers reported in the model descriptions of the DSGE models currently used for policy analysis at the central bank in Brazil, Chile, Colombia and Peru. For Brazil see de Castro et.al (2011), Chile see Medina et.al (2007); Colombia see Gonzalez et.al (2011); for Peru see Castillo (2006).

Table V.1a. Estimated Parameters

parameters	prior mean	prior	pstdev	mode	s.d.	post. mean	90% HPD interval	
				Global				
$\rho_{Y^\star}$	0.50	beta	0.150	0.7988	0.0224	0.806	0.717	0.886
$\rho_{R^\star}$	0.50	beta	0.150	0.6858	0.0288	0.666	0.563	0.751
ϕ_R	0.50	beta	0.150	0.4348	0.039	0.451	0.340	0.556
ϕ_{Co}	0.50	beta	0.150	0.935	0.0154	0.922	0.888	0.959
				Brazil				
ρ^z	0.50	beta	0.150	0.615	0.0211	0.599	0.478	0.753
ρ^{Co}	0.50	beta	0.150	0.6762	0.0399	0.659	0.497	0.807
ρ^{z^R}	0.50	beta	0.15	0.5041	0.0474	0.537	0.409	0.680
a	0.50	gamma	0.250	0.232	0.0158	0.276	0.146	0.393
ω^R	0.00	norm	0.015	0.000	0.0137	0.001	-0.025	0.024
ω^{Co}	0.00	norm	0.015	-0.021	0.0071	-0.020	-0.032	-0.009
Ω_u	0.05	gamma	0.025	0.001	0.0003	0.001	0.000	0.002
η_F	0.50	beta	0.150	0.2846	0.0245	0.331	0.188	0.479
η_H	0.50	beta	0.150	0.5784	0.0469	0.516	0.309	0.719
				Chile				
ρ^z	0.50	beta	0.150	0.6697	0.0518	0.665	0.544	0.793
ρ^{Co}	0.50	beta	0.150	0.8135	0.0344	0.814	0.745	0.881
ρ^{z^R}	0.50	beta	0.150	0.3549	0.0384	0.332	0.200	0.462
a	0.50	gamma	0.250	1.0074	0.0657	1.157	0.964	1.343
ω^R	0.00	norm	0.015	-0.0000	0.0173	0.002	-0.023	0.028
ω^{Co}	0.00	norm	0.015	-0.0092	0.0061	-0.009	-0.020	0.001
Ω_u	0.05	gamma	0.025	0.0010	0.0005	0.001	0.001	0.002
η_F	0.50	beta	0.150	0.5096	0.0215	0.447	0.346	0.568
η_H	0.50	beta	0.150	0.5862	0.0374	0.528	0.395	0.654
				Colombia				
ρ^z	0.50	beta	0.150	0.5306	0.0345	0.791	0.542	0.975
ρ^{Co}	0.50	beta	0.150	0.7257	0.0339	0.712	0.627	0.800
ρ^{z^R}	0.50	beta	0.150	0.7195	0.0334	0.649	0.522	0.771
a	0.50	gamma	0.250	0.444	0.0346	0.502	0.308	0.697
ω^R	0.00	norm	0.015	-0.0000	0.0124	0.001	-0.025	0.026
ω^{Co}	0.00	norm	0.015	-0.0157	0.0055	-0.015	-0.025	-0.005
Ω_u	0.05	gamma	0.025	0.0035	0.0021	0.004	0.001	0.007
η_F	0.50	beta	0.150	0.5091	0.0544	0.494	0.250	0.712
η_H	0.50	beta	0.150	0.4291	0.036	0.448	0.345	0.564
				Peru				
ρ^z	0.50	beta	0.150	0.4953	0.0404	0.572	0.356	0.792
ρ^{Co}	0.50	beta	0.150	0.7267	0.0411	0.692	0.600	0.784
ρ^{z^R}	0.50	beta	0.150	0.6517	0.0462	0.607	0.475	0.728
a	0.50	gamma	0.250	0.6966	0.0242	0.777	0.672	0.870
ω^R	0.00	norm	0.015	-0.0001	0.0143	-0.001	-0.027	0.028
ω^{Co}	0.00	norm	0.015	-0.0103	0.0046	-0.011	-0.020	-0.002
Ω_u	0.05	gamma	0.025	0.0009	0.0005	0.002	0.000	0.003
η_F	0.50	beta	0.150	0.5373	0.0221	0.555	0.408	0.740
η_H	0.50	beta	0.150	0.4723	0.039	0.490	0.306	0.692

