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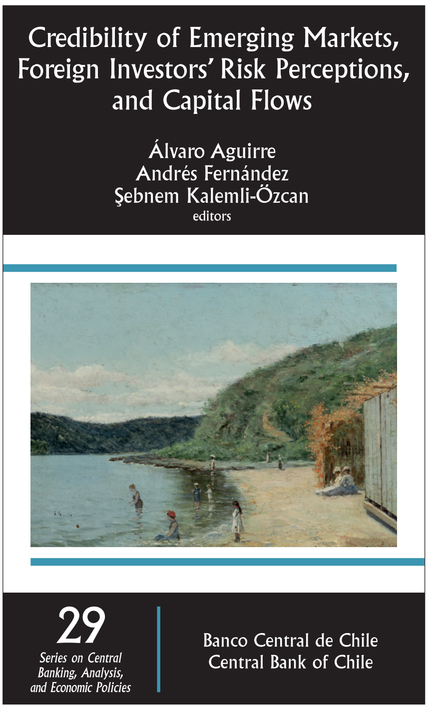

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A common view held by academics as well as policymakers assigns an important role to global factors as drivers of fluctuations in economic activity in emerging market economies (EMEs). This follows naturally from the fact that these economies are often small and open to trade in global goods and capital markets, which makes them vulnerable to shocks in these markets. However, the nature of these global forces as well as their transmission mechanism into EMEs continues to be

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debated and is the subject of an active research area in international macroeconomics. While an influential view postulates a financial origin in the form of a global financial cycle (Miranda-Agrippino and Rey, 2020), others have argued in favor of alternative global forces in the form of fluctuations in commodity prices (Fernández and others, 2017, 2018, 2020), changes in sovereign risks (Longstaff and others, 2011; Aguiar and others, 2016), and a common growth factor among EMEs (Claessens and others, 2012).

This paper aims at identifying the global forces that matter the most for EMEs, how they are interrelated, and the way they shape the business cycle in these economies. Our strategy is divided into two steps. First, we estimate a global dynamic factor model by using data from a set of EMEs as well as other variables from advanced economies, and international prices in goods and financial markets. Importantly, given the array of alternative origins of these global forces, our identification assumptions encompass the different views in the literature by allowing for three distinct global factors to coexist: a *financial* factor that captures the comovement of financial variables across countries; a *price* factor that accommodates joint movements in commodity, import prices, and CPIs; and a *growth* factor that captures any further comovement in GDP across EMEs that the aforementioned forces cannot explain and may come, for instance, from common variations in total factor productivity.

While the global dynamic factor model is enough to obtain a proper identification of the three factors and the way they are interrelated, it cannot provide a detailed analysis of the transmission mechanism of shocks to these factors in the EMEs considered. For that purpose, the second step of our analysis zooms in on Chile—one of the countries in our sample of EMEs—and embeds the dynamic factor model as another layer of the Extended Model for Analysis and Simulation (XMAS), which is the large-scale DSGE model used regularly at the Central Bank of Chile for policy analysis and forecasting (García and others, 2019). This allows us to combine the estimated comovement of the global forces pinned down by the dynamic factor model with the rich structure of the DSGE, thereby providing us with an appropriate setup to analyze the transmission mechanism of global disturbances into the Chilean economy. In addition, because the enlarged model inherits the estimated Taylor rule, we can study the way in which changes in global factors trigger monetary policy responses.

Our work highlights three main findings. First, the three estimated global factors display strong comovement, with a preponderance of the financial factor affecting the two other ones. Indeed, a shock to the financial factor—akin to a relaxation of global financial conditions—induces a *risk-on*-type of (delayed) response in the other factors whereby growth in EMEs rises and prices increase. A shock to the price factor, on the other hand, is consistent with a global cost-push shock that triggers a contraction of the growth factor along with price factor hikes and a fall in the financial factor. Shocks to the growth factor have relatively modest effects on the other two factors.

Second, consistent with the conventional wisdom that global forces matter for EMEs, we find that the three identified factors explain an important share of the business cycle in the sample of EMEs considered. Indeed, they account for more than a third of the variance in GDP (39%), of which the financial and price factors explain the majority and the growth factor explains a relatively more modest share. The factors also have the ability to explain an important share of the variance of sovereign risk across the sample EMEs (24%) and even more of their stock-market indices (67%), with the financial factor accounting for the lion's share. Lastly, shocks to the three estimated factors account for a strikingly high share of the variance of the other global variables considered, like GDP and CPIs of EMEs' trading partners (39% and 43%, respectively), import price indices (43%), exchange rates against the U.S. dollar (49%), and world commodity prices (30%). Once again, shocks to the global financial and price factors appear as the main driving force behind this comovement in global variables.

Following a shock to the estimated global financial factor, EMEs' GDP increase, EMBIs fall while stock markets boom, inflation accelerates (with a delay) fueled by swelling import prices along with hikes in the prices of the main commodities exported. In contrast, a shock to the price factor increases the price of imports more than the price of the main commodity exported, which triggers a boost in inflation, a slowdown in economic activity and stock markets, and a rise in sovereign risks. Lastly, a shock to the growth factor that boosts GDP across EMEs implies only modest expansions in inflation and stock-market activity, and even milder drops in EMBIs. Our main results carry on with plausible alternative identification assumptions. Even when we rule out a contemporaneous effect of the financial factor on EMEs' GDP, we still get its already documented preponderant role. This shows, perhaps surprisingly, that global financial forces have the ability to affect economic activity in EMEs regardless of the modeling stance on the contemporary, direct link between them and economic activity.

Our third key result relates to the transmission mechanism of global factors to domestic EMEs' variables. The baseline factor model also allows us to quantitatively assess the relative importance of global factors to both global and domestic variables: while the financial factor explains the most significant part of the variance of global variables, in the case of growth and inflation rates of EMEs, the global price factor entails a comparable role.

The augmented DSGE model for the Chilean economy allows us to study those results more closely. A key finding from the analysis reveals that the relevance of the global financial factor in affecting domestic variables gets dampened, while the opposite happens regarding the global price factor. In order to grasp this contrasting result, we first note that the transmission channel from global factors to domestic variables in the model is not direct but operates through other global variables, such as commodity prices and global demand. Hence, the ultimate role played by factors on the dynamics of domestic variables hinges subsequently on the extent to which shocks to these factors affect global variables, which only then translates into EMEs' performance. Therefore, while a shock to the global financial factor triggers movements in global variables that steer domestic variables in opposing directions, after a global price shock, in contrast, such offsetting effect in domestic variables is no longer present.

The quantitative features of the way in which domestic EMEs' variables correlate with shocks to global forces have relevant policy implications for these economies. In contrast to shocks to the financial factor, monetary policy should react more strongly to price shocks: even though global variables react individually less in this latter case, they all push the economy in the same direction, which ends up calling for a bolder monetary policy response.

The rest of the paper is divided into three sections: Section 1 presents results from the estimated dynamic factor model. Section 2 embeds the dynamic factor structure into the Chilean large-scale DSGE model. Concluding remarks are presented in section 3. Additional material is gathered in the Appendices.

1. A Structural Factor Model

When building the dynamic factor model, we are guided by the literature on global macroeconomic forces shaping the business cycle of EMEs: we postulate a set of common global factors that encompass the various views from the literature. Indeed, regarding the global forces that previous research has documented, the cornerstone pieces involve a global financial cycle (Miranda-Agrippino and Rey, 2020), the price of commodities (Fernández and others, 2017; Fernández and others, 2018; Fernández and others, 2020), sovereign debt spreads (Longstaff and others, 2011; Aguiar and others, 2016), and growth factors (Kose and others, 2012).

Building upon this literature, our modeling strategy writes down our panel dataset as a linear function of three unobserved common factors that, without loss of generality, we associate with financial, price, and growth forces. Crucially, our approach is nonetheless agnostic in terms of how relevant each factor is and the extent to which the three factors are interrelated. By estimating the model, we let the data speak on these issues.

We impose some structure on the contemporary behavior of factors in the estimation stage of a state-space formulation with parameter constraints. More precisely, we impose constraints on the loading matrix of the observation equations. Thus, by limiting the effects of certain factors on, say, commodity prices or financial variables, we are able to associate these factors with certain subsets of the time series data observed. Therefore, our approach allows for the estimation of a set of common factors with an ex-ante association to specific macroeconomic phenomena.

1.1 Data

We estimate our model by using an unbalanced quarterly panel dataset between 2003Q1 to 2018Q4. Similar to Fernández and others (2018) and Bajraj and others (2021), our sample includes mainly commodity-exporting EMEs, namely, Argentina, Brazil, Bulgaria, Chile, Colombia, Ecuador, Malaysia, Mexico, Peru, Russia, South Africa, and Ukraine. For each of these countries, we include a set of variables that characterize EMEs' business cycle (we call them "EME variables"), and another set with EMEs' most relevant external variables (we call them "global variables"). In the first group we include each EME's real GDP,[1] CPI,[2] EMBI Spread,[3] and major stock market

1. IMF data, except Central Reserve Bank of Peru for Peru; and OECD for Russia and South Africa.

2. IMF data, except Bloomberg for Argentina.

3. JP Morgan EMBI Global spreads, from Bloomberg. Following Aguiar and others (2016), we deflate each EME's EMBI with the country's external debt (% of GDP, from the World Bank) and GDP growth (see footnote 10).

indices.[4] In the group of global variables we include each country's import price index;[5] the prices of the top-ten commodities exported by EMEs (crude oil, copper, aluminum, natural gas, coal, iron, gold, coffee, bananas, soybean meal);[6] and real GDP, CPI, and exchange rate (local currency per U.S. dollar) of the EMEs' top-ten trading partners (namely, United States, China, Eurozone, Japan, United Kingdom, India, Korea, Taiwan, Brazil, and Mexico).[7] Additionally, Wu and Xia (2016)'s estimation of the U.S. shadow federal funds rate is included in the set of global variables.

To rule out the presence of integrated series, all the time series for GDP, CPI, stock indices, import price indices, and commodity prices enter the model in first (log) differences, while EMBIs and the shadow federal funds rate enter in first differences. All variables correspond to quarterly averages, and are centered (demeaned) and scaled by the inverse of their standard deviation.

1.2 State-Space Formulation

Let $Y_t = ((Y_{it})^N, (G_{jt})^{10}, CMDTY_t, SFFR_t)'$ denote our vector of observable time series, where $Y_{it} = (GDP_{it}, CPI_{it}, EMBI_{it}, Stock_{it}, ImportPrice_{it})'$ represents the specific variables described above for each EME $i = 1,\ldots,N$ in period $t = 1,\ldots,T$. The vector $G_{jt} = (GDP_{jt}, CPI_{jt}, FX_{jt})$ denotes the observations for each top $j = 1,\ldots,10$ EMEs' trading

4. In U.S. dollars, as in Miranda-Agrippino and Rey (2020). We use the following indexes from Bloomberg: Merval (ARG), IBOV (BRA), SOFIX (BGR), IPSA (CHL), COLCAP (COL), ECGUBVG (ECU), FBMKLCI (MYS), MEXBOL (MEX), SPBLPGPT (PER), RTSI$ (RUS), PSI20 (ZAF) and PFTS (UKR). U.S. dollar FX are from the BIS.

5. Import price deflator, from Haver Analytics.

6. Commodity prices are from the IMF, expressed in U.S. dollars and deflated with the U.S. CPI (from St. Louis Fed). In order to select the top-ten commodity exports of this group of EMEs, we: (1) rank the commodities exported by each country by their average exports as % of GDP in the period 2003–2018 (data from UN Comtrade); (2) for each commodity, compute the average ranking (across the 12 EMEs); and (3) select the 10 commodities with the highest average ranking. The list is similar if, instead of computing the average, we use each commodity's median ranking across EMEs.

