Global drivers and macroeconomic volatility in EMEs: A dynamic-factor, general equilibrium perspective

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Motivation

- Academics and policymakers point to **global factors as important drivers of macroeconomic fluctuations in emerging market economies** (EMEs)
  - In particular, small economies, open to global goods and capital markets
- The literature has associated these global factors to
  - **Financial conditions** (Miranda-Agrippino & Rey, 2020)
  - **Commodity prices** (Fernández *et al.*, 2017, 2018, 2020)
  - **Changes in sovereign risk** (Longstaff *et al.*, 2011; Aguiar *et al.*, 2016)
  - **Global growth** factors (Claessens *et al.*, 2012; Kose *et al.*, 2012)
- However, there is still an active debate about the **nature of these global forces, as well as their transmission mechanism into EME**s.

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**.

1. We **estimate a global dynamic factor model** using data from a set of 12 commodity-exporting EMEs over the last two decades, as well as other variables from advanced economies and international prices in goods and financial markets.
   - Our identification assumptions allow for **three distinct global factors to coexist: (1) a *financial*, (2) a *price*, and (3) a *growth* factor.**
2. We **evaluate the transmission mechanism and quantitative relevance of global disturbances into the Chilean economy**, as well as the MP response induced by them.
   - We **embed the dynamic factor model as another layer of the DSGE model** used regularly at the Central Bank of Chile for policy analysis and forecasting (*XMAS*).

Main results

1. Strong comovement of estimated global factors

- High interaction among factors.
- Preponderance of the financial factor affecting the two other factors.

2. Factors explain important share of EMEs business cycle and commodity prices

- The financial factor captures *risk on/off* episodes, and explains the most significant part of the variance of global variables.
- For EMEs, shocks to the price factor, akin to cost-push shocks, are especially relevant.

3. DSGE analysis for the Chilean economy highlights why price factor shocks explain more of the domestic cycle

- 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.
- This calls for a more active MP response in the presence of global price shocks.

Outline

A structural factor model

We model the dynamics of our **vector of *observed* macroeconomic variables,** Y_t, as

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

- F_t is the **vector of *unobserved* factors**, meant to capture common sources of variation in the observed variables across countries.
- Λ is the **matrix of factor loadings**.
- $u_t \sim N(0, H)$

Factors follow an autoregressive process:

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

- $w_t \sim N(0, Q)$ and $F_0 \sim N(\mu_0, \Sigma_0)$,
- H and Q are diagonal matrices (Q is the identity for scale identification)

EMEs (mostly commodity-exporters): ARG, BRA, BGR, CHL, COL, ECU, MYS, MEX, PER, RUS, UKR, ZAF.

Top-10 Trade partners (TP): USA, CHN, EZ, JPN, GBR, IND, KOR, TWN + (BRA & MEX).

Top-10 commodity goods exported: Crude oil, copper, aluminum, nat. gas, coal, iron, gold, coffee, bananas, soybean meal.

Sample: 2002Q1–2018Q4, unbalanced panel (robustness sample: since 1995).

The vector of **observables** (Y_t) consists of:

EME variables **(48 series)**

- Real GDP
- CPI
- EMBI
- Stocks

Global variables **(48 series)**

- EMEs' Import price indexes
- Real GDP, CPI & FX for top-10 TP
- Prices for top-10 exported commodities
- US *shadow* FFR (Wu & Xia, 2016)

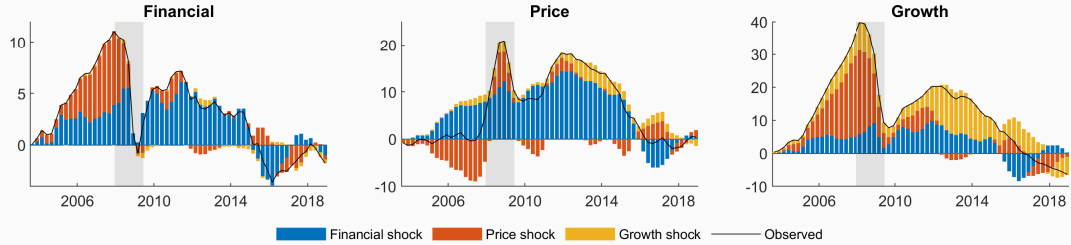
- The model's general specification does not allow for structural interpretation of estimated factors.
  - **Impose parameter constraints** (set to 0 some of Λ's entries) to "name" factors (Bajraj *et al.*, 2021).
  - **Operate contemporaneously**: they don't affect factor covariance matrix.
  - In line with factors identified in the literature.
- Estimated factors:
  - A global, financial **factor**, associated with financial data and other variables.
  - A price **factor**, associated to CPIs, import prices and commodity prices.
  - A growth **factor**, associated to EMEs' GDP and their trade partners.
- Model estimated in log-differences by ML.