Note: **:** This table shows the priors and posteriors based on 100,000 draws from the Metropolis-Hastings (MH) algorithm, discarding the first 50,000 draws. The mean and covariance matrix of the proposal density for the MH algorithm were the maximum of the posterior distribution and the negative inverse Hessian around that maximum obtained with Nelder-Mead simplex based optimization routine. The computations were conducted using Dynare 4.4.2. HPD stands for higher posterior density.

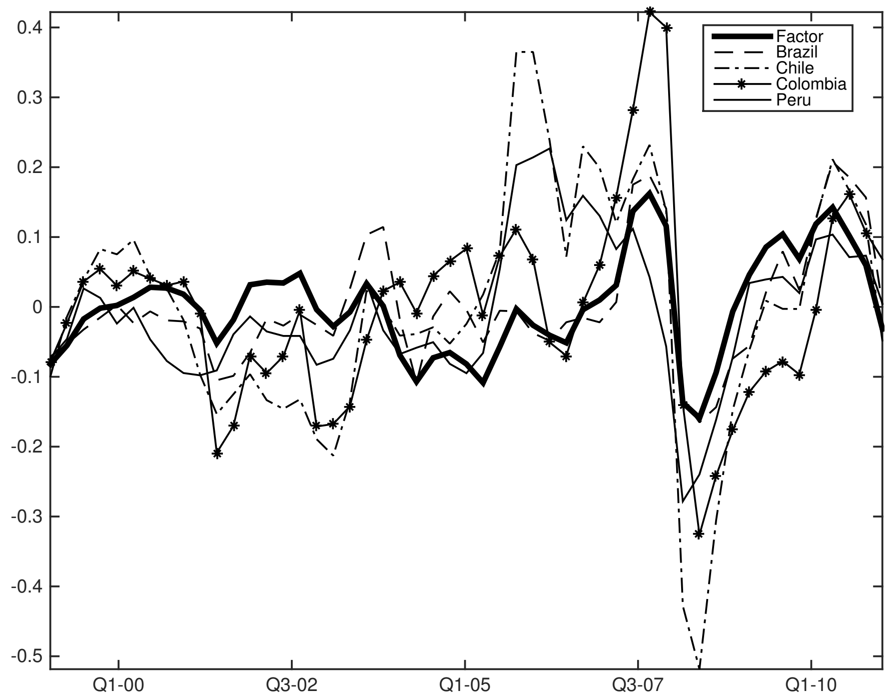
Table V.1b. Estimated Standard Deviations of the Shocks

s.d. of the shocks	prior mean	prior	pstdev	mode	s.d.	post. mean	90% HPD interval	
				Global				
$\sigma^{Y^\star}$	0.01	invg	Inf	0.0064	0.0006	0.007	0.005	0.008
$\sigma^{R^\star}$	0.01	invg	Inf	0.0024	0.0002	0.002	0.002	0.003
σ^{f^R}	0.01	invg	Inf	0.0021	0.0003	0.002	0.002	0.003
$\sigma^{f^{Co}}$	0.01	invg	Inf	0.0523	0.0063	0.055	0.044	0.066
				Brazil				
σ^{z^R}	0.01	invg	Inf	0.0032	0.0004	0.003	0.003	0.004
σ^{Co}	0.01	invg	Inf	0.0386	0.0053	0.038	0.028	0.048
σ^{z}	0.01	invg	Inf	0.013	0.0014	0.014	0.011	0.016
				Chile				
σ^{z^R}	0.01	invg	Inf	0.0019	0.0002	0.002	0.002	0.002
σ^{Co}	0.01	invg	Inf	0.0773	0.0079	0.077	0.063	0.092
σ^{z}	0.01	invg	Inf	0.0302	0.0028	0.031	0.026	0.036
				Colombia				
σ^{z^R}	0.01	invg	Inf	0.0018	0.0002	0.002	0.002	0.002
σ^{Co}	0.01	invg	Inf	0.0737	0.0094	0.073	0.057	0.087
σ^{z}	0.01	invg	Inf	0.0101	0.0011	0.010	0.008	0.012
				Peru				
σ^{z^R}	0.01	invg	Inf	0.0017	0.0002	0.002	0.002	0.002
σ^{Co}	0.01	invg	Inf	0.0462	0.0052	0.049	0.039	0.060
σ^{z}	0.01	invg	Inf	0.0101	0.0010	0.010	0.009	0.012

