

# TERMS-OF-TRADE SHOCKS ARE NOT ALL ALIKE

**Federico Di Pace<sup>1</sup>   Luciana Juvenal<sup>2</sup>   Ivan Petrella<sup>3</sup>**

<sup>1</sup>*Bank of England*

<sup>2</sup>*International Monetary Fund*

<sup>3</sup>*Warwick Business School and CEPR*

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- ▶ Disconnect between theory and empirics (Schmitt-Grohé and Uribe, 2018)
  - ToT shocks fail to capture the transmission of world shocks

# This Paper: Overview

- ▶ ToT are an insufficient statistic to summarize how international prices affect the economy

$$ToT = \frac{p^{x,\$}}{p^{m,\$}}$$

- ▶ ToT shock may result from
  - ▶ A shift in  $p^{x,\$}$
  - ▶ A shift in  $p^{m,\$}$
  - ▶ A not perfectly offsetting movement in both
- ▶ The literature (implicitly) assumes that the economy responds symmetrically to  $\uparrow p^{x,\$}$  or  $\downarrow p^{m,\$}$
- ▶ This paper shows empirically and theoretically that this is not the case

# This Paper: Empirics

- ▶ Construct measure of  $P^{x,\$}$  and  $P^{m,\$}$  using commodity and manufacturing prices matched with time-varying trade shares for a sample of 38 countries
- ▶ Estimate  $p^{x,\$}$ ,  $p^{m,\$}$  and  $y^g$  shocks using a SVAR with sign-restrictions complemented by narrative restrictions [▶ ToT](#) [▶ World Shocks](#)



# This Paper: Results

## Empirics:

- ▶  $p^{x,\$}$  and  $p^{m,\$}$  shocks do not mirror each other
  - ▶ Effects of  $p^{x,\$}$  shocks resemble “*traditional ToT*” shock
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- ▶  $p^{x,\$}$  and  $p^{m,\$}$  shocks explain up to 30 percent of GDP
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## Link theory with empirics:

- ▶ Propose a framework based on standard SOE model to show that  $p^{x,\$}$  and  $p^{m,\$}$  shocks can have distinct effects on output
- ▶ Capture heterogeneity in transmission of  $p^{x,\$}$  and  $p^{m,\$}$  shocks

# DATA AND EMPIRICS

# Data

- ▶ Annual data from 1980 to 2019 for 38 countries classified as emerging and developing
- ▶ Data set combines data on:
  - ▶ Macroeconomic indicators (WDI)
  - ▶ Commodity prices (World Bank Commodity Price Data)
  - ▶ Producer Price Indices (FRED)
  - ▶ Country-specific sectoral export and import shares (MIT Atlas)
- ▶ Export and Import Prices:
  - ▶ Sectoral export and import values (SITC Rev. 2) for 988 categories are matched with 62 commodity and industry classifications to recalculate export and import shares
  - ▶ Prices: 47 commodity sectors + 15 manufacturing categories
  - ▶ For each country, compute  $P^{x,\$}$  and  $P^{m,\$}$  following the indications of the IMF Export and Import Prices Manual

# Export and Import Prices: Descriptive Statistics (Selected Countries)

	Export Prices			Import Prices			$Corr(p^{x,\$}, p^{m,\$})$
	$\sigma(p^{x,\$})$	$\rho_1(p^{x,\$})$	$Corr(p^{x,\$}, y)$	$\sigma(p^{m,\$})$	$\rho_1(p^{m,\$})$	$Corr(p^{m,\$}, y)$	
Algeria	36.2	79.1	68.7	6.5	74.7	17.9	49.9
Argentina	15.5	76.5	63.2	5.4	77.2	67.2	95.9
Bangladesh	3.3	59.2	-5.5	9.9	77.5	1.3	53.3
Bolivia	19.6	77.3	21.3	6.3	75.9	-1.3	80.3
Brazil	12.8	76.8	83.4	9.8	74.3	74.9	93.0
Burkina Faso	17.2	68.9	-20.5	7.1	68.7	17.3	67.7
Cameroon	25.0	79.3	3.2	8.8	75.1	8.7	87.3
Chad	27.6	68.9	49.4	5.0	75.3	53.2	87.8
Colombia	20.2	74.6	17.0	5.4	72.2	47.8	83.6
...							
Uruguay	10.8	75.7	48.3	11.0	78.5	11.2	75.8
<b>Median</b>	<b>14.5</b>	71.2	30.8	<b>7.4</b>	74.9	20.6	<b>81.6</b>