Constraints on loadings matrix

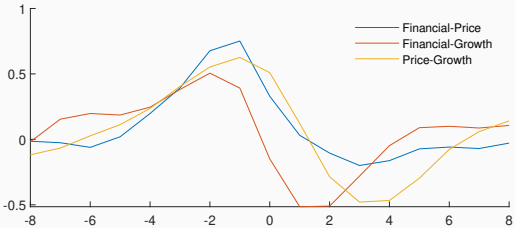
	Factor		
	Financial	Price	Growth
EME Variables			
GDP EMEs	●	○	●
CPI EMEs	●	●	○
EMBIs	●	○	○
Stock Mkt. Indexes	●	○	○
Global Variables			
Import Price Indexes	●	●	○
GDP Trade Partners	●	○	●
CPI Trade Partners	●	●	○
Exchange Rates	●	○	○
Commodity prices	●	●	○
Shadow FFR	●	○	○

Notes: White circles refer entries in the loadings matrix that are set to zero, whereas black circles correspond to unconstrained entries.

Global Factors strongly co-move and are dominated by financial factor shocks



Historical decomposition of estimated factors. Factors *in levels* obtained via cumulation of the original factors estimated in log-differences. For presentation purposes, initial values are omitted. Shaded areas denote NBER US recession dates.

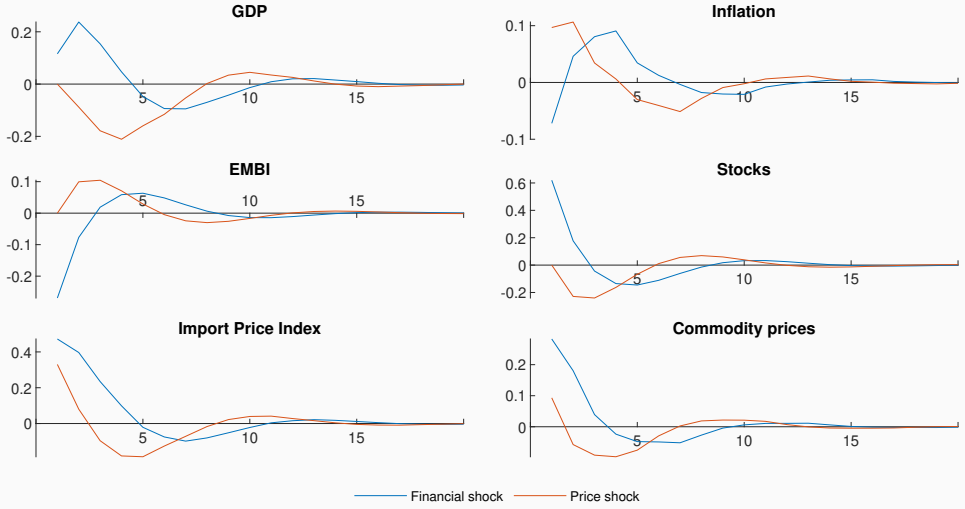


Cross-correlations. Each line depicts the correlation between the first factor and shifted copies of the second.

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

Variance explained by shocks to factors. Figures correspond to the share of the 20-period ahead forecast error variance that is attributable to each of the global factors' shocks.

Financial factor appears as a risk-on shock, while price factor seems like a cost-push shock



Impulse response functions. Medians for each group of variables across EMEs.

More

- **Shocks to the three global factors account for a large share of variance** in both EMEs (particularly GDP, stock mkt. indices, and sovereign spreads) and their most relevant external variables.
- On average, **shocks to financial factor have relatively more explanatory power** regarding both EME and global variables.
- **Price factor shocks also plays a relevant role, specially for GDP and CPI in EMEs**.
- Shocks to growth factor play sparse role.