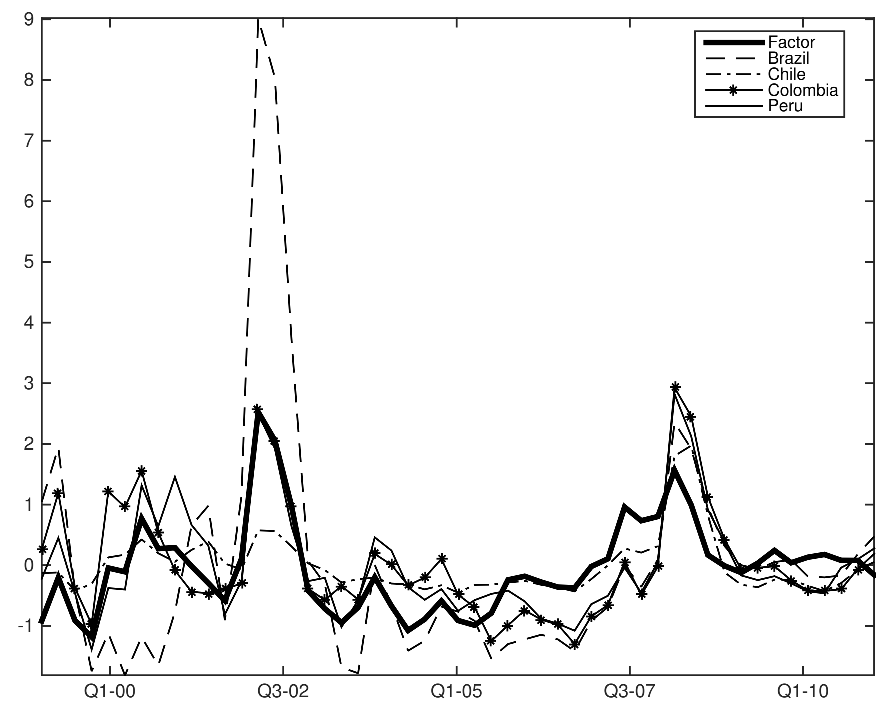
Marginal Likelihood: 3278.7

Note: This table shows the priors and posteriors based on 100,000 draws from the Metropolis-Hastings (MH) algorithm, discarding the first 50,000 draws. The mean and covariance matrix of the proposal density for the MH algorithm were the maximum of the posterior distribution and the negative inverse Hessian around that maximum obtained with Nelder-Mead simplex based optimization routine. The computations were conducted using Dynare 4.4.2. The marginal likelihood is computed with Geweke's modified harmonic mean.

Figure V.1. Common Factors



(a) Commodities



(b) Spreads

Note: The common factor is the latent variable obtained from the Kalman filter smoothing evaluated at the mean of the posterior distribution.

Table V.2 Forecast Error Variance Decomposition of Output

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	5.22	0.06	3.29	0.64
$\varepsilon^{Y^\star}$	0.02	0	0.23	0.02
ε^{f^R}	1.8	0.02	1.24	0.22
$\varepsilon^{f^{Co}}$	73.09	57.5	60.63	73.3
		Country Specific		
ν^R	6.2	0.04	3.84	0.22
ν^{Co}	1.69	31.16	9.53	5.98
ε^z	11.98	11.22	21.23	19.6