# Econometric Method

- ▶ “Small open economy” assumption: there is no impact from the current or lagged country specific macroeconomic variables to the “foreign block” of variables

$$\mathbf{z}_t = \left[ y_t^g, p_t^{x,\$}, p_t^{m,\$} \right]'$$

- ▶ The impact of the three shocks of interest,  $\mathbf{u}_t$ , to the “foreign block” of variables can be recovered from the following structural VAR, which we estimate country-by-country:

$$\mathbf{z}_t = \mathbf{a} + \mathbf{A}_1 \mathbf{z}_{t-1} + \mathbf{A}_0^{-1} \mathbf{u}_t$$

- ▶  $\mathbf{A}_0^{-1}$  captures the contemporaneous impulse response of the shocks to the foreign block
- ▶  $\mathbf{u}_t \sim N(0, I)$



# Econometric Method

- ▶ To retrieve the impact of the shocks  $\mathbf{u}_t$  to the macro variables of each country we use a simple regression approach (Kilian 2008, 2010):

$$x_{i,t} = \rho_0 + \rho_1 x_{i,t-1} + \gamma_0 \mathbf{z}_t + \gamma_1 \mathbf{z}_{t-1} + \varepsilon_{i,t}$$

- ▶  $x_{i,t}$  as a generic country-specific variable
- ▶  $\varepsilon_{i,t}$  is serially uncorrelated residuals
- ▶ Under strict exogeneity we can retrieve the impact of the shocks onto macro variables:

$$x_{i,t} = c_0 + \gamma_0 \mathbf{A}_0^{-1} \mathbf{u}_t + \sum_{j=1}^{\infty} \rho_1^{-j} (\gamma_0 + \gamma_1 \mathbf{A}_1) \mathbf{A}_1^{-j} \mathbf{A}_0^{-1} \mathbf{u}_{t-j} + \sum_{j=0}^{\infty} \rho_1^{-j} \varepsilon_{i,t}$$

# Identification: Sign Restrictions

- ▶ Based on sign restrictions (Uhlig, 2005)

Shock/Variable	Global <i>GDP</i>	Export Prices	Import Prices	Domestic <i>GDP</i>
$p^{x,\$}$		+		+
$p^{m,\$}$			+	-
$y^g$	+	+	+	+

- ▶ Narrative restrictions (Antolín-Díaz and Rubio-Ramírez, 2018)
- ▶ Relative elasticity restrictions

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  - ▶ Structural shocks or historical decompositions are in line with selected narrative
- ▶ For export/import price shocks identify episodes of substantial price changes that are unrelated to the state of the economy
  - ▶ Example: geopolitical events, natural disasters, weather shocks, El Niño and La Niña events
- ▶ Total of 23 events associated to a  $p^{x,\$}$  or  $p^{m,\$}$  shock if a country is an exporter or importer of the specific commodity that year

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- ▶ Total of 23 events associated to a  $p^{x,\$}$  or  $p^{m,\$}$  shock if a country is an exporter or importer of the specific commodity that year
- ▶ Great recession is a prototype  $y^g$  shock
  - ▶ In 2009 the  $y^g$  shock is negative and the largest contributor to the innovations to global GDP