Variance explained by shocks to factors

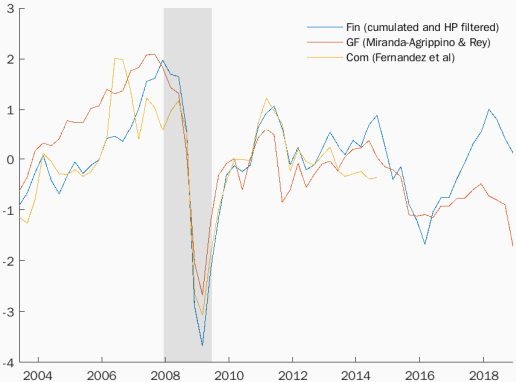
	Factor			
	Financial	Price	Growth	Total
All Variables	23.3	12.9	1.0	40.8
A. EME Variables				
GDP EMEs	14.0	15.2	7.2	38.5
CPI EMEs	3.9	5.0	0.3	9.2
EMBI	17.9	5.8	0.4	24.1
Stock Mkt. Index	49.9	16.2	1.0	67.1
B. Global Variables				
Import. Price Index	28.2	17.4	1.6	43.5
GDP Trade Partners	22.2	13.0	3.4	39.1
CPI Trade Partners	24.8	16.9	1.7	43.4
Exc. Rate (Loc. Curr./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

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

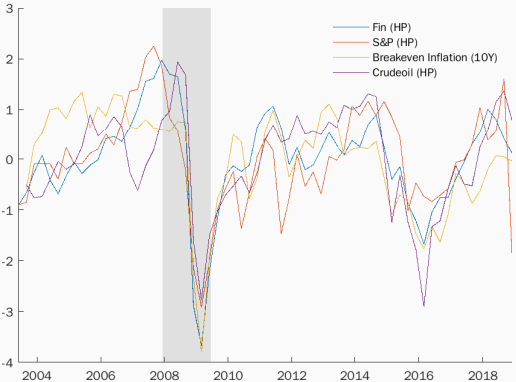
What is behind the Financial factor

Our financial factor coincides with other factors estimated in the literature, and with relevant global financial indicators.

vs. other factors in the literature



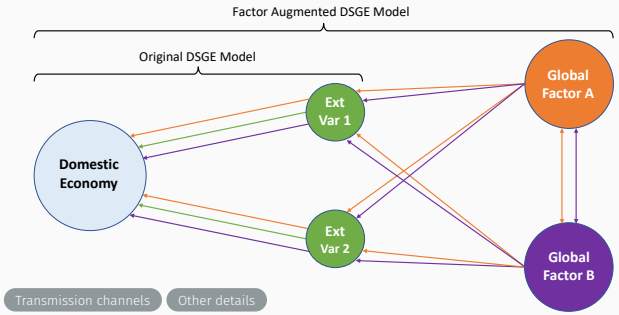
vs. other financial variables



Comparing the "financial" factor. Centered and scaled variables (s.d.=1). In both figures the financial factor is the cyclical component (HP filter) of the cumulated estimated factor. *GF* is the global financial factor estimated by Miranda-Agrippino & Rey (2020); *Com* is the commodity global factor estimated by Fernández et al. (2018). Shaded areas denote NBER US recession dates. 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.