(a) Unconditional

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	1.23	0.1	1.29	0.05
$\varepsilon^{Y^\star}$	0.01	0.00	0.05	0.00
ε^{f^R}	0.55	0.05	0.72	0.07
$\varepsilon^{f^{Co}}$	17.91	18.95	11.8	11.27
		Country Specific		
ν^R	1.6	0.06	1.11	0.04
ν^{Co}	3.02	31.69	11.16	9.93
ε^z	75.68	49.15	73.87	78.65

(b) Conditional (one quarter ahead)

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	1.89	0.12	1.91	0.12
$\varepsilon^{Y^\star}$	0.01	0.00	0.06	0.00
ε^{f^R}	0.64	0.04	0.7	0.06
$\varepsilon^{f^{Co}}$	33.91	32.64	22.32	21.65
		Country Specific		
ν^R	2.23	0.08	2.16	0.05
ν^{Co}	2.95	39.98	11.34	10.01
ε^z	58.37	27.15	61.51	68.11

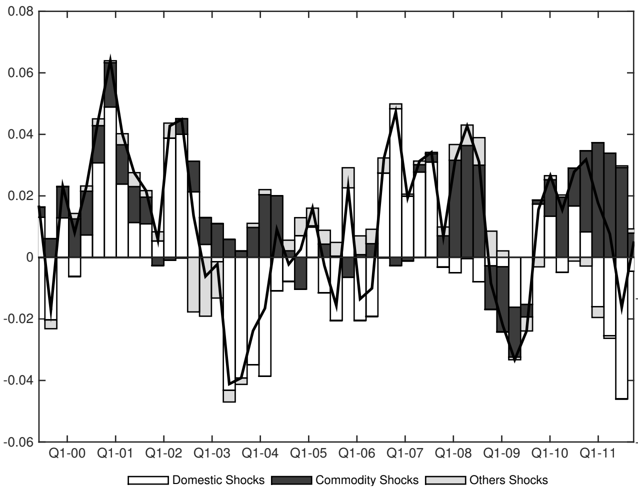
(c) Conditional (four quarters ahead)

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	2.54	0.09	2.49	0.64
$\varepsilon^{Y^\star}$	0.01	0	0.08	0
ε^{f^R}	0.8	0.02	0.81	0.16
$\varepsilon^{f^{Co}}$	53.33	46.27	40.41	44.16
		Country Specific		
ν^R	2.91	0.06	3.39	0.19
ν^{Co}	2.27	36.61	10.03	7.89
ε^z	38.14	16.95	42.78	46.95

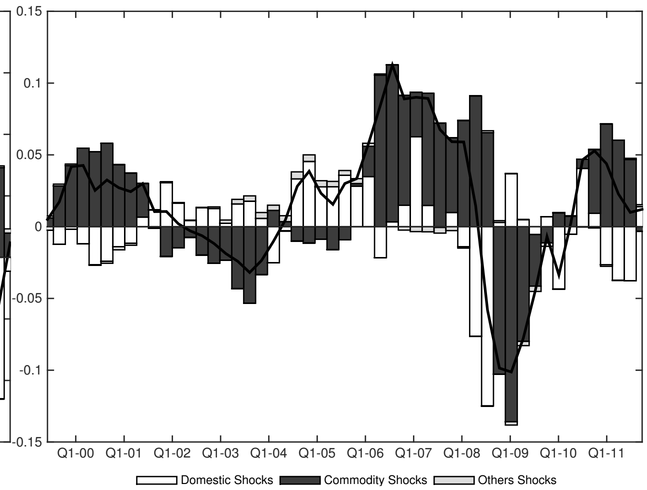
(d) Conditional (twelve quarters ahead)

Note: The panels report the forecast error variance decomposition (FEVD) calculated at the posterior mean of output for four alternative forecast horizons.