# Narrative Approach

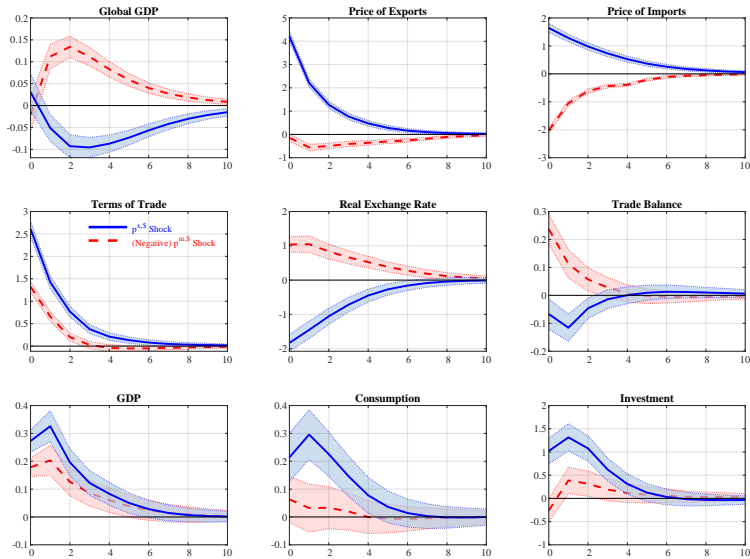
## Example

- ▶ **Commodity:** Coffee
- ▶ **Year of event:** 1986
- ▶ **Type of event:** Positive price shock
  - ▶ Drought in Brazil triggered a large price increase in Arabicas (Source: International Coffee Organization Report)
  - ▶ Between 1985 and 1986 Arabica coffee prices increased from 3.23 to 4.29 dollars per kilo (+30%)

Table: Narrative Restrictions: Export Prices

Commodity:	Coffee	
Year:	1986	
Sign:	+	Exp. Share
Colombia	✓	51%
Guatemala	✓	42%
...		
Dominican Republic	✓	8%

# Impulse Response to Export and Import Price Shocks



## Forecast Error Variance Decomposition

	Export Prices		Import Prices		Terms of Trade		Real Exchange Rate	
	$p^x, \$$	$p^m, \$$	$p^x, \$$	$p^m, \$$	$p^x, \$$	$p^m, \$$	$p^x, \$$	$p^m, \$$
0	68.72	7.53	24.84	45.58	65.54	19.16	9.29	7.00
1	69.05	9.14	28.55	42.55	64.46	18.62	12.62	10.31
4	63.94	13.18	32.51	38.96	58.18	21.44	17.04	14.22
10	61.80	14.60	33.56	37.82	56.32	22.69	19.18	15.32

	Trade Balance		Output		Consumption		Investment	
	$p^x, \$$	$p^m, \$$	$p^x, \$$	$p^m, \$$	$p^x, \$$	$p^m, \$$	$p^x, \$$	$p^m, \$$
0	7.62	7.00	5.20	3.07	8.29	5.44	6.92	4.67
1	11.57	10.31	9.72	6.19	11.94	8.74	10.70	7.89
4	14.77	14.22	16.03	10.91	16.16	12.36	15.35	11.28
10	16.04	15.32	18.46	12.93	17.86	13.63	17.07	12.47



# LINKING THEORY AND EMPIRICS

# Theoretical Framework

- ▶ In standard SOE only ToT matter for equilibrium allocations (Mendoza, 1995; Schmitt-Grohé and Uribe, 2018)
- ▶ Frame analysis in a model typically used to study ToT shocks: MXN model (SGU, 2018)
  - ▶ Three sectors: importable (M), exportable (X), nontradable (N)
- ▶ Export and import prices can have an independent and heterogeneous impact

## ToT Component

$$p_t^{x,\$} = \frac{P_t^{x,\$}}{P_t^*} = (ToT_t)^{1-\chi_m^*} \times \frac{P_t^{\tau,*}}{P_t^*}$$

$$p_t^{m,\$} = \frac{P_t^{m,\$}}{P_t^*} = (ToT_t)^{-\chi_m^*} \times \frac{P_t^{\tau,*}}{P_t^*}$$

- ▶  $ToT_t$  makes  $p_t^{x,\$}$  and  $p_t^{m,\$}$  comove negatively
- ▶  $\frac{P_t^{\tau,*}}{P_t^*}$  makes  $p_t^{x,\$}$  and  $p_t^{m,\$}$  comove positively
- ▶  $P_t^{\tau,*}/P_t^*$  is a common shifter of  $p_t^{x,\$}$  and  $p_t^{m,\$}$ : impact not visible when looking at ToT