Global factors and emerging economies: Transmission mechanisms

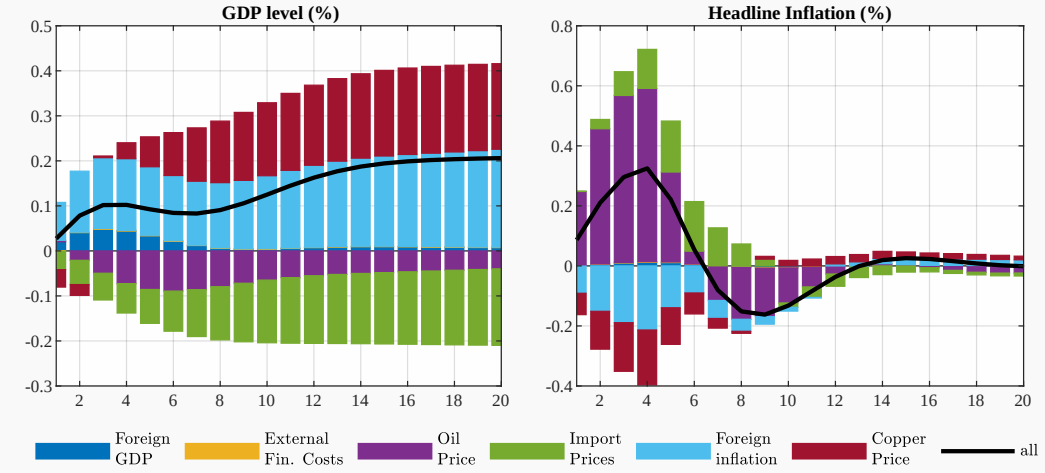
- **Large-scale DSGE model estimated for Chile** (García *et al.*, 2019), regularly used at the CB of Chile for forecasting and policy analysis.
- **Connects external and domestic blocks through different channels**:
  - Trade partners' GDP and prices, commodity prices (copper and oil), import prices, interest rates and sovereign spreads.



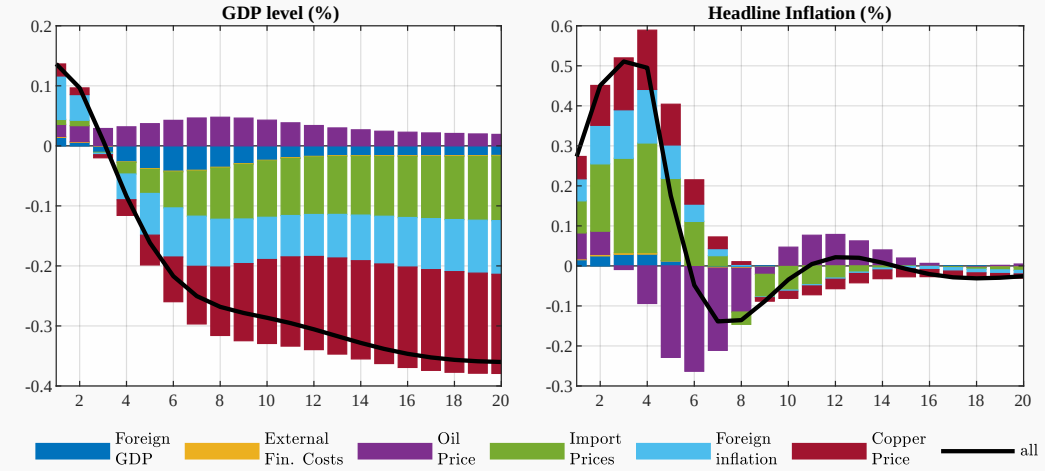
- **Original DSGE model**:
  - Only direct effects (green arrows).
  - External variables assumed orthogonal.
- **Factor-augmented DSGE model**:
  - Factors affect domestic economy through global variables (orange and purple arrows).
  - Systematic effect of factors induce correlation among external variables.
  - Allows to measure factor's effects separately by channel.

More

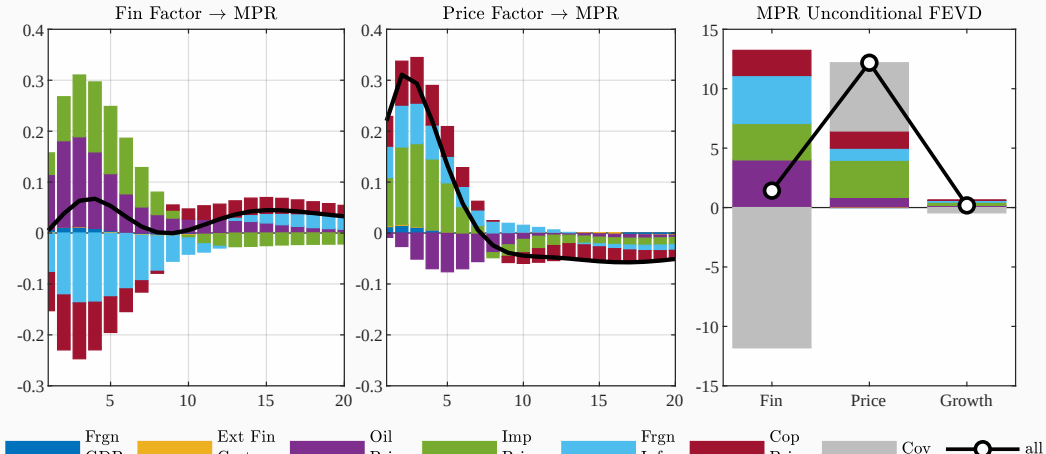
- More output and inflation.
- Factor shocks have relevant implications, although many times push in opposite directions.