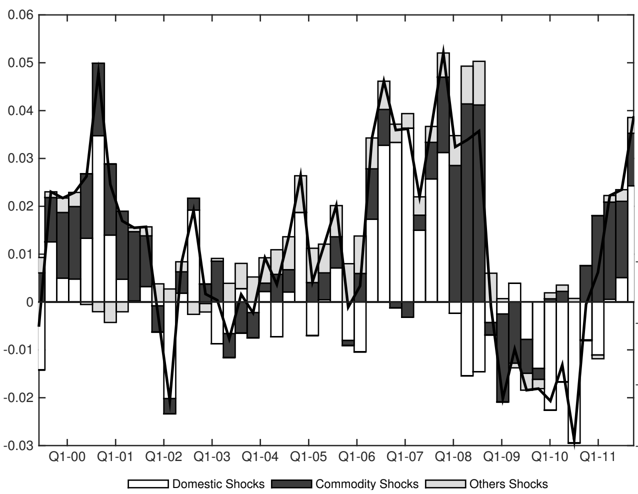
Figure V.2 Historical Decomposition of Output



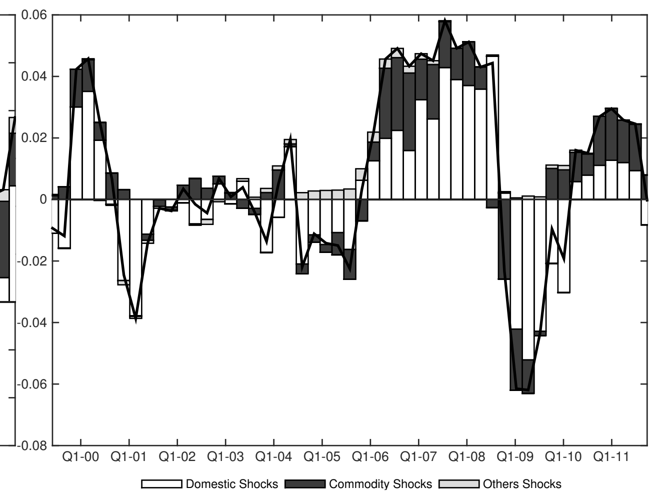
(a) Brazil



(b) Chile



(c) Colombia



(d) Peru

Note: Domestic shocks: Domestic productivity (ε^z); Commodity shocks: idiosyncratic commodity price (ν^{Co}) and Common factor in commodity prices $\left(\varepsilon^{f^{Co}}\right)$; Other shocks: Idiosyncratic spread (ν^R), World riskless interest rate $\left(\varepsilon^{R^\star}\right)$, World demand $\left(\varepsilon^{Y^\star}\right)$ and Common factor in spreads $\left(\varepsilon^{f^R}\right)$.

Table V.3 Counterfactual Historical Decompositions Experiments

shocks	Brazil	Chile	Colombia	Peru
S.D. of observed GDP cycle	0.0241	0.0458	0.0206	0.0301
Counterfactual S.D. excluding each shock separately (in percent of the observed S.D) (%)				
ν^R (Idiosyncratic spread)	93.4	100.2	98.1	99.7
ν^{Co} (Idiosyncratic commodity price)	104.6	54.8	79.6	87.4
ε^z (Domestic productivity)	57.7	109.6	67.0	36.2
$\varepsilon^{R^\star}$ (World interest rate)	106.2	102.2	102.4	100.7
$\varepsilon^{Y^\star}$ (World demand)	99.2	99.3	98.1	100.7
ε^{f^R} (Common factor in spreads)	97.9	99.1	97.6	99.3
$\varepsilon^{f^{Co}}$ (Common factor in commodity prices)	92.9	107.2	102.4	95.0
S.D. of GDP cycle excluding all external shocks (%)				
$\left\{\nu^R, \nu^{Co}, \varepsilon^{R^\star}, \varepsilon^{Y^\star}, \varepsilon^{f^R}, \varepsilon^{f^{Co}}\right\}$	93.4	71.0	80.6	77.7
S.D. of GDP cycle excluding two external idiosyncratic shocks (%)				
$\left\{\nu^R, \nu^{Co}\right\}$	98.8	53.7	77.7	87.0
S.D. of GDP cycle excluding two common factor shocks (%)				
$\left\{\varepsilon^{f^R}, \varepsilon^{f^{Co}}\right\}$	90.0	106.1	99.5	93.7
S.D. of GDP cycle excluding external demand and world riskless interest rate shocks (%)				
$\left\{\varepsilon^{R^\star}, \varepsilon^{Y^\star}\right\}$	105.8	101.7	100.5	101.3
S.D. of GDP cycle excluding two spread shocks (%)				
$\left\{\nu^R, \varepsilon^{f^R}\right\}$	92.1	99.3	76.7	98.7
S.D. of GDP cycle excluding two commodities price shocks (%)				
$\left\{\nu^{Co}, \varepsilon^{f^{Co}}\right\}$	97.1	71.4	80.1	78.1