→ In the MXN model  $P_t^{\tau,*}/P_t^* = 1 \implies p_t^{x,\$}$  and  $p_t^{m,\$}$  are perfectly negatively correlated

→ In the data  $p_t^{x,\$}$  and  $p_t^{m,\$}$  are positively correlated. The variation in  $P_t^{\tau,*}/P_t^*$  dominates that of ToT

## $p^{x,\$}$ and $p^{m,\$}$ Shocks in a Traditional MXN Model

- ▶ Standard SOE MXN model assumes that  $p_t^\tau = q_t$
- ▶ This requires  $p_t^{\tau,*} = 1$  (SGU, 2017 and 2018)
- ▶ Under this assumption all real allocations are only function of the ToT
- ▶ Consider the relative price of tradables (in log deviation from SS)

$$\tilde{p}_t^\tau = (1 - \chi_m) \tilde{p}_t^x + \chi_m \tilde{p}_t^m$$

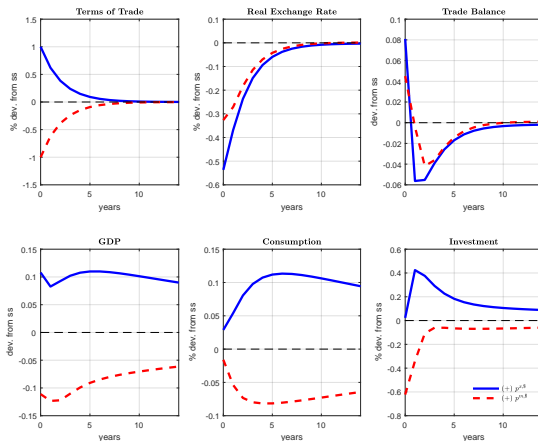
The LOOP in exports and import prices requires that  $p_t^x = p_t^{x,\$} q_t$  and  $p_t^m = p_t^{m,\$} q_t$ , therefore:

$$\tilde{p}_t^\tau = (1 - \chi_m) \tilde{p}_t^{x,\$} + \chi_m \tilde{p}_t^{m,\$} + \tilde{q}_t$$

- ▶ Unless  $\tilde{p}_t^{x,\$} = -\chi_m \tilde{p}_t^{m,\$} / (1 - \chi_m) \forall t$ ,  $p_t^\tau \neq q_t$

# Independent $p^{x,\$}$ and $p^{m,\$}$ within a Calibrated MXN Model

Figure: Impulse Responses of Macro Aggregates

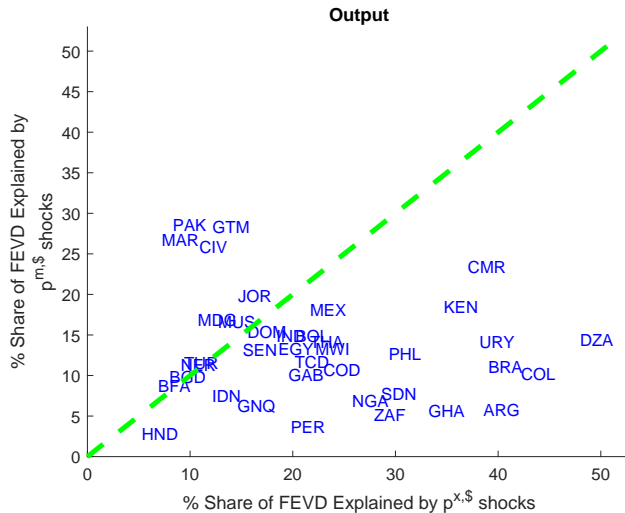


# Conclusions

- ▶ **Terms-of-trade shocks are not all alike:** Economy responds differently to export and import price shocks
- ▶ Export and import price shocks explain a large share (up to 30 percent) of domestic country business cycle of developing economies
- ▶ **Policy makers concern about ToT fluctuations: well founded**
- ▶ ToT measured as a univariate variable may be an inaccurate proxy of how ToT affect the economy
- ▶ Theoretical models aimed at capturing the transmission of ToT shocks should reflect that