7. The series are from Haver Analytics. For Brazil and Mexico only data on ER are added, given that their GDP and CPI series are included in the group of EME variables. The EMEs' top-ten trading partners correspond to the countries with the highest average trade ranking across the EMEs (for each EME, we rank the trading partners by their average total exports to GDP in the period 2003–2018, and then, for each trading partner, we average these rankings across EMEs).

partners;[8] while the vector $CMDTY_t$ has the stacked observations for the ten commodity prices included; and *SFFR* finally represents the measure of the U.S. shadow rate already mentioned. We model the dynamics of the $(5N+36) \times 1$ vector Y_t as

$$Y_t = \Lambda F_t + u_t, \qquad t = 1,\dots,T, \tag{1}$$

where F_t is the $q \times 1$ vector of (unobserved) factors and Λ is the $(5N+36) \times q$ matrix of factor loadings.[9]

The factors are meant to capture the common sources of variation in the observed macroeconomic variables across countries. These could be changes in global financial conditions (e.g., changes in global risk appetite or in U.S. monetary policy) which are likely to affect a wide array of variables, shocks that affect commodity prices (e.g., changes in China's investment or growth perspectives), or other changes in global conditions that typically affect EMEs' macroeconomic performance (e.g., changes in global demand, changes in the international prices of capital goods or global inflation). The vector u_t, $u_t \sim N(0,H)$, captures variability at the country-variable level associated with idiosyncratic events or measurement error.

The vector of unobserved factors F_t is assumed to follow an autoregressive process

$$F_t = \Phi F_{t-1} + w_t, \qquad t = 1,\dots,T, \tag{2}$$

where $w_t \sim N(0,Q)$ and $F_0 \sim N(\mu_0, \Sigma_0)$. The matrices H and Q are assumed to be diagonal, while Φ is left unconstrained. We estimate the model parameters by maximum likelihood and extract the factors by using the Kalman smoother.

8. Mexico and Brazil's GDP and CPI series are excluded from G_{jt}, given that they are already included in Y_{it}. The U.S. FX series is also excluded, given that currency parities are defined with respect to the U.S. dollar.

9. Following Aguiar and others (2016), we include a set of exogenous controls for the exclusive case of spreads, so we in practice estimate

$$Y_t = \Lambda F_t + \Gamma X_t + u_t, \qquad t = 1,\dots,T,$$

where X_t comprises a vector of zeros, except in the event where the dependent variable is a country spread, in which case we control for the pair (ΔGDP_{it}, Debt-to-GDP_{it}) for country $i = 1,\dots,N$ in period $t = 1,\dots,T$ and we constrain Γ so that X_{it} only affects their respective, country-specific spreads.

It should be noted that, without further restrictions, the state-space model defined by equations (1) and (2) does not allow for a structural interpretation of the estimated factors, so we impose a set of constraints on the loading matrix Λ (i.e., we set to 0 some of its entries), and therefore limit the effect of the estimated factors on the observable variables. Among the multiple constraints that could be imposed on the $(5N + 36) \times q$ matrix Λ, we restrict the analysis to those alternatives that appear the most compatible with the set of factors identified by previous research, as laid out above.

1.3 Baseline Specification

We now formally define the set of constraints on the loading matrix and provide their structural interpretation. A guiding principle that we follow is that a specific factor will be pinned down only by the set of observable variables most closely related to it. For example, the common "growth factor" that we estimate will be contemporaneously related only to the time series of GDP, either for country-specific EMEs or those of their main trading partners.

Table 1 presents the full set of restrictions in a schematic format. Column names list the factors that we wish to identify—financial, price, and growth common forces. Then, for each variable listed, we use the black and white circles to specify which factor is allowed to contemporaneously affect each variable. A white circle means that we fix the corresponding entry in Λ to be zero, whereas a black circle means that the corresponding entry is unconstrained. First, we let the 'financial' factor to impact all the variables in the model, hence the black circles in the first column. While the lack of constraints for this factor can be equivalently grasped as a 'global' common force, we will provide further evidence that we can loosely associate it to one of a financial origin. The 'price' factor, in turn, affects merely observable prices, namely commodity prices, import prices, and local CPIs. Lastly, the 'growth' factor is identified based on GDP data, which allows for the identification of a comovement between local EMEs' cycles and the GDP fluctuations of their main trading partners. We will present a variation of these choices later on.

1.3.1 Estimated Global Factors

The estimated factors, along with their historical shocks decomposition are presented in the top panel of figure 1. Since the model is estimated in log-differences, the estimated factors are interpreted in the same way. The bars portray the incidence of each shock in the dynamics of the factors. The bottom panel of the figure presents the estimated factors in levels (net of initial values) and the cumulative effect of the shocks contributions depicted above.

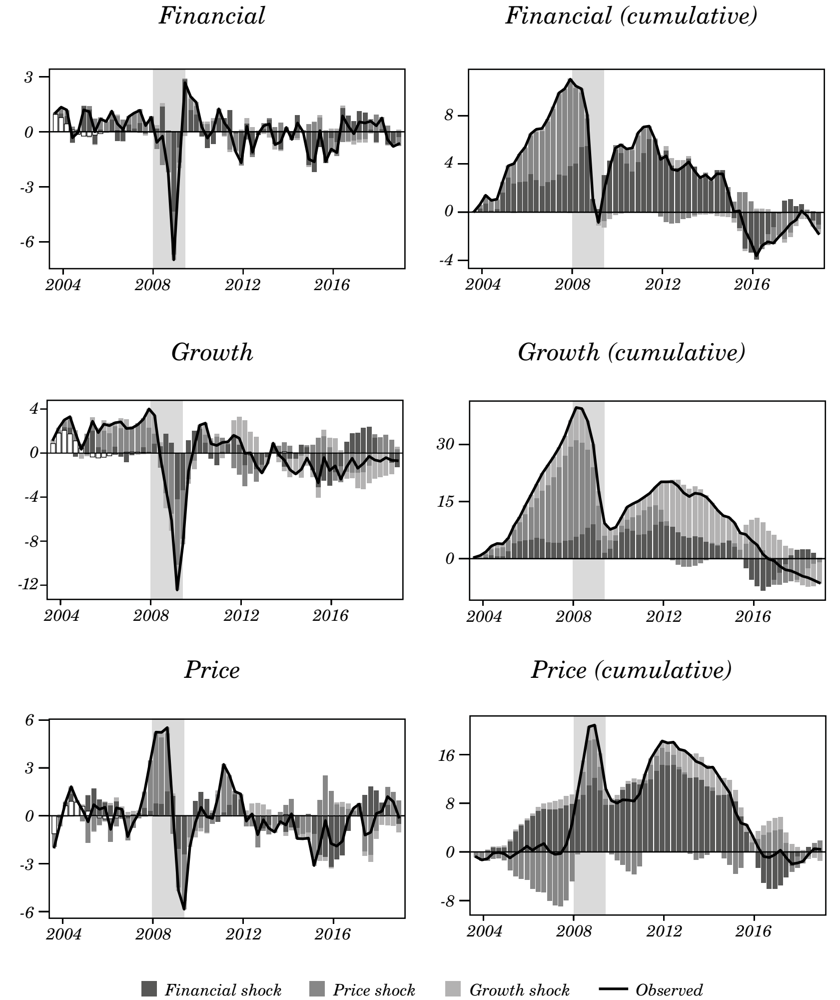
The factors' dynamics are consistent with the U.S. recession indicator as identified by NBER (shaded area), all of them experiencing very significant variability around the Global Financial Crisis (GFC). After increasing consistently in the years 2003–2007, the financial factor leads the fall during the crisis, followed by the growth factor. The price factor, on the other hand, experienced a dramatic increase between 2007 and 2008, and only fell in 2009.

Table 1. Baseline Model
(restrictions on loading matrix)

	Factor		
	Financial	*Price*	*Growth*
EME variables			
GDP EMEs	●	○	●
CPI EMEs	●	●	○
EMBI	●	○	○
Stock market index	●	○	○
Global variables			
Import price index	●	●	○
GDP trade partners	●	○	●
CPI trade partners	●	●	○
Exchange rate	●	○	○
Commodities	●	●	○
Shadow FFR	●	○	○

Source: Authors' calculations.
Notes: White circles refer entries in the Λ matrix that are set to zero, whereas black circles correspond to unconstrained entries.

Figure 1. Historical Decomposition of Factors – Baseline Model



Source: Authors' calculations.

Notes: Top panel: factors as originally estimated in log-differences (centered and scaled such that s.d.=1). Bottom panel: factors in levels obtained by cumulating log-differences. For presentation purposes, initial values are omitted in the cumulative version. Shaded areas denote NBER U.S. recession dates.

The historical shocks decomposition in figure 1 (in particular, the bottom panel) highlights a rich interaction among the estimated factors. Financial shocks not only affect the financial factor but also have significant effects on the price and growth factors. Similarly, price shocks induce important movements in both the financial and the growth factor. The level of interaction among the factors is formally quantified in table 2, which reports the share of each factor's variance explained by the different shocks. Financial shocks are the most relevant, explaining between 35 and 74pp of the factors' 20-quarter-ahead forecast error variance. On the other hand, growth shocks contribute the least, with most of their effect passing through the growth factor, and little effect on the others. Price shocks explain between a quarter and a half of the variance of each factor.

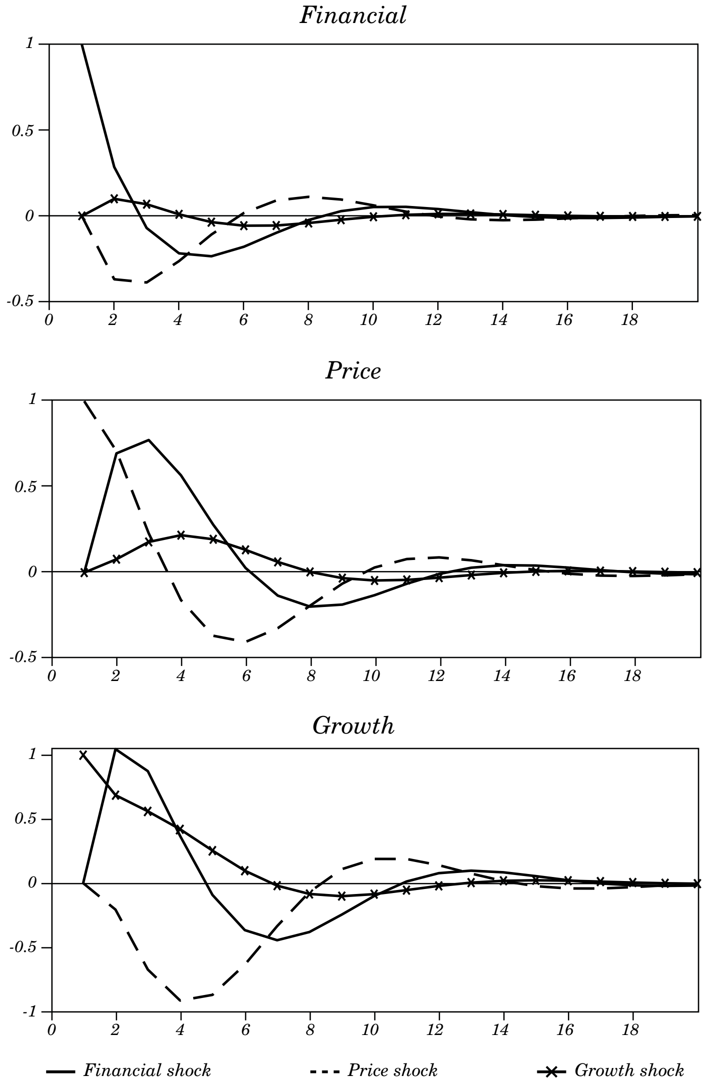
The strong comovement among factors is also reflected in their impulse responses to shocks. Figure 2a shows that, despite their relatively short persistence, shocks to the financial factor induce prominent positive responses (of comparable proportions, between 0.8 and 1 s.d.) in both the price factor and the growth factor. On the other hand, a price shock also has significant effects on financial and growth factors, but in the opposite direction. Finally, shocks to growth tend to be more persistent, but they hardly affect the dynamics of the other factors.