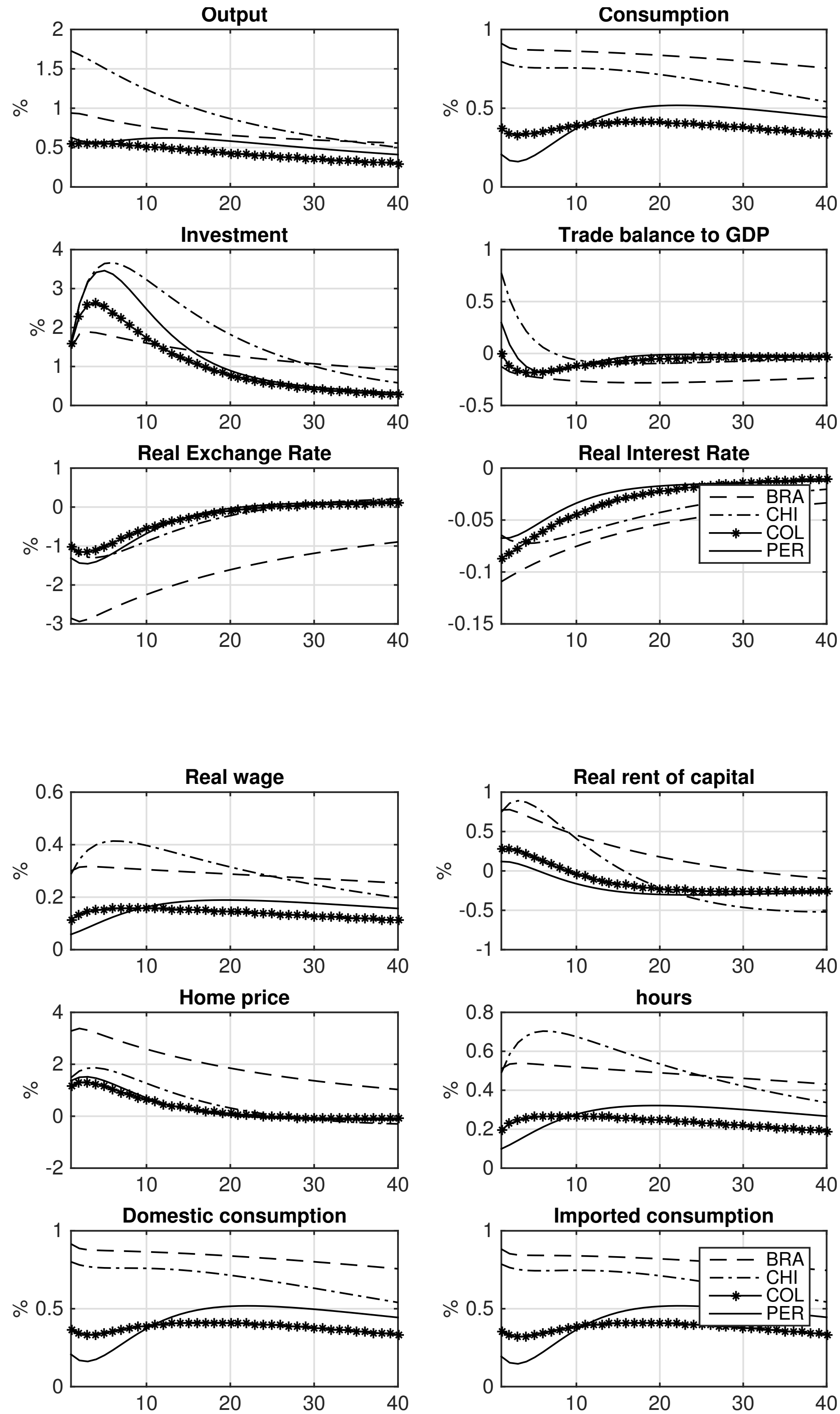
Note: The table presents in rows two and below the counterfactual standard deviation (S.D) of output implied by the model when one or several of the structural shocks are turned off. The numbers reported are in percentage of the observed S.D presented in the first row computed over the entire sample period.