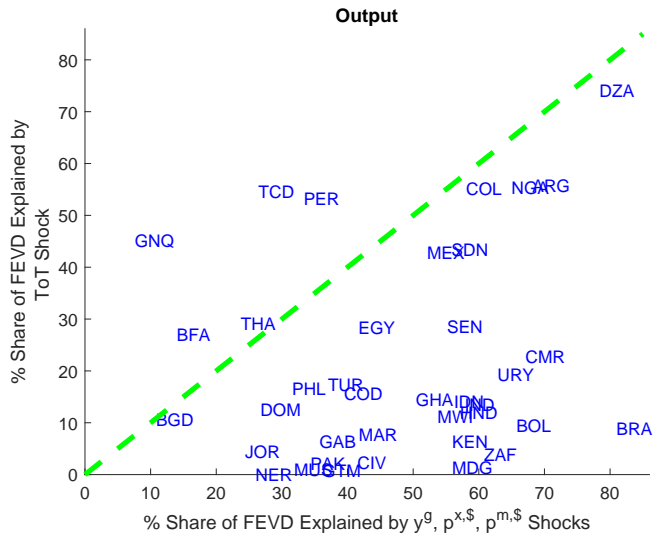
# EXTRA SLIDES

# FEVD by Country

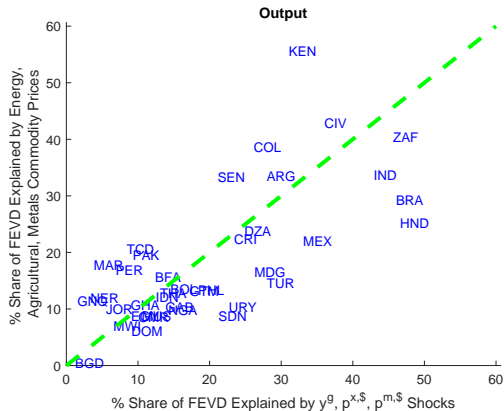
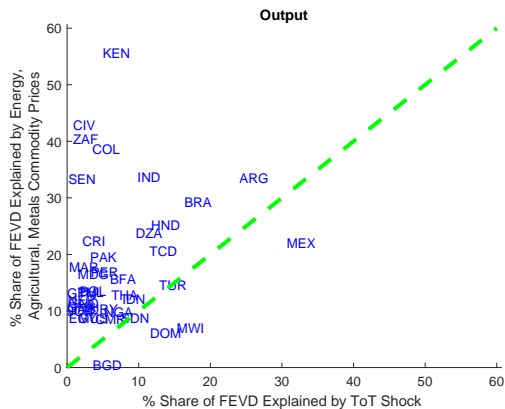




## ToT Shocks Fail to Capture the Transmission of World Shocks



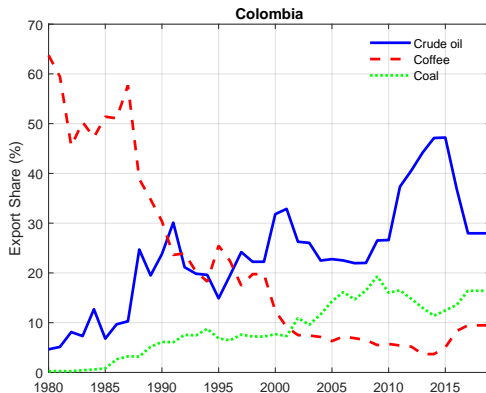
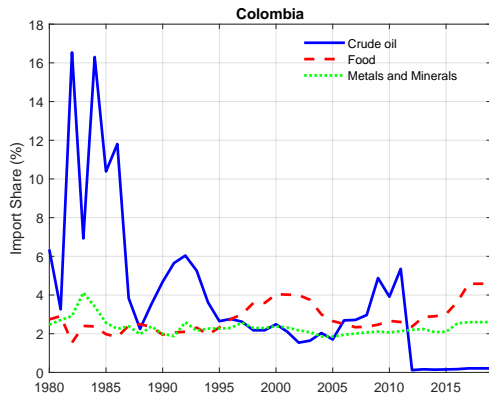
# ToT Shocks Fail to Capture the Transmission of World Shocks