Table 2. Share of Factors' Variance Explained by Global Factor Shocks – Baseline

	Factor		
	Financial	*Price*	*Growth*
Financial Factor	74.3	24.2	1.5
Price Factor	42.1	53.9	4.0
Growth Factor	34.9	37.0	28.0
Average	50.5	38.4	11.2

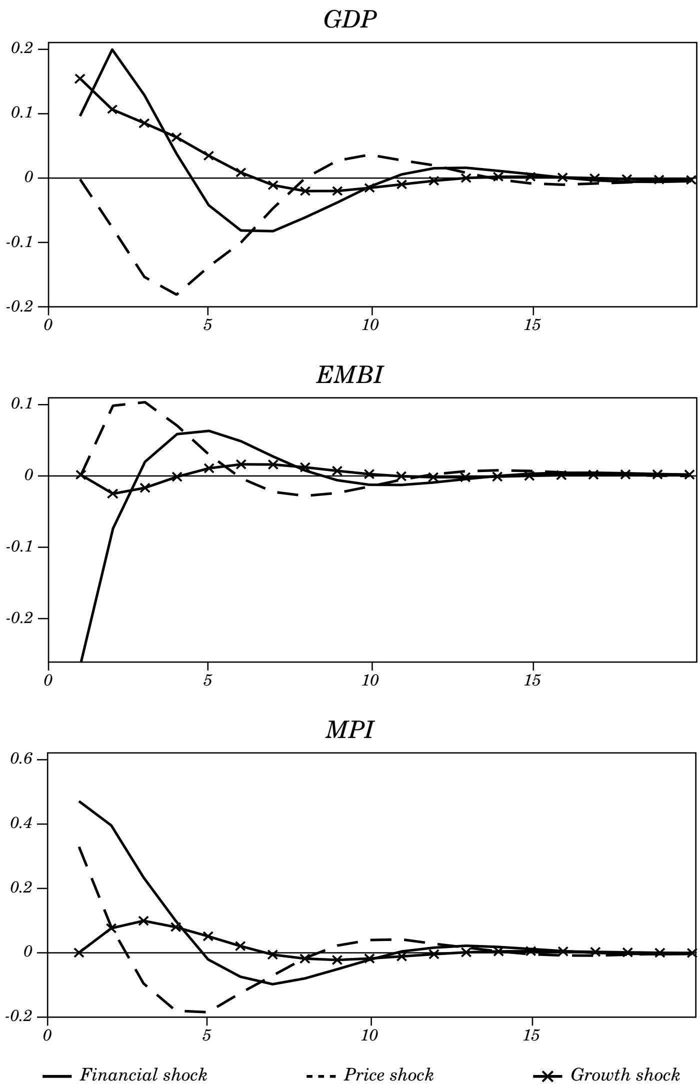
Source: Authors' calculations.
Notes: Percentage. Figures correspond to the share of the 20-period ahead forecast error variance that is attributable to each of the global factors shocks.

Figure 2a. Impulse Response Functions – Baseline Model



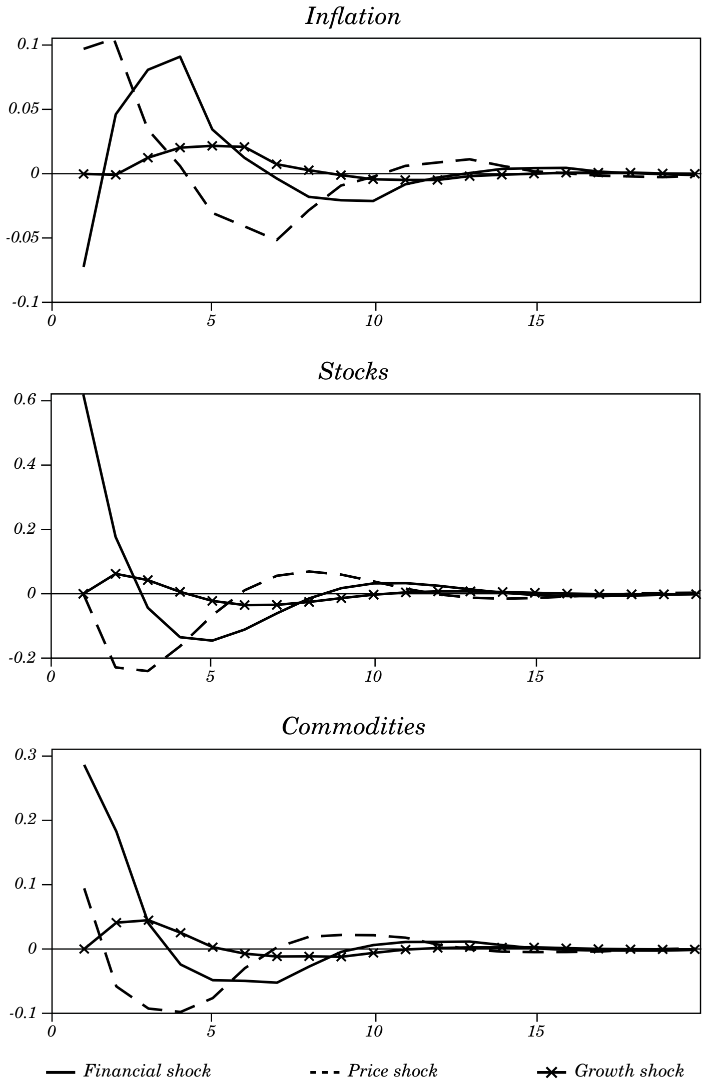
Source: Authors' calculations.
Notes: Impulse response functions to the original 'financial', 'growth' and 'price' shocks.

Figure 2b. Impulse Response Functions – Baseline Model



Source: Authors' calculations.
Notes: Impulse response functions to the original 'financial', 'growth' and 'price' shocks.

Figure 2b. Impulse Response Functions – Baseline Model (continued)



Source: Authors' calculations.
Notes: Impulse response functions to the original 'financial', 'growth' and 'price' shocks.

1.3.2 Relevance of Global Factors

We now explore the relevance of the estimated global factors when explaining the dynamics of the pool of EMEs considered and their main trading partners. Table 3 presents the results of this exploration by means of forecast error variance decomposition analysis. Together, shocks to the three global factors account for more than 38 percent of the variance in GDP of EMEs (sample median), a quarter of the variance of sovereign risks (as measured by the EMBI indices), and more than two-thirds of the variance of the stock-market indices. A more modest role is found when accounting for CPI dynamics, for which the factors explain nine percent.

At the same time, the factors explain a large share of the variance of the EMEs' most relevant external variables (i.e., "global variables")—more specifically, 39 percent of the variance of GDP, 43 percent of that of inflation, and almost 49 percent of the variance in the exchange rate of the EMEs' main trading partners. Shocks to these factors also contribute to an important fraction of the movements in commodity prices, in particular crude oil, copper, and aluminum (the top-three most exported commodities in our sample of EMEs), for which roughly two thirds of the variance is explained.

Table 3 allows us to further appreciate the individual contribution of each one of the factors to the dynamics of the different groups of variables in the model. Not surprisingly, financial shocks are the ones that contribute the most to the variance of the financial variables included in the model (EMEs' stocks and EMBIs, and trading partners' exchange rates). What might be surprising, however, is that financial shocks are also the most relevant ones for commodity prices, as well as for the GDP and inflation of the EMEs' trading partners. On the other hand, shocks to the price factor are the ones that contribute the most to explaining the variance of GDP and inflation in EMEs. We will analyze this in more detail in section 2.3.3, where we use the estimated global shocks in the context of a full DSGE model for the Chilean economy.

How do we interpret these factor shocks? Figure 2b shows that a shock to the global financial factor is associated with a *risk-on* episode when a relaxation of (global) financial conditions induces a strong positive response of EMEs' stock market indices, a reduction of sovereign risk, and a marked increase in the prices of commodities exported by these economies. These episodes also translate into higher growth and inflation in EMEs,[10] as well as into an increase in the price of imports. Price shocks, on the other hand, have very different effects on the dynamics of these emerging commodity-exporting economies: import prices and inflation increase significantly, while economic activity slows down; stocks indices and commodity prices fall, and sovereign risk rises. As such, shocks to the price factor could be interpreted as cost-push shocks or negative (global) supply-side shocks. Finally, growth shocks are mainly associated with increases in EMEs' GDP growth and mild (mostly positive) effects on the rest of their price and financial variables.

Table 3. Share of Variance Explained by Global Factor Shocks
(%, group medians)

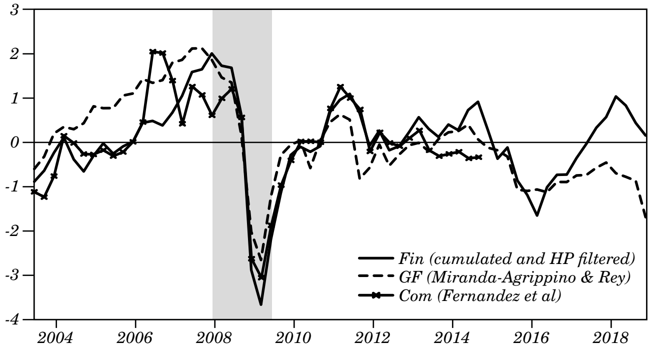
	Factor			
	Financial	*Price*	*Growth*	*Total*
All variables	23.3	12.9	1.0	40.8
EME variables				
GDP EMEs	14.0	15.2	7.2	38.5
CPI EMEs	3.9	5.0	0.3	9.2
EMBI	17.9	5.8	0.4	24.1
Stock market index	49.9	16.2	1.0	67.1
Global variables				
Import price index	28.2	17.4	1.6	43.5
GDP trade partners	22.2	13.0	3.4	39.1
CPI trade partners	24.8	16.9	1.7	43.4
Exchange rate (local currency/USD	36.3	11.8	0.7	48.8
Commodity prices	17.0	9.0	0.7	29.8
Crude oil	49.4	14.0	1.5	64.8
Copper	48.9	14.6	1.0	64.5
Aluminum	50.5	14.1	1.2	65.8

Source: Authors' calculations.
Notes: Baseline Model. Figures correspond to the share of the 20-period ahead forecast error variance that is attributable to each of the global factors shocks. For each column, group medians are reported (which implies that the sum of the columns does not necessarily add up to the total).