- Contractionary and inflationary.
- Factor shocks have somewhat smaller effects, but they all tend to push in the same direction.



- Direct effects from financial factor explain more.
- Covariances dampen overall impact.



Concluding remarks

Concluding remarks

- We analyzed the role of global drivers on the business cycles of EMEs.
- Distinguishing feature of the analysis: identification of multiple external forces by means of a constrained dynamic factor model.
- We found empirical support for the overall relevance of a global financial factor, followed by external factors akin to price and growth shocks.
- We embedded our empirical factor structure as an additional layer of Chile's Central Bank DSGE model.
- The results have relevant implications for monetary policy, rationalizing why a central bank should react more strongly in the face of price factor shocks.

Thank you!

Number of factors

At least three global, macroeconomic factors have been considered by previous research (financial, growth, commodity).

- A single factor explains a third of variance.
- Additional factors improve model fitting.
- Formal tests for DFM models point in the same direction (Ahn-Horenstein).

Variance explained by additional factors

Forecast Error Variance Decomposition

Nth factor	1st	2nd	3rd	4th
Mean	30.7%	9.8%	7.9%	4.8%
Median	30.0%	11.2%	10.2%	1.7%

Notes: Variance explained by additional factors. Model estimated in log-differences by ML. EMEs: ARG, BRA, BGR, CHL, COL, ECU, MYS, MEX, PER, RUS, UKR, ZAF. Trade partners: USA, CHN, EZ, JPN, GBR, IND, KOR, TWN + BRA & MEX.

Table 1: 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

Notes: Max. Number of Factors corresponds to the maximal amount of factors considered in the corresponding principal components estimation. BN: Bai & Ng (2002), IC_{p2} information criterion; AH: Ahn & Horenstein (2013), eigenvalue ratio criterion; AW: Amengual & Watson (2007) estimate of dynamic factors given BN.

We follow Bajraj, Lorca & Wlasiuk (2021) in order to incorporate external factors into XMAS.

$$Y_t = \Lambda F_t + \Gamma X_t + u_t, \qquad t = 1, 2, \ldots, T$$

where

- Y_t is $N \times 1$ vector of observables (i.e. EMEs GDP, EMBI, Stocks, etc.)
- X_t is $q \times 1$ vector of exogenous regressors (i.e. variables to adjust EMBI)
- F_t is $r \times 1$ unobserved vector of factors
- Λ is $N \times r$ loading matrix

Factors follow autoregressive process:

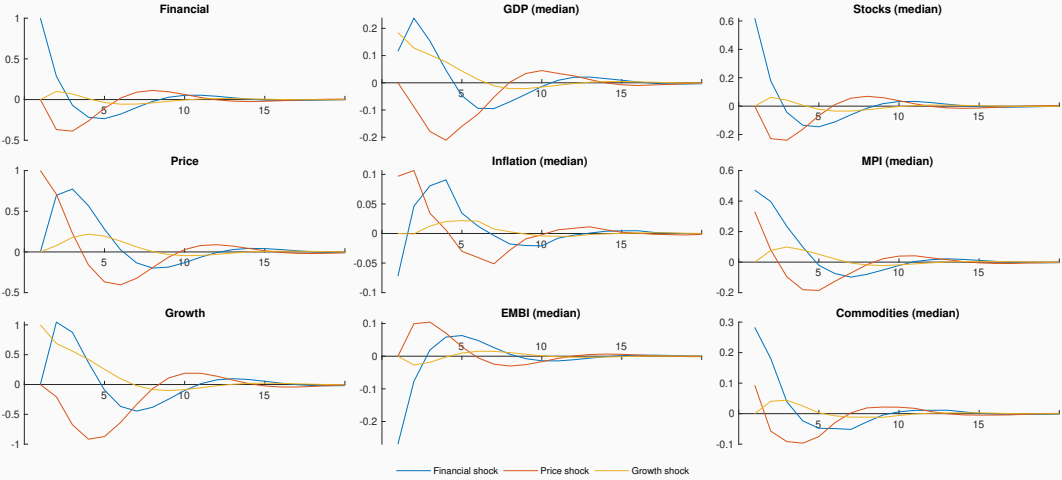
$$F_t = \Phi F_{t-1} + w_t$$

where

- $u_t \sim 1; w_t \sim N(0, Q); F_0 \sim N(\mu_0, \Sigma_0)$
- H and Q are diagonal matrices, and
- Q is the identity matrix.

Impulse response functions

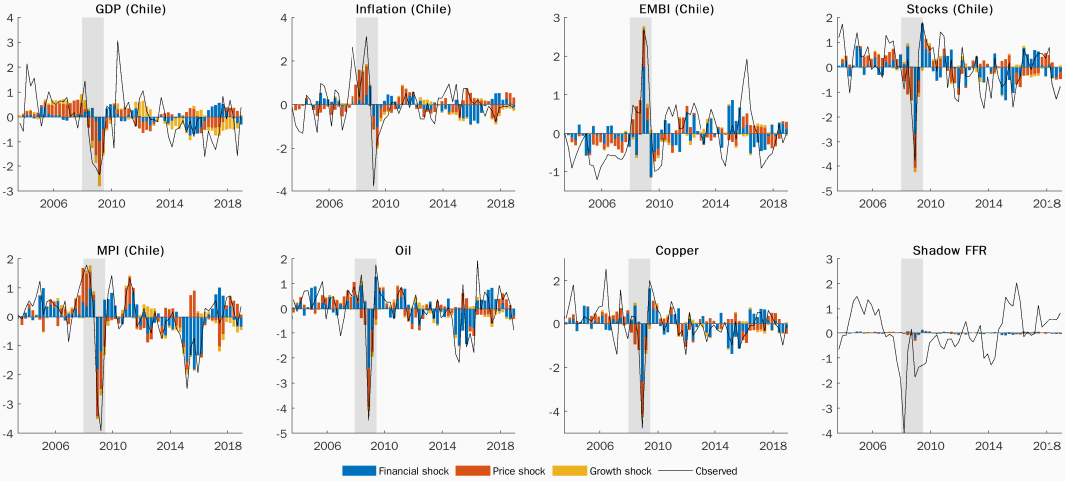
Back



Variance explained

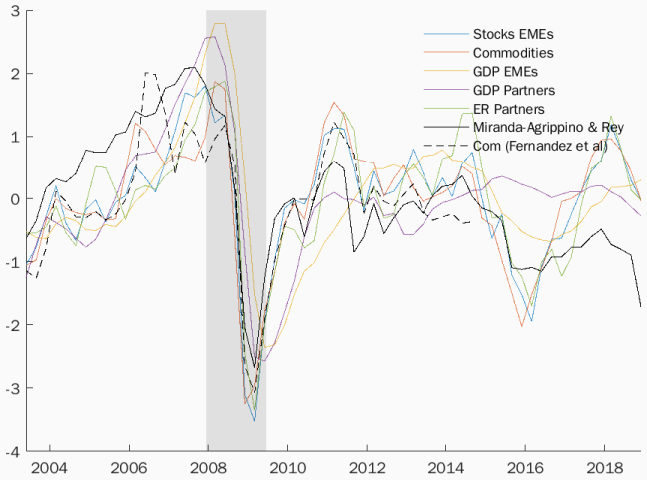
Here goes the table.