► Go back

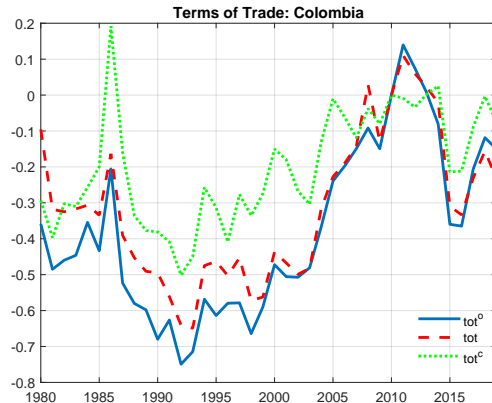
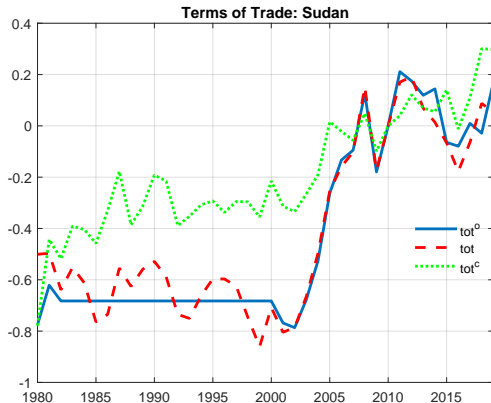
# Export and Import Shares

- When constructing  $P^{x,\$}$  and  $P^{m,\$}$  we account for **changing composition of exports and imports**. This is important...

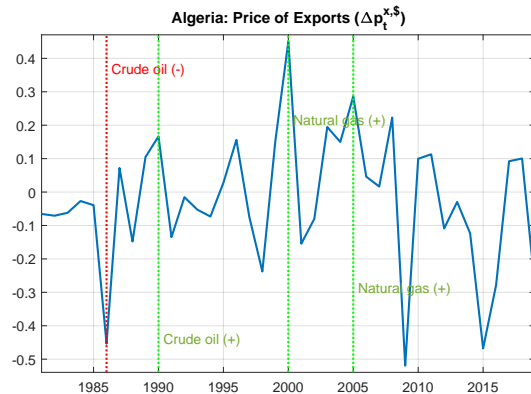
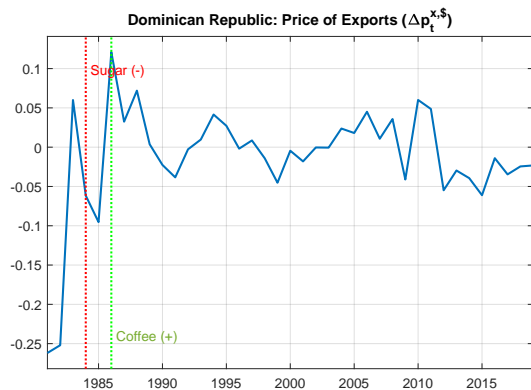