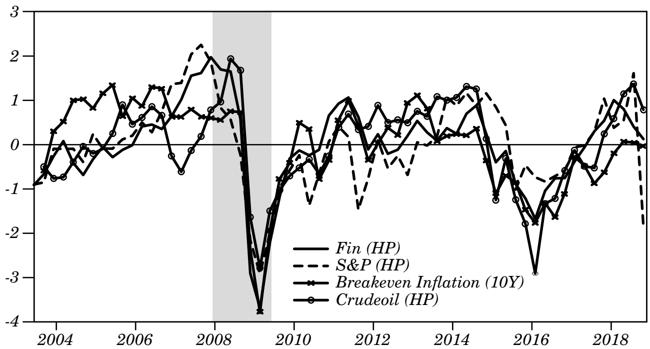
10. Initially, inflation decreases in EMEs as a consequence of a financial shock due to the appreciation of the local currency.

Figure 3: Comparing the 'Financial' Factor

(*a*) *Other factors in the literature*



(*b*) *Other variables*



Source: Authors' calculations.
Notes: Centered and scaled variables (s.d.=1). In both figures, the financial factor is the cyclical component (HP filter) of the cumulative estimated factor. (a) GF is the global financial factor estimated by MirandaAgrippino and Rey (2020); Com is the commodity global factor estimated by Fernández and others (2018). Shaded areas denote NBER U.S. recession dates. (b) U.S. Breakeven inflation (10Y) is expressed in percentage points, obtained from FRED. Cyclical component (HP filter) of the S&P 500 index and Brent oil price, originally obtained from Haver Analytics.

1.3.3 What is Behind the 'Financial' Factor?

Of the three factors, the financial factor has the most prominent role. As shown in table 3, the median share of the variance across all variables explained by it is over 23 percent. Moreover, as mentioned above, we allow it to affect all variables in a contemporary fashion. But this raises the question: why label it *financial*? While the idea of a global financial factor driving business cycles of EMEs seems easy to endorse in a context where such factor is identified by means of purely financial markets data,[11] calling our first factor a *financial* one may appear unwarranted *prima facie*. Part of the answer lies in figure 3 which shows the cyclical component of the cumulative financial factor accompanied by several other time series for comparison.

Figure 3a compares the financial factor to the global financial cycle in Miranda-Agrippino and Rey (2020), which they extract by using 858 asset price series. Similarly, figure 3b displays the cyclical component of the cumulative financial factor together with some of the main financial indicators—the cyclical component of the S&P index and the U.S. 10-Year breakeven inflation rate. We interpret the strong resemblance between our estimated financial factor and these other series as indicative of a financial nature of the factor.

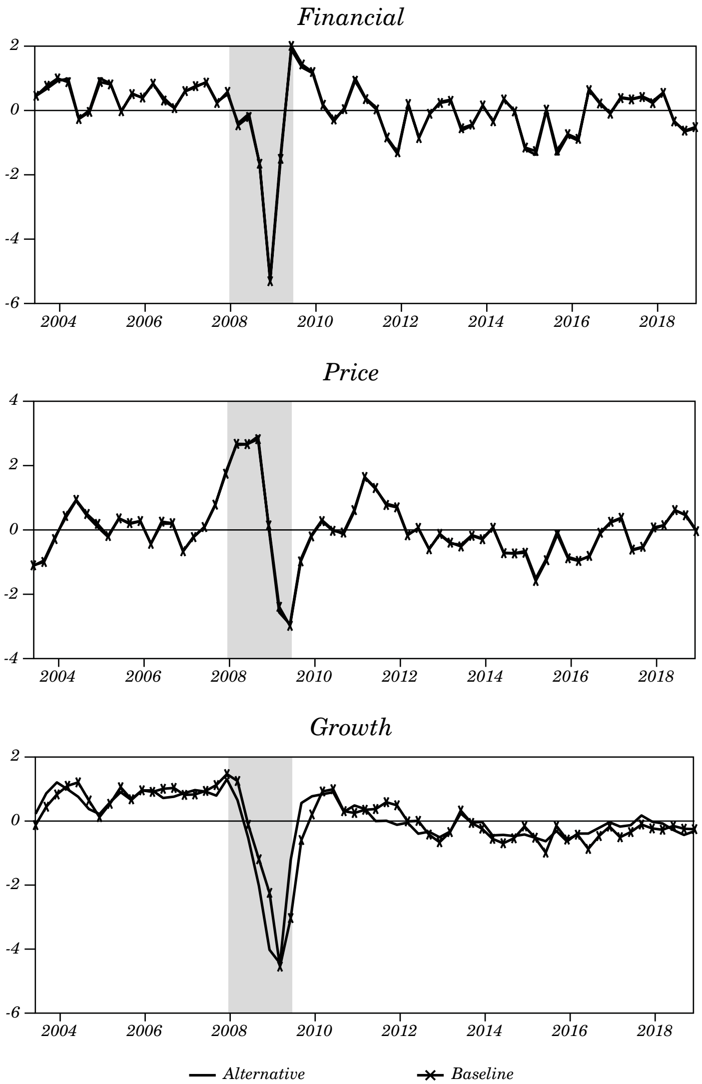
To further explore this idea, we analyze the effect of relaxing the assumption that the financial factor unloads on all the variables of the model. More specifically, we disallow a contemporaneous impact of the financial factor on GDP. This is consistent with a timing assumption often used when identifying financial shocks, whereby shocks in financial markets can affect real economic activity only with a lag.[12] In practice this is implemented by imposing a zero entry in the loading matrix of Equation (1) for all GDP variables, as table 4 describes.

Figure 4 presents the baseline factors and the new ones pinned down by using the alternative identification assumption. The immediate, noticeable remark is that the new financial factor is virtually indistinguishable from the baseline case. The same can be said for the price factor. In other words, the identification of our financial factor does not require the contemporary information provided by GDP: it is already captured by means of the financial variables and prices. A second, more subtle feature is the fact that now the growth factor is more similar to the financial factor. Actually, the correlation between the growth and financial factors increases from 0.33 in the baseline specification to 0.67 in this alternative specification.

Further results—collected in Appendix B—show that results in terms of forecast error variance decomposition qualitatively don't change much, except that we now observe a higher relevance for the growth factor at the expense of the new financial factor. This is not surprising since it is now the only common force inducing activity contemporaneously. Importantly, however, the alternative model has a poorer empirical fit vis-á-vis the baseline scenario related to an overall drop in the variance explained by all three factors, which further validates our baseline specification.

11. For example, Miranda-Agrippino and Rey (2020).
12. For example, Gilchrist and Zakrajsek, 2012.

Figure 4. Alternative Specification: Model without GDP-Financial Factor Channel
(comparison of estimated factors with those of the baseline model)



Source: Authors' calculations.
Notes: The figure shows the factors (in log-diff) estimated with the alternative model specification (with no direct channel between GDP variables and the financial factor) along with those estimated in the baseline model. All factors have been centered and scaled such that s.d. = 1. Shaded areas denote NBER U.S. recession dates.

Table 4. Alternative Specification: Model without GDP-Financial Factor Channel
(Restrictions on Loading Matrix)

	Factor		
	Financial	*Price*	*Growth*
EME variables			
GDP EMEs	○	○	●
CPI EMEs	●	●	○
EMBI	●	○	○
Stock market index	●	○	○
Global variables			
Import price index	●	●	○
GDP trade partners	○	○	●
CPI trade partners	●	●	○
Exchange rate	●	○	○
Commodities	●	●	○
Shadow FFR	●	○	○

Source: Authors' calculations.
Notes: White circles refer entries in the Λ matrix that are set to zero, whereas black circles correspond to unconstrained entries.

Moreover, figures 3a and 3b also display the similarity between the financial factor and the commodity factor of Fernández and others (2018)—which they extract from the cyclical component of country-specific commodity price indices that they construct—and the Brent crude oil price. This could be interpreted as evidence of the *financialization* hypothesis of commodity prices.[13]

Finally, a remark about the growth factor is warranted. It is, perhaps, surprising that the growth factor plays only a minor role in explaining the variance in the data. One possible explanation is

13. Some leading advocates of the financialization hypothesis include Jensen and others (2002), Tang and Xiong (2012), Adams and Glück (2015), and Basak and Pavlova (2016); while Hamilton and Wu (2015), and Chari and Christiano (2017) mark its dismissal.

that part of the commonality in the growth of the economies in our sample is already captured by the financial factor. This explanation is consistent with the results highlighted in the alternative specification above, where after disallowing a contemporaneous impact of the financial factor on GDP, the growth factor adapts by increasing its resemblance to the financial factor. This would suggest caution in the interpretation of the growth factor. Another explanation is that we may be over-restricting the contemporaneous impact of the growth factor and, hence, understating its relevance. However, the restrictions we impose are less severe than they may appear at first sight since they only refer to the contemporaneous impact of the factors on the variables. And, because the transition matrix is left unconstrained, each factor still affects every observable variable with a lag. Nevertheless, this explanation deserves further examination. An alternative approach we may pursue in the future is to impose *sign* restrictions instead of *zero* restrictions on the factor loadings, which could give the model additional flexibility in the identification of the factors while maintaining their structural interpretation.

2.Global Factors and Emerging Economies: Transmission Mechanisms

This section digs deeper into the channels through which global factors affect emerging market economies. To do this, we build on a large-scale DSGE model estimated for Chile—one of the EMEs considered in our pool of economies studied thus far—, augmenting it with a global factors block that comes from the estimated dynamic factor model presented in the previous section.

While the baseline factor model can be used to obtain a reduced form estimate of the global factors aggregate effect on some domestic EMEs' variables, it tells us little about the underlying mechanisms that ultimately determine the empirical results we observe. In contrast, the factor-augmented DSGE model allows us to disentangle the effects that the factors have on EMEs between the different channels that link the domestic and global blocks by taking advantage of the rich structure of the model. As a result, not only does the augmented model show the expected effect that shocks to the factors have on different domestic variables, but can also explain the transmission mechanisms that lead to those aggregate effects, through the lens of the structural model.

2.1 Baseline DSGE Model

The large-scale DSGE model estimated for the Chilean economy is based on García and others (2019). It is regularly used at the Central Bank of Chile for forecasting and policy analysis. The model considers a local economy and an external sector. The local economy interacts with the rest of the world in two dimensions: in the real sector by importing and exporting goods and services, and in the financial sector by trading bonds on international markets.

The following two subsections provide a brief narrative description of the core model's domestic and external blocks. A subsequent section presents how the model is augmented with the dynamic factor block. For further technical details of the DSGE model, readers are referred to García and others (2019).[14]

2.1.1 The Domestic Block

Four types of agents participate in the domestic economy: households, firms, the government, and a central bank. A fraction of households is composed of financially constrained hand-to-mouth agents. They consume private and public goods and services, supply labor to firms, pay taxes on consumption, labor income, and capital income, and receive lump-sum transfers from the government. The fraction of households that are not financially constrained can smooth consumption by saving and borrowing in local and foreign currency. They also invest in capital goods and receive dividends from firms they own (both locally and abroad). Households also face involuntary unemployment spells due to a labor market with search and matching frictions as in Mortensen and Pissarides (1994), which also features endogenous separations and wage rigidities.

Different types of firms are in charge of production. In the non-commodity sector, firms producing domestic goods utilize capital, labor, and oil as inputs, with pricing decisions subject to Calvo-type nominal rigidities. Another set of firms sell differentiated imported goods on the domestic market and are also subject to nominal rigidities. Domestic and imported goods are then combined to form a homogeneous intermediate good used for final consumption or investment goods. The assumption of rigid prices in local currency leads to an incomplete

14. For a description of the DSGE model and how it is regularly used for policy analysis see Central Bank of Chile (2020)

exchange rate passthrough, in line with empirical evidence. Profits generated by firms are delivered in the form of dividends to their owners (unconstrained households).