Table V.4. Second Moments

	Brazil		**Chile**		**Colombia**		**Peru**	
	Data	**Model**	**Data**	**Model**	**Data**	**Model**	**Data**	**Model**
$corr\left(Y, z^R\right)$	-0.20	-0.66	-0.66	-0.68	-0.24	-0.49	-0.53	-0.42
$corr\left(Y, p^{Co}\right)$	0.22	0.53	0.83	0.83	0.69	0.60	0.80	0.61
$corr\left(z^R, p^{Co}\right)$	-0.14	-0.53	-0.64	-0.57	-0.30	-0.45	-0.61	-0.47

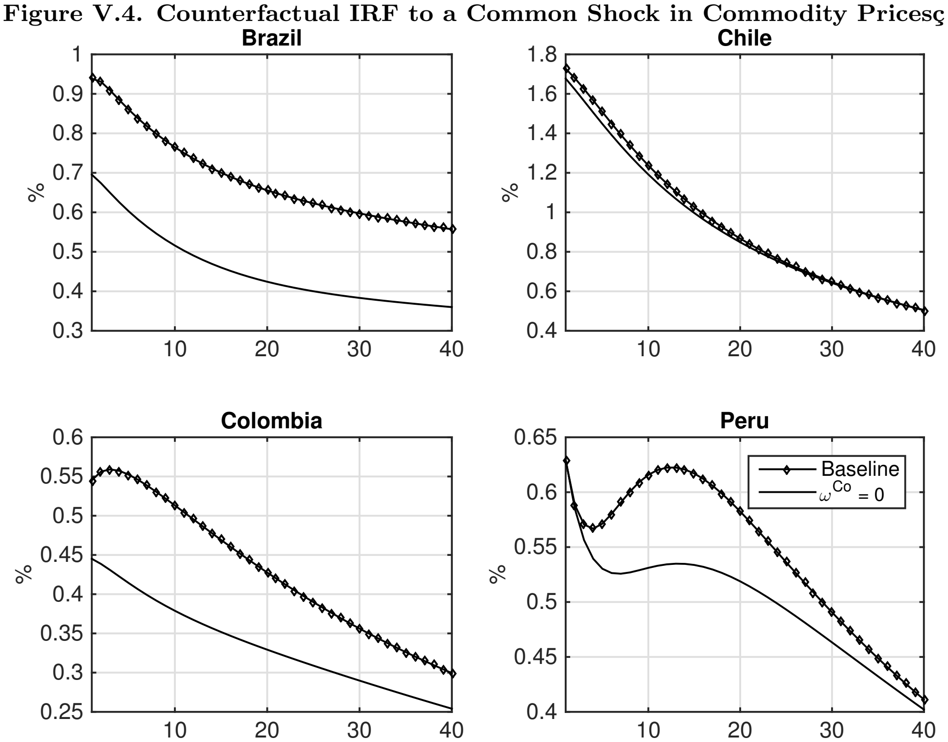
Note: *corr* denotes contemporaneous correlation; Y is real income; z^R is interest rate spread; and p^{Co} is the commodity price index. Columns labelled Data report the statistics based on the data that is used to estimate the model (see text for further details). Columns labelled Model report the same statistics generated by the benchmark model using the posterior means.

Figure V3. Impulse Responses to a Common Shock in Commodity Prices



Note: The subplots present the impulse response functions following a common factor shock in commodity prices. Units are percentage deviations from steady state levels.

Figure V.4. Counterfactual IRF to a Common Shock in Commodity Pricesç



Note: The figure reports the IRF of output when the semi-elasticity that governs the response of spreads to changes in the common factor of commodity prices is counterfactually set to zero, holding everything else constant.