# Terms of Trade Measures: A Comparison

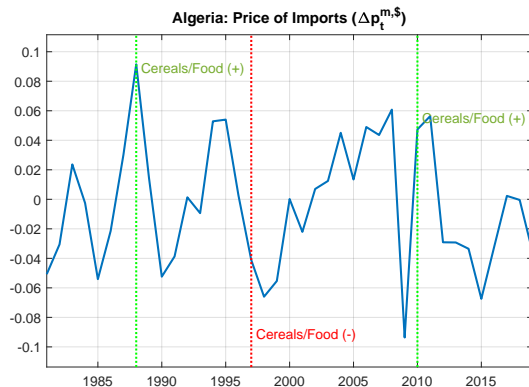
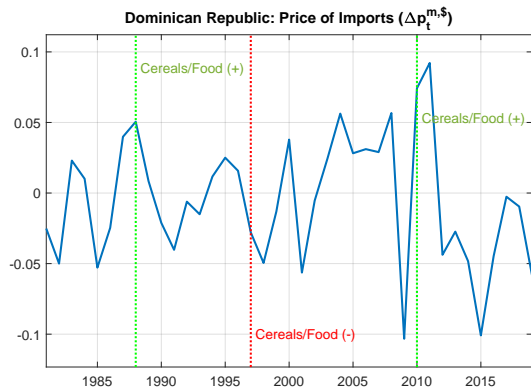
- **Commodity Terms of Trade** overstate the volatility of  $p^{x,\$}$  and particularly of  $p^{m,\$}$ ...



# Narrative Events are Often Visible in the Raw Data



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# Export and Import Price Indices

- ▶ Trade shares: Sectoral export and import values (SITC Rev. 2) for 988 categories are matched with 62 commodity and industry classifications to recalculate export and import shares
- ▶ Prices: 47 commodity sectors + 15 manufacturing categories
- ▶ For each country, we compute  $p^{x,\$}$  and  $p^{m,\$}$  following the indications of the IMF Export and Import Prices Manual

$$P^{0:t} = P^{0:t-1} \sum_{j=1}^{No. Goods} w_{j,t-1} P_j^{t:t-1}. \quad (1)$$

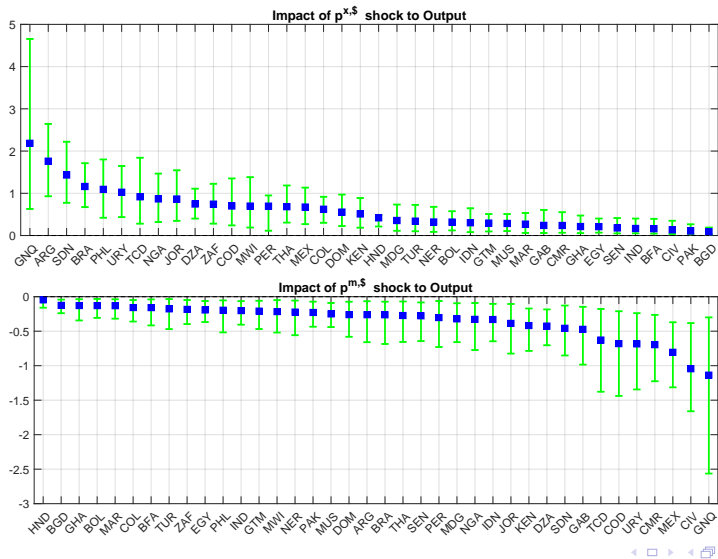
$$P^{0:t} = \prod_{\tau=1}^t \left[ \sum_{j=1}^{No. Goods} \left( w_{j,\tau-1} \frac{P_{j,\tau}}{P_{j,\tau-1}} \right) \right]. \quad (2)$$

### Table: Summary Narrative Restrictions

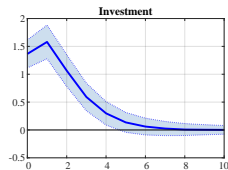
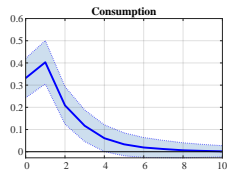
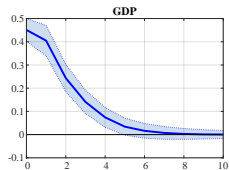
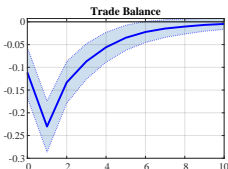
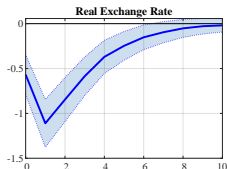
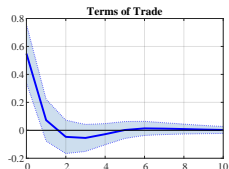