Finally, the commodity sector is modeled as a representative, capital-intensive exporting firm, with shared ownership between the government and foreign agents.

The government follows a structural balance fiscal rule where the desired spending of each period is defined not by current but by structural or long-term revenues, mimicking the Chilean legislation on fiscal spending. The effective spending path may eventually differ from the rule due to exogenous shocks. Expenditures are split between government consumption, investment in public goods, and transfers to households. These are financed with tax revenues, income from property in the mining sector, and debt issuance. In addition, the government has a program in place to smooth out after-tax gas price volatility, which involves a variable combination of taxes and subsidies for gas consumption.

The central bank conducts monetary policy based on a Taylor-type policy rule. Under this rule, the interest rate responds to deviations of inflation from the 3 percent target and of output growth from long-term growth. When evaluating inflationary pressures, the central bank responds to a weighted average of current and expected inflation, which consider both core and headline measures. Additional exogenous disturbances allow for the effective rate to deviate from what the systematic part of the rule prescribes.

2.1.2 Foreign Block and Linkages with the Domestic Economy

In the foreign block, prices of commodities (copper and oil) and other imported goods (excluding oil) are modeled as exogenous, together with the trading partners' growth and inflation, and a risk-free external rate. The exchange rate is determined through an arbitrage relationship between local and foreign currency interest rates, while the net foreign asset position, as a percentage of GDP, determines the country risk as in Schmitt-Grohé and Uribe (2003). Both the exchange rate and the risk premium dynamics also allow for additional nonsystematic exogenous disturbances.

Below we describe how each variable from the external block is linked with the domestic economy and how movements in those variables affect domestic variables.

• Commodity export prices: A representative firm produces a commodity that is fully exported at an exogenously determined foreign-currency-denominated price. The firm's ownership is shared between the government and foreign investors. Cash flows are shared accordingly, but the government also levies taxes on the foreign investors' profit share. As in Fornero and Kirchner (2018), production uses sector-specific capital, subject to adjustment costs and time-to-build frictions in investment. The labor share of the sector is assumed to be negligible.

A shock to the price of the exportable commodity, by increasing government income, reduces the fiscal financial burden, allowing for an expansion of the spending budget. The shock also triggers an expansion of the sector's investment that, due to the time-to-build technology, is only relevant if the shock is persistent enough to offset the investment lag. Additionally, the currency appreciation that follows the rise of the commodity price reduces marginal costs through cheaper imports. Overall, the shock is both expansionary and deflationary.

• Commodity import prices: Commodity imports, modeled as oil imports, are both directly a part of the final consumption basket and part of the production function of domestic wholesale goods, alongside labor and capital.

A shock in commodity import prices directly affects inflation through higher prices in the gas and energy components of the CPI. However, the impact is partially dampened by a fiscally financed smoothing policy for gas prices that, on the other hand, puts pressure on the fiscal budget. Higher oil prices also affect core CPI (excluding energy and food) through two channels. First, through indexation of non-oil-related prices to past headline inflation. Second, as oil is also an input in the production function of general goods, a higher price raises marginal costs and inflation. The shock is associated with only a modest interest-rate response explained mainly by two reasons. On one hand, monetary policy responds only partially to noncore CPI and short-term inflation. On the other hand, as a higher cost of intermediate imported goods can be understood as a negative supply shock, the pressure to raise rates due to higher inflation is partially dampened by a desire to compensate for the lower output.

• Other import prices: Non-commodity imports are used as an input for the production of final goods, in combination with domestically produced intermediate goods. Thus, a shock to import prices directly raises marginal costs, thus leading to higher inflation and lower output.

• Commercial partners' inflation rate: Higher inflation of commercial partners, all else equal, will make the exportable good more competitive, thus fostering exports. In addition, higher foreign prices, while keeping nominal import prices constant, reduce real import prices ($\frac{P^M}{P}\downarrow = \frac{P^{M*}}{P^*\uparrow} rer$). While the shock does cause a real depreciation, it is not enough to offset the drop in the foreign-currency real import prices, which leads to lower real marginal costs and lower inflation.[15]

• Commercial partners' growth rate: In the model, the demand for non-commodity exports is directly linked with the size of the foreign economy. If commercial partners' GDP is expanding, they will demand more of the local economy exports, thus stimulating domestic GDP. Higher demand will also lead, everything else equal, to more inflation and higher monetary policy rates.

• Foreign financing costs: The relevant interest rate for the decision of holding and acquiring new foreign-currency debt includes both a risk-free rate (proxied by the federal funds rate) and a risk premium. While in the model the former is entirely exogenous and the latter has both exogenous and endogenous components, a shock to either will have the same effect of increasing the financing cost in foreign currency. Thus, alongside an exchange rate depreciation, inflation will rise and output will drop.

2.2 The Factor-Augmented Model

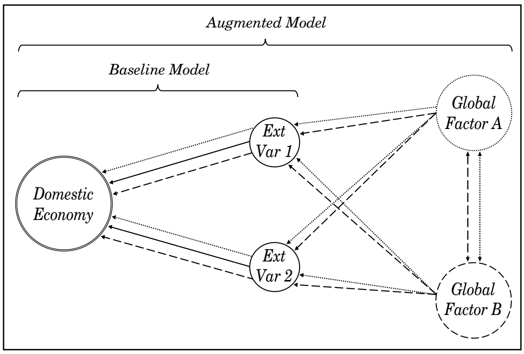
In order to analyze the domestic implications of a shock to the global factors, we augment the baseline DSGE model's external block by allowing for the factors to influence the different variables in the model's external block. To do so, we follow the same structure for the factors as described in the previous section. We only modify the external block; the rest of the model is kept as in the baseline DSGE from García and others (2019). We take the estimated factors F_t and state-transition coefficient matrix Φ from the baseline factor model and re-estimate the matrix of factor loadings Λ and the variance matrix H, allowing for autocorrelation on the exogenous disturbances and

15. The partial adjustment of the exchange rate might be due to the presence of nominal rigidities that inhibit full price adjustments.

keeping the same identification restrictions from table 1.[16] Finally, in order to ensure uniqueness in the steady state, we add, when needed, a small error correction parameter to the dynamic equations.

Figure 5 schematically summarizes the differences between baseline and augmented models. In the former, the model only considers the direct effect of the variables (the solid arrows in the figure). Furthermore, external variables are also assumed to be orthogonal as they are only affected by their own shocks. In contrast, the augmented model allows for indirect effects of the global factors on the domestic economy through their influence on the dynamics of the external variables (the figure's dotted and dashed arrows). In the augmented model, the orthogonality among external variables breaks down, as the systematic effect that the factors have on those variables induces correlation among them.

Figure 5. External Block Structure in the Baseline and Factor-Augmented DSGE Model



Source: Authors' calculations.
Notes: In the diagram, the arrows show the transmission mechanism of a shock originating from a source depicted with the same type of line.

16. We re-estimate the Λ and H matrices due to small differences between the observables in the factor model and the DSGE model. The differences range from the sample size to variables definitions. For the DSGE model, the sample is restricted by the date the Central Bank of Chile started using nominal instead of real rates as the policy instrument, while for the factor model we make use of the longer data availability. Additionally, in order to maintain consistency among countries and as described in section 1.1, for the factor model we construct each country's commercial partners price index by using the top-ten commercial partners. For the DSGE model, we use the official series reported by the statistical department of the Central Bank of Chile, which consider a broader coverage.

In short, the setup provided by the augmented model allows us to combine the comovement in global forces pinned down by the dynamic factor model with the rich propagation mechanisms embedded in the DSGE model. We explore next how shocks to global forces affect domestic variables through the lens of this setup.

2.3 Domestic Implications of Global Factor Shocks

This section describes the model-implied effects that shocks to the factors have on Chile by using the augmented model. We analyze the aggregate impacts while also differentiating between alternative transmission channels. We also emphasize how, for some shocks, different channels reinforce one another, which leads to larger aggregate effects, while for others, the final impact may be dampened due to offsetting effects.

2.3.1 Aggregate and Disaggregate Effects

The augmented DSGE model can be used to predict the expected aggregate effect that a factor shock has on any given variable of interest. By selectively *turning off* different channels, we can further distinguish between the parts of the aggregate effects that are associated with a particular mechanism.

For example, we can ask the model what would the impact of a shock to the financial factor on domestic output be, and call that the *aggregate effect* of the financial factor on GDP. Additionally, by taking advantage of the structural nature of the model, we can further ask what would the impact of a shock to the financial factor on domestic output be in a counterfactual world where all variables from the external block but the oil price remained constant. We would then call the answer to that question the effect of the financial factor on GDP *due to movements in oil prices*.

More formally, lets summarize the augmented model by the following set of equations:

$$E_t\,(D_{t+1}) = D^i\,(Y^t, Z^t) \tag{3}$$

$$Y_t = \Lambda F_t + u_t \tag{4}$$

$$F_t = \Phi F_{t-1} + w_t. \tag{5}$$

The vectors D_t, Y_t, and F_t represent, respectively, the variables from the domestic block, the foreign block, and the global factors at time t. The elements of the factor vector F affect each other with the structure given by Φ and unload on the global variables contained in the vector Y through the loading matrix Λ. The vectors Y^t and Z^t denote all the information available at time t about the past and expected trajectories of external variables Y and other relevant variables Z, and $D^i(Y^t, Z^t)$ denote the policy functions for the expected value of D_{t+i} given the set of information contained in Y^t and Z^t.

We define $Y^j_{t+i} = E_t(Y_t \mid \in^j_t)$ as the expected response of the vector Y at period $t+i$ given a shock to the factor j at time t. For each of the global variables included in vector Y_t, $Y^{j,k}_{t+i}$ is a vector equal to Y^j_{t+i} with all its elements equal to zero except the one in position k, such that $Y^j_{t+i} = \sum_{k=1}^{N_Y} Y^j_{t+k}$.

We also define $E_t(D_{t+i} \mid Y_t = Y^{t,j,k}) = D^{i,j,k}\ (Y^{t,j,k} = Z^t)$ where $Y^{t,j,k}$ denote all information available at time t about the past and expected trajectories of the variable $Y^{j,k}_t$. The policy function $D^{i,j,k}\ (Y^{t,j,k}, Z^t)$ is then the expected value for D_{t+i}, given shocks to factor j in a counterfactual world where all the external variables, except for the one in position k remain constant. Then, computing $D^{i,j,k}\ (Y^{t,j,k}, Z^t)$ for every k allows us to decompose the expected response at time $t+i$ of a shock to factor j, through each channel k, of any variable of interest contained in D. In other words, we will be able to decompose the effect that a shock to a factor has in a domestic variable between the shares that can be attributed to each global variable that link the model's domestic and external blocks.

2.3.2 Dynamic Shock Effects

In section 1.3.1 we described how shocks to the global factors affect different global variables. To summarize, the financial shock tends to raise commodity and import prices, as well as commercial partners' inflation rates and GDP growth while easing financial conditions for the EMEs. Shocks to the growth factor induce similar effects, although the responses are more muted and take longer to reach their peaks. On the other hand, shocks to the price factor are associated with increased import prices, a drop in commodity prices, commercial partners' inflation rates and GDP growth, and worsened financial conditions.

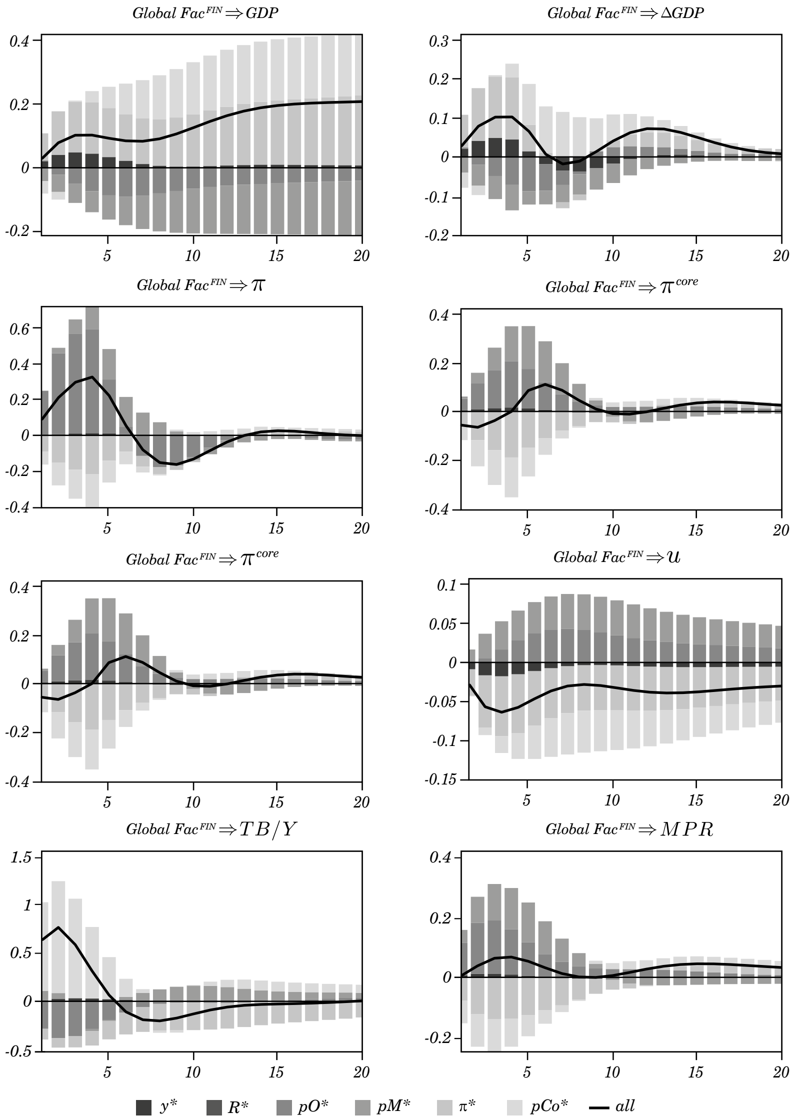
In this section, we use the factor-augmented DSGE model to analyze how the previously described effects end up affecting EMEs' domestic variables. We use the methodology described in section 2.3.1 to decompose the responses in the different channels through which the foreign and domestic blocks are linked. The domestic responses to a financial factor shock are summarized in figure 6.

Regarding commodities, higher export and import prices following a financial shock have opposite effects. On the one hand, a higher price of the exportable commodity price pCo^*, which for Chile corresponds to copper, increases the country's income and the trade balance, and appreciates the exchange rate, thus inducing lower inflation and monetary-policy rates. The higher commodity price also fosters output through incentives to increase the specific investment of the sector (not reported in the figure). On the other hand, a higher commodity import price pO^*, namely oil for Chile, tends to have the opposite effect. Since oil is an input in the production function, an increase in its price acts as a negative supply shock by raising marginal costs and contracting the economy. The higher price also deteriorates the trade balance. Inflation raises through two channels, first through the direct impact on the gas and energy components of headline CPI and, second, through its impact on core inflation (excluding energy and food), by the previously described higher marginal costs and by the indexation of core goods to headline inflation.

Compared to the effects of higher commodity import prices, higher non-oil import prices pM^* have similar implications, though less pronounced, on headline inflation, as it does not affect the noncore basket as much, and more intensive in core inflation, where it affects marginal costs through pricier imported inputs. Higher inflation of commercial partners π^* tends to increase the competitiveness of the domestic economy by fostering exports. Assuming nominal import prices constant, higher foreign inflation makes real import prices drop, and then also marginal costs and inflation. The shock to the financial factor also increases foreign GDP growth y^*, demand for exports, and then domestic GDP. The financial factor also reduces the foreign financing costs, summarized in the model by R^*. This channel, however, shows negligible effects due the estimation sample covering a period where the country's risk premium was low and stable.

Summing up, after a shock to the financial factor, the commodity export price and foreign inflation channels lead to increased output and lower inflation. In contrast, the import price channels in commodity and non-commodity sectors have the opposite effect, leading to lower output and higher inflation. The first set of channels dominates regarding GDP growth, leading to higher output, while the second set of channels dominates in terms of higher overall inflation. Finally, the foreign growth channel positively affects both GDP and inflation, although the effect on the latter is negligible.

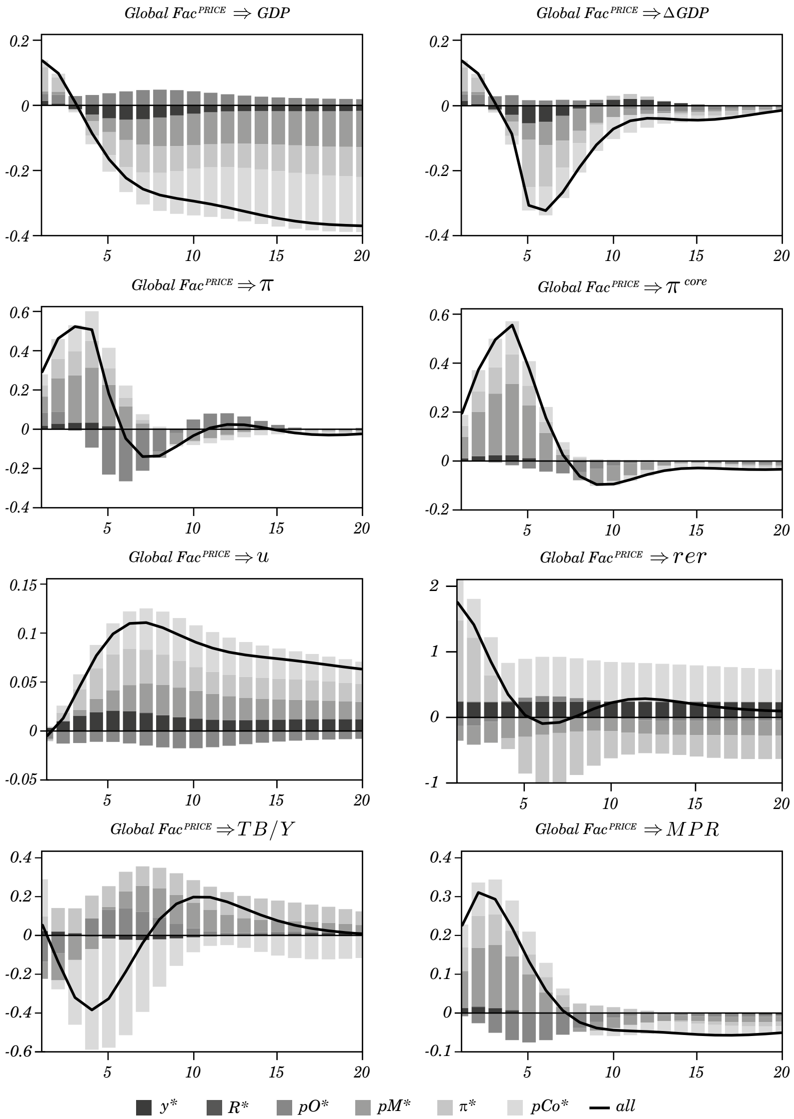
Figure 6. Domestic Effects of a Shock to the Financial Global Factor



Source: Authors' calculations.

Notes: (1) The bars show the response of each variable to one standard deviation shock to the financial global factor shock while keeping only one channel open at the time. (2) The black line is the response of each variable to the shock when all channels are open. It is, by construction, equal to the sum of the bars. (3) GDP refers to the deviation of the level of GDP from the long-run productivity growth path, ΔGDP denote GDP annual growth, π and πcore denote respectively annual headline and core inflation (where food and energy items are removed), u is unemployment, rer is the real exchange rate, TB/Y is the trade balance as a fraction of GDP, and MPR refers to the annualized monetary-policy rate.

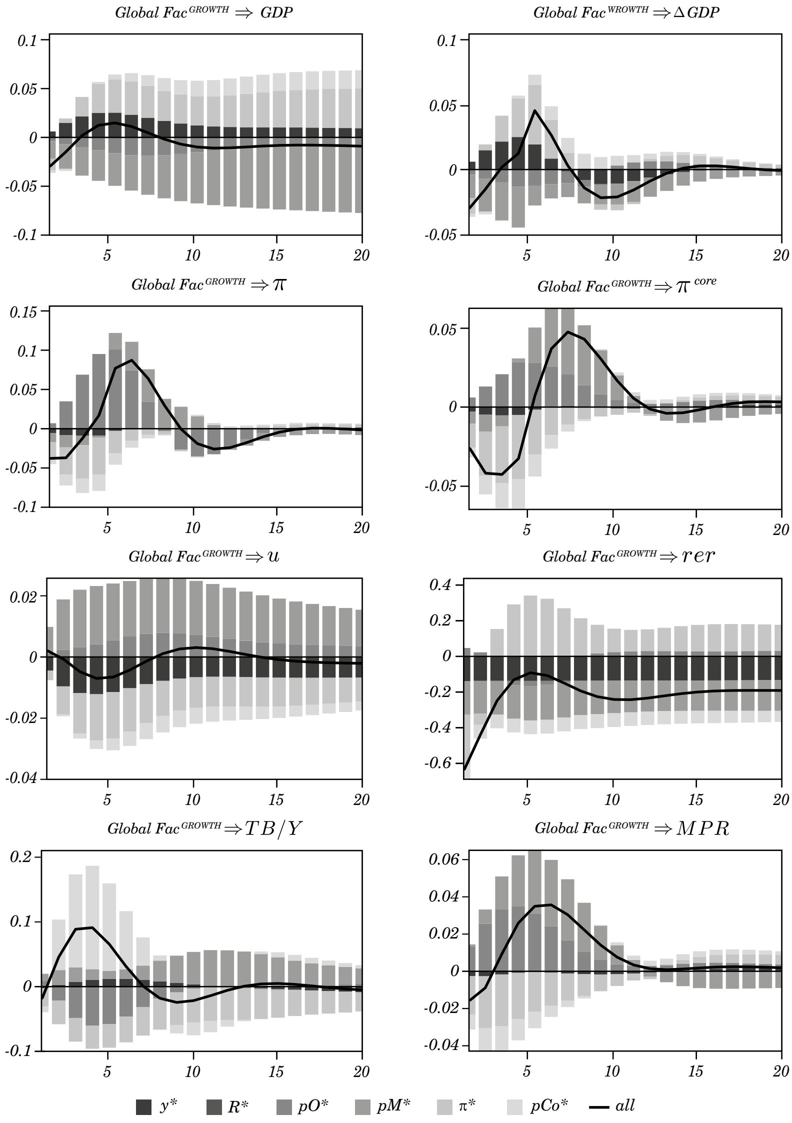
Figure 7. Domestic Effects of a Shock to the Price Global Factor



Source: Authors' calculations.

Notes: (1) The bars show the response of each variable to one standard deviation shock to the price global factor shock while keeping only one channel open at the time. (2) The black line is the response of each variable to the shock when all channels are open. It is, by construction, equal to the sum of the bars. (3) GDP refers to the deviation of the level of GDP from the long-run productivity growth path, ΔGDP denote GDP annual growth, π and πcore denote respectively annual headline and core inflation (where food and energy items are removed), u is unemployment, rer is the real exchange rate, TB/Y is the trade balance as a fraction of GDP, and MPR refers to the annualized monetary-policy rate.

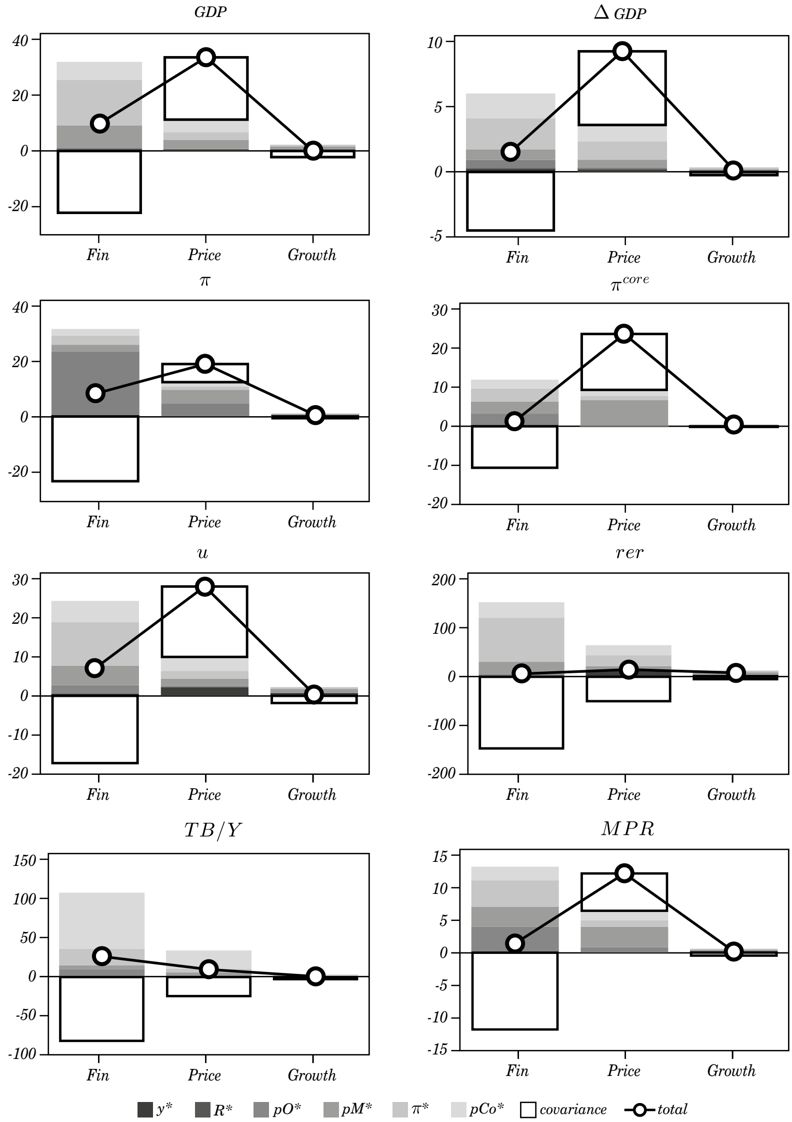
Figure 8. Domestic Effects of a Shock to the Growth Global Factor



Source: Authors' calculations.

Notes: (1) The bars show the response of each variable to one standard deviation shock to the growth global factor shock while keeping only one channel open at the time. (2) The black line is the response of each variable to the shock when all channels are open. It is, by construction, equal to the sum of the bars. (3) GDP refers to the deviation of the level of GDP from the long-run productivity growth path, ΔGDP denote GDP annual growth, π and πcore denote respectively annual headline and core inflation (where food and energy items are removed), u is unemployment, rer is the real exchange rate, TB/Y is the trade balance as a fraction of GDP, and MPR refers to the annualized monetary-policy rate.

Figure 9. Share of Variance Explained by Global Factors per Channel



Source: Authors' calculations.

Notes: (1) The bars correspond to the unconditional share of the forecast error variance that is attributable to each of the global factor's shocks. (2) Each color represents the variance explained by a factor while keeping only the corresponding channel open. The gray bars correspond to the share attributable to covariances, computed as the difference between the explained variance when all channels are open and the sum of the explained variance keeping one channel open at a time. (3) GDP refers to the deviation of the level of GDP from the long-run productivity growth path, ΔGDP denote GDP annual growth, π and πcore denote respectively annual headline and core inflation (where food and energy items are removed), u is unemployment, rer is the real exchange rate, TB/Y is the trade balance as a fraction of GDP, and MPR refers to the annualized monetary-policy rate.

Figure 7 describes the effects of a shock on the global price factor. A key finding of this exercise is that, in contrast to the previous case, all channels point in the same direction, with the exception of the imported commodity . Lower commodity export prices lower exports (and output) and raise inflation. In this case, the currency depreciation channel dominates the deflationary pressures due to lower exports. Lower foreign inflation raises real import prices and marginal costs, acting as a negative supply shock that lowers output and raises inflation. Foreign demand also drops, with a subsequent effect of lower output. The only channel that goes against these drivers is the commodity import price. As with the exported commodity, the factor shock lowers the import price, leading to lower marginal costs, higher output, and less inflation. The deflationary impact is compounded by an additional direct effect in the final consumer basket due to the gas and energy component.

Finally, consistent with the similar effect that shocks to the financial and growth factors have on most foreign variables, figure 8 shows how the domestic effects of a shock to the latter are qualitatively comparable to the responses after a shock to the former, albeit in a smaller scale.

To summarize, shocks to the financial factor lead to higher output and inflation. On the other hand, shocks to the price factors are followed by lower output and higher inflation. Shocks to the growth factor have similar effects to those of the financial factor, although smaller in magnitude. As the aggregate effect on inflation is much more pronounced following shocks to the price factor, so are the associated movements of the monetary-policy rate.

2.3.3 Variance Decomposition and the Role of Covariances

In section 1.3.2 we showed, by using the baseline factor model, that the financial factor has a dominant role in explaining the variance of most global variables as compared with the other global factors. However, as shown in table 3, this fact does not translate into the financial factor explaining an equivalently significant share of EME's GDP and inflation variances, where the price factor has a comparable role.

Table 5. Variance Decomposition in the DSGE Model: the Role of Covariances

	GDP	ΔGDP	π	$\pi core$	μ	rer	TB/Y	MPR	$Median$
Financial global factor									
Sum of FEVD by channel	32	6	32	12	24	152	108	13	32
Role of covariances	-22	-4	-23	-11	-17	-146	-82	-12	-22
Total explained variances	10	2	8	1	7	6	26	1	7
Price global factor									
Sum of FEVD by channel	11	4	12	9	10	65	34	6	11
Role of covariances	22	6	7	14	18	-50	-24	6	6
Total explained variances	34	9	19	24	28	15	10	12	19
Growth global factor									
Sum of FEVD by channel	2.3	0.4	1.1	0.5	2.2	12.9	3.5	0.6	2.2
Role of covariances	-2.2	-0.2	-0.6	-0.1	-1.8	-4.6	-2.7	-0.4	-1.6
Total explained variances	0.1	0.1	0.5	0.3	0.4	8.3	0.8	0.2	0.4

Source: Authors' calculations.

Notes: (1) The percentages correspond to the unconditional share of the forecast error variance that is attributable to each of the global factor's shocks. (2) Sum of FEVD by channels is computed as the sum of the variance explained by a factor while keeping only one channel open at a time. Total explained variance is the explained variance by the factor when all channels are open. The role of covariances is computed as the difference between both. (3) GDP refers to the deviation of the level of GDP from the long-run productivity growth path, ΔGDP denote GDP annual growth, π and πcore denote respectively annual headline and core inflation (where food and energy items are removed), u is unemployment, *rer* is the real exchange rate, TB/Y is the trade balance as a fraction of GDP, and MPR refers to the annualized monetary-policy rate.

The use of the factor-augmented DSGE model allows us to shed more light onto those results. By decomposing the factor effects by channels, we see that the greater importance of the financial factor in explaining the external variables' variance directly maps to an equivalent role, channel by channel, in explaining the domestic variables' variance. As can be seen by comparing the size of the shaded bars from figure 9, if we consider only the direct effect of the different channels, shocks to the financial factor explain the most variance, followed by shocks to the global price factor, and lastly, shocks to the growth one.

As with the baseline factor model, the analysis carried on with the DSGE also shows that for domestic variables, relative to their role in explaining global variables, the relative importance of the financial factor is dampened, while the impact of the price factor expands. To understand the discrepancy, it is worth paying particular attention to the role of covariances. As we can see by comparing figures 6 and 7, after a shock to the financial factor, different channels push the domestic variables in different directions, dampening the aggregate effect. The opposite happens after a shock to the price factor, where most channels tend to push the domestic variables in the same direction.

The share of domestic variables' variance attributed to a global factor shock can significantly differ depending on whether the shock pushes global variables in similar or opposing directions. Figure 9 and table 5 show the role that the comovements between the different transmission channels have on the aggregate explained variance. On the one hand, the financial factor shows the most significant channel-by-channel effect. However, as their effects tend to cancel each other, the aggregate explained variance is reduced due to this negative covariance effect. On the other hand, for the price factor, while different channels have an individually smaller impact, they tend to always go in the same direction, which leads to an exacerbated effect on the explained variance. This suggests that it is not enough to analyze separately how the factors explain the variance of global variables, given that the extent to which those responses comove can be equally or more important. In this example, while EMEs appear to be relatively well-hedged to deal with shocks to the financial factor, when it comes to shocks to the price factor, *when it rains, it pours*: when one channel affects the economy negatively, they all do.

We showed that the DSGE model manages to capture and explain both the relative dampening and the relative amplification of, respectively, the importance of the financial and price factors in explaining the dynamics of domestic variables. However, the dampening on the financial factor appears to be much more pronounced in the DSGE model than in its empirical counterpart. How can we account for this discrepancy? If the DSGE model were an accurate and comprehensive representation of the true data generating model, it would be expected for the factors to have a similar role in the DSGE and in the reduced form empirical model. However, by comparing tables 3 and 5, it is clear that the relative role of the financial factor in the DSGE model is much smaller. Understanding some key differences between both modeling approaches can be helpful to comprehend the root cause of the disparity regarding the assigned role of the financial factor. The empirical model attempts to maximize, in a reduced form, the covariance between the explanatory variables (the factors) and the dependent variables (from the domestic economy). It is then a helpful tool to get a good answer for the question of "how much" of a role global factors play, at the expense of being silent on 'how' shocks propagate. The structural nature of the DSGE model, on the other hand, is better equipped to answer the question of 'how' factor shocks are transmitted. However, the answer to the "how much" question will only be as accurate as how the different channels through which the factors affect the domestic economy are explicitly modeled. The estimation of the relative importance of a factor could be biased if a relevant transmission mechanism is missing in the model, more so if this missing channel disproportionately affects the transmission of one particular factor. Given that the DSGE model is, with the exception of an endogenous risk premium channel *à la* Schmitt-Grohé and Uribe (2003), absent of financial frictions, it would be reasonable to hypothesize that the model may be underrepresenting the true importance of the financial factor. Adding a global factors block to a model that incorporates financial frictions but is otherwise a similarly featured large-scale DSGE model as the one used in this paper[17] could provide a good test for this hypothesis and is a promising avenue for future research.

17. A suitable model could be the one described in Calani *and others* (2022). The model, also estimated for the Chilean economy, builds on the framework from García *and others* (2019) by introducing, similar to Clerc *and others* (2014), three layers of financial frictions, allowing for households, entrepreneurs, and banks to default on their financial obligations.

3. Conclusions

This paper has analyzed the role of global drivers on the business cycles of EMEs. The distinguishing feature of the analysis lied on the careful identification of multiple external forces by means of a constrained dynamic factor model. In accordance with prominent previous research, we have found empirical support for the overall relevance of a global financial factor—which explained more than a third of GDP fluctuations—followed by external factors akin to price and growth/productivity shocks.

In order to better understand the transmission mechanisms underlying the aggregate effects of shocks to our estimated factors, we focused on Chile—one of the EMEs in our sample—and embedded the previous empirical factor structure as an additional tier of the DSGE model of the Central Bank of Chile, whereby its original foreign variables now hinged on a set of foreign factors. In an apparent puzzling result at first, the aggregate empirical dominance of the financial factor compared to the price factor became the other way around, so we inspected the mechanism and found that, while a shock to the global financial factor triggered movements in global variables that steered domestic variables in opposing directions, after a global price shock, in contrast, such offsetting effects in domestic variables were no longer present. These results enriched our understanding of the consequences for monetary policy, which now should react more strongly in the face of price-factor shocks.

Finally, while we subjected our factor model to many robustness tests, we left aside some relevant issues possibly worth exploring in future work, such as the relation of our financial factor with relevant statistics, for instance, the U.S. break-even inflation. Another relevant research avenue should be the DSGE estimation for different economies, so we could eventually appraise the generality of the *inverse* effects of the financial and price-factor shocks at the local level.

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APPENDICES

APPENDIX A
Number of Common Factors

The number of factors that we considered in our baseline model was mostly guided by the set of different drivers underlined by previous research. In this brief digression we tackle the issue of the number of factors from a purely statistical sense in which we specifically apply the cornerstone contributions of Bai and Ng (2002, 2007); Amengual and Watson (2007), and Ahn and Horenstein (2013) to our dataset. The common thread across this literature is the specification of either a dynamic or static approximate factor model that is consequently estimated by principal components. With such estimation results at hand, these papers formulate some penalty criteria that ultimately provides the true number of factors asymptotically. Now, in our case however, since we are posing a state-space model with loading matrix constraints estimated by maximum likelihood, we cannot directly apply the results of the aforementioned tests for our specific formulation, although we can still use such optimal, dynamic factor model results if we actually fit that very same model to our data, and therefore take the optimal number of tests as a guidance for the specification we actually pursue in the paper.

Table A1 shows the number of factors for the aforementioned tests. The main pattern that emerges is the following: from the vantage point of the relatively more short-sample focus of Ahn and Horenstein (2013), we get a single dynamic factor inducing cycles into the features of the emerging economies we considered, while on the contrary, the asymptotic test of Bai and Ng (2002) leads to three factors. In any case, we get a sort of consistency between the number of factors that we include by entirely looking at the literature and those supported by statistical criteria.

Table A1. Statistical Number of Factors

	Statistical Test		
Max. number of factors	*BN*	*AH*	*AW*
2	2	1	1
4	3	1	1
6	3	1	1

Source: Authors' calculations.
Notes: Max. Number of Factors corresponds to the maximal number of factors considered in the corresponding principal components estimation. BN: Bai and Ng (2002), ICp2 information criterion; AH: Ahn and Horenstein (2013), eigenvalue ratio criterion; AW: Amengual and Watson (2007) estimate of dynamic factors given BN.

APPENDIX B
Model without GDP-Financial Factor Channel

Here we present additional results of the alternative model specification without a GDP financial factor channel, described in section 1.3.3. Tables B1 and B2 show, respectively, the factors' and the variables' forecast error variance decomposition at the 20-quarter horizon. Not surprisingly, by comparing those numbers with respect to the baseline scenario of table 2 in the text, we observe a higher relevance for the growth factor: since it is now the only common force inducing activity contemporaneously, it roughly doubles the variance explained across the set of factors considered.

Table B1. Factors' Variance Decomposition
(model without GDP-Financial factor channel (%))

	Shocks		
	Financial	*Price*	*Growth*
Financial Factor	71.6	24.8	3.6
Price Factor	31.7	60.4	7.9
Growth Factor	16.8	41.7	41.5
Average	40.0	42.3	17.7

Source: Authors' calculations.
Notes: Alternative model specification, with no direct channel between GDP variables and the financial factor. Figures correspond to the share of the 20-period ahead forecast error variance that is attributable to each of the global factors' shocks.

Table B2. Share of Variance Explained by Global Factor Shocks
(model without GDP-Financial factor channel (%, group medians)

	Factor			
	Financial	*Price*	*Growth*	*Total*
All variables				
	13.1	13.7	2.4	38.8
EME variables	6.0	15.0	14.9	35.9
GDP EMEs	2.9	5.2	0.6	8.7
CPI EMEs	16.0	5.6	0.8	22.4
EMBI	46.8	16.2	2.3	65.4
Stock market index				
Global variables				
Import price index	26.6	25.0	4.9	58.9
GDP trade partners	5.9	14.6	14.5	35.0
CPI trade partners	19.7	17.8	3.4	40.9
Exchange rate (local currency/USD	34.7	12.0	1.7	48.4
Commodity prices	13.9	9.4	1.7	28.1
Crude oil	46.2	14.6	3.3	64.0
Copper	47.0	15.3	2.4	64.7
Aluminum	47.7	14.5	2.7	65.0

Source: Authors' calculations.
Notes: Alternative model specification, with no direct channel between GDP variables and the financial factor. See notes in Table B1.

Appendix C
More Robustness Checks

C.1 Blending Growth and Price Factors

Here given the scant relevance of the growth factor in the baseline scenario, we explore the possibility of blending such factor with the price factor, as we show in table C1. What we get is a decrease of roughly three percentage points for the total median variance explained by the aggregation of factors. On the other hand, the explanatory power of the financial factor increases substantially, while the combined factor sees its variance explained eroded by seven points on average. These results therefore suggest that the separation of the growth and price factors catalyze a better identification and transmission of shocks.

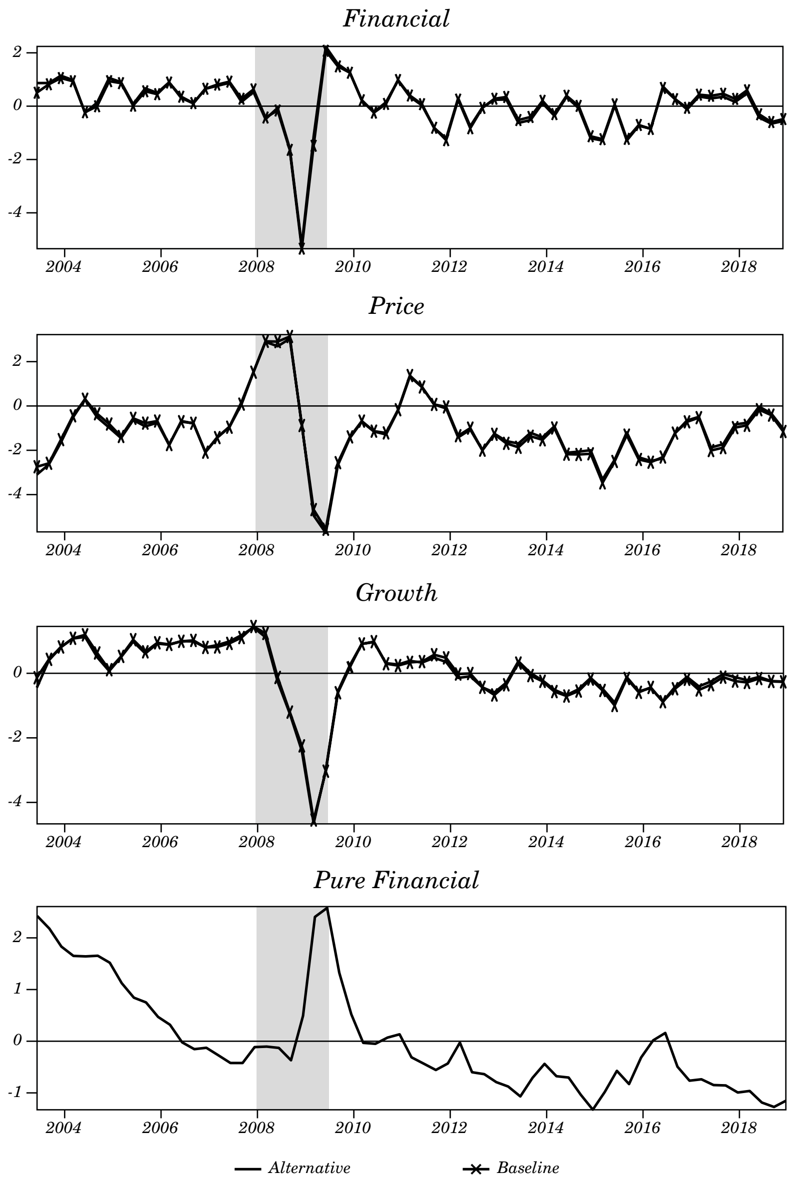
Table C1. Alternative Specification: Joint Growth and Price Factor (Two-Factor Model)
(restrictions on loading matrix)

	Factor	
	Financial	*Price*
EME variables		
GDP EMEs	●	●
CPI EMEs	●	●
EMBI	●	○
Stock market index	●	○
Global variables		
Import price index	●	●
GDP trade partners	●	●
CPI trade partners	●	●
Exchange rate	●	○
Commodities	●	●
Shadow FFR	●	○

Source: Authors' calculations.
Notes: White circles refer entries in the Λ matrix that are set to zero, whereas black circles correspond to unconstrained entries.

Figure C1. Alternative Specification: Additional 'Financial' Factor

(comparison of Estimated Factors with those of the Baseline Model)



Source: Authors' calculations.

Notes: All factors have been centered and scaled such that s.d. = 1.

C.2 An Additional "Purely Financial" Factor (Four-factor model)

Given the fact that the financial factor in the baseline model does not strictly discern a global interpretation from a strictly financial one, we take a look at the scenario in which we disentangle such global factor from a strict common force that only affects financial market variables. Table C2 shows the identifying details.

In figure C1 we plot the consequent time series of the factors we got. The salient feature is the overall stability of the new factors with respect to the baseline results. In terms of quantitative results, even though the aggregate variance explained increases, the actual combined variance explained by the global, price, and growth factors remains intact, which broadly suggests that the global/financial factor in the baseline scenario actually captures common forces across all the variables of the model, while exclusively financial movements appear to have less relevance.

Table C2. Alternative Specification: Additional "Purely Financial" Factor
(restrictions on loading matrix)

	Factor			
	Financial	*Pure Financial*	*Price*	*Growth*
EME variables				
GDP EMEs	●	○	○	●
CPI EMEs	●	○	●	●
EMBI	●	●	○	○
Stock market index	●	●	○	○
Global variables				
Import price index	●	○	●	○
GDP trade partners	●	○	○	●
CPI trade partners	●	○	●	○
Exchange rate	●	●	○	○
Commodities	●	○	●	○
Shadow FFR	●	●	○	○

Source: Authors' calculations.
Notes: White circles refer entries in the Λ matrix that are set to zero, whereas black circles correspond to unconstrained entries.