Table V.5. Variance Decomposition of Output: Alternative Models

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	18.87	0.04	4.63	0.22
$\varepsilon^{Y^\star}$	0.1	0.01	0.75	0.08
ε^{f^R}	-	-	-	-
$\varepsilon^{f^{Co}}$	-	-	-	-
		country specific		
ν^R	28.82	0.03	3.29	0.28
ν^{Co}	-	-	-	-
ε^z	52.21	99.91	91.33	99.42
Marginal likelihood				3225.9

(a) Basic RBC model

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	19.76	0.22	8.21	0.54
$\varepsilon^{Y^\star}$	0.08	0.02	0.68	0.11
ε^{f^R}	-	-	-	-
$\varepsilon^{f^{Co}}$	-	-	-	-
		country specific		
ν^R	29.77	0.13	5.33	0.64
ν^{Co}	-	-	-	-
ε^z	50.39	99.63	85.78	98.7
Marginal likelihood				3220.7

(b) Basic RBC + Working Capital

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	16.95	0.08	3.36	0.36
$\varepsilon^{Y^\star}$	0.09	0.01	0.25	0.1
ε^{f^R}	10.06	0.06	2.04	0.34
$\varepsilon^{f^{Co}}$	-	-	-	-
		country specific		
ν^R	22.32	0.12	50.79	0.37
ν^{Co}	-	-	-	-
ε^z	50.57	99.73	43.56	98.82
Marginal likelihood				3213.2

(c) RBC + WK + Common Factor f^R

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	22.41	0.18	7.88	2.15
$\varepsilon^{Y^\star}$	0.06	0	0.42	0.08
ε^{f^R}	5.08	0.03	2.25	0.69
$\varepsilon^{f^{Co}}$	-	-	-	-
		country specific		
ν^R	22.85	0.14	17.24	3.18
ν^{Co}	16.6	81.14	32.45	22.75
ε^z	32.99	18.5	39.75	71.14
Marginal likelihood				3257.8

(d) RBC + WK + Common Factor f^R+ ν^{Co}

Note: The panels report the forecast error variance decomposition (FEVD) calculated at the posterior mean of output for four alternative reduced models. Panel (a): Benchmark model with no commodity shocks, working capital needs, or common factor in spreads; Panel (b): Benchmark model with no commodity shocks, or common factor in spreads; Panel (c): Benchmark model with no commodity shocks; Panel (d): Benchmark model with no common factor shocks in commodity prices (only idiosyncratic). Marginal Likelihood are computed with Geweke´s modified harmonic mean.

Table VI.1 Forecast Error Variance Decomposition: Alternative Dynamic Factor Structure

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	18.65	0.27	9.09	1.98
$\varepsilon^{Y^\star}$	0.04	0	0.39	0.05
ε^{f^R}	5.17	0.06	3.2	0.58
$\varepsilon^{f^{Co}}$	43.9	44.22	36.89	45.26
		Country Specific		
ν^R	10.75	0.12	4.19	0.8
ν^{Co}	2.04	32.95	11.61	8.92
ε^z	19.44	22.37	34.63	42.41

(a) AR 2 process for common factor

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	13.79	0.2	7.61	1.4
$\varepsilon^{Y^\star}$	0.04	0	0.39	0.05
ε^{f^R}	3.55	0.04	2.38	0.43
$\varepsilon^{f^{Co}}$	47.89	41.2	37.26	44.18
		Country Specific		
ν^R	11.75	0.12	4.22	1.13
ν^{Co}	2.13	36.26	11.78	10.05
ε^z	20.84	22.18	36.35	42.75

(b) Lagged effect of common factors on Commodity and EMBI

shocks	Brazil	Chile	Colombia	Peru
		Global		
$\varepsilon^{R^\star}$	18.61	0.34	8.26	2.24
$\varepsilon^{Y^\star}$	0.03	0	0.31	0.05
ε^{f^R}	4.45	0.05	2.52	0.57
$\varepsilon^{f^{Co}}$	42.1	41.65	31.95	42.65
		Country Specific		
ν^R	11.65	0.05	1.79	0.35
ν^{Co}	2.15	34.94	16.08	9.94
ε^z	21.01	22.96	39.1	44.2

(c) AR 2 process for common factor and lagged effect on Commodity and EMBI

Note: The panels report the forecast error variance decomposition (FEVD) calculated at the posterior mean of output for three alternative specifications of the dynamic factor structure