Historical decomposition of selected variables



Back

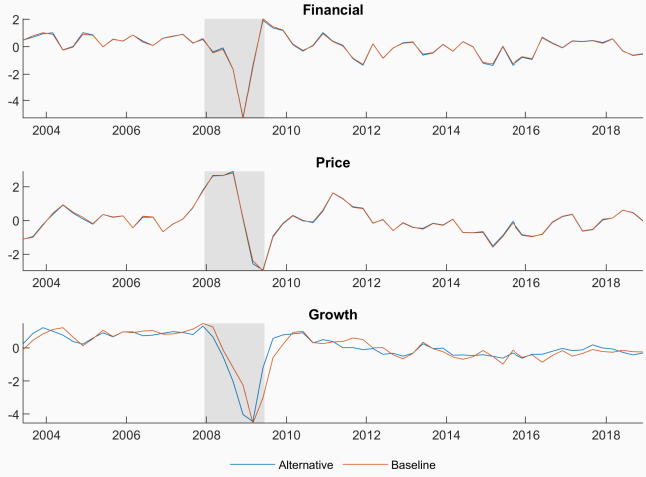
Common factors for different datasets



Scaled factors. Cyclical component from HP filter for log-differenced data.

Model without Financial channel for GDP

Back



Alternative specification

Constraints on loading matrices

	Factor		
	Financial	Price	Growth
EME Variables			
GDP EMEs	○	○	●
CPI EMEs	●	●	○
EMBI	●	○	○
Stock Mkt. Index	●	○	○
Global Variables			
Import Price Index	●	●	○
GDP Trade Partners	○	○	●
CPI Trade Partners	●	●	○
Exchange Rate	●	○	○
Commodities	●	●	○
Shadow FFR	●	○	○

Notes: White circles refer entries in the loadings matrix that are set to zero, whereas black circles correspond to unconstrained entries.

- Estimation:
  - While keeping first-stage identification constraints, we re-estimate factor loadings for external variables in XMAS.
  - We also estimate variance and shock persistence from idiosyncratic shocks in external block.
  - Rest of parameters are kept constant (Garcia et al., 2019).
- Effect decomposition channel:
  - Model:

$$C_t = AF_t + \mu_t$$
$$F_t = BF_{t-1} + \epsilon_t$$

  - We define $\widetilde{C}^j_{t+i} = \mathbb{E}_{t+i}\left(C_t|\epsilon(j)_t\right)$ as expected response from channel vector C_t for period $t+i$ for factor j in t.
  - We also define $\widetilde{C}^{j,k}_{t+i}$ as the vector where all elements are in steady-state values, except for position k, where

$$\widetilde{C}^j_{t+i} = \sum_{k=1}^{N_c} \widetilde{C}^{j,k}_{t+i}$$

  - Therefore, we can decompose effects from factor j, through channel k, in different variables Y, using XMAS policy functions, where:

$$\widetilde{Y}^{j,k}_{t+i} = Y\left(\widetilde{C}^{j,k}_{t+i}\right) \quad \text{and} \quad \widetilde{Y}^j = \sum_{k=1}^{N_c} \widetilde{Y}^{j,k}_{t+i}$$

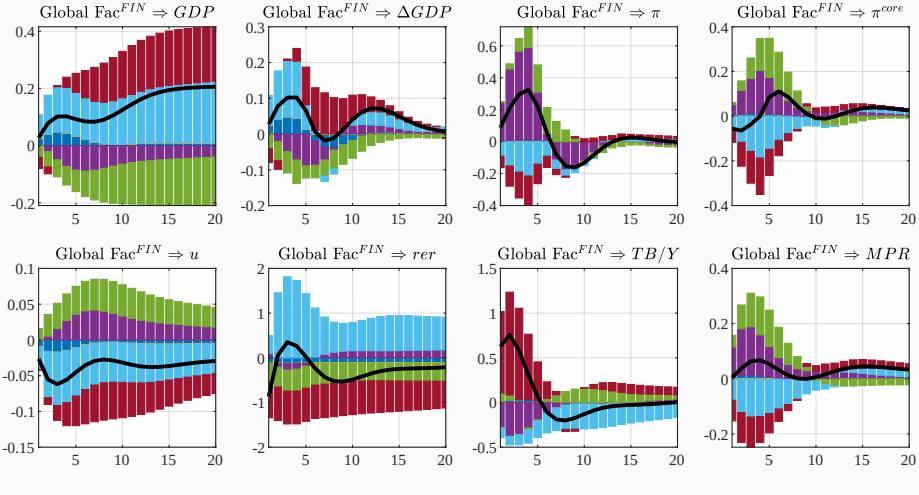
We summarize effects from external variables on Xmas (ceteris paribus)

- Copper price:
  - Increase government revenue.
  - Induce currency appreciation, which reduces inflation.
  - Persistent movements increase investment in the sector.
- Oil price:
  - Increases government spending as a shock buffer.
  - More energy related inflation.
  - Higher marginal production costs.
  - Higher core inflation.
- Import prices:
  - Increase cost of imported goods, and therefore inflation.

- Trade partners inflation:
  - Increases foreign demand for domestic goods.
  - For constant nominal prices, the price of imported goods as measured in units of domestic goods fall $\left(p^m = \frac{p^{m*}}{p^*} rer\right)$.
- Trade partners growth:
  - Increase external demand for domestic goods.
- Foreign rate and sovereign risk:
  - Increase relative funding costs in foreign currency.
  - FX depreciation

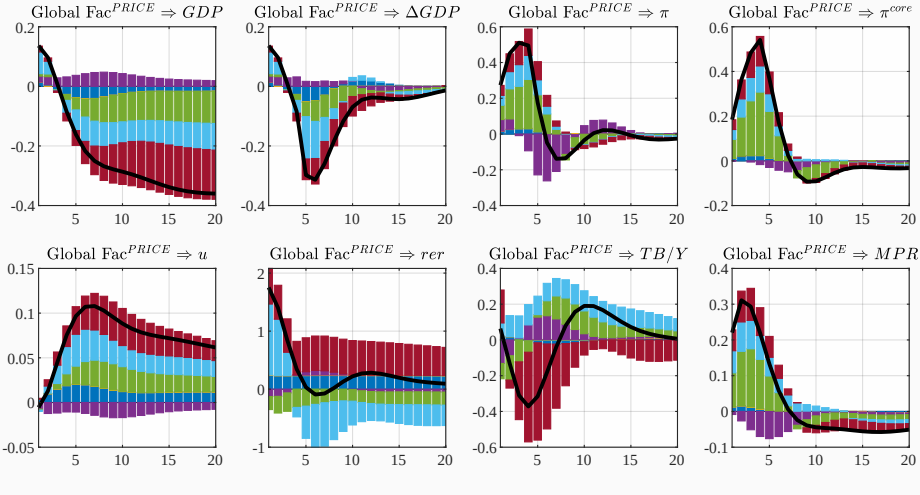
Shock to financial factor - IRFs

Back

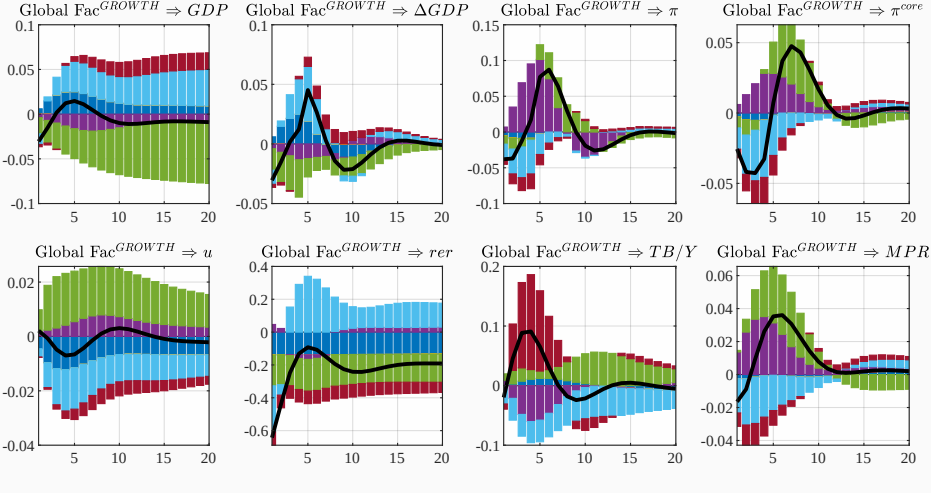


Shock to price factor - IRFs

Back



Shock to growth factor - IRFs



The Role of Covariances (i): Unconditional FEVD (DSGE)

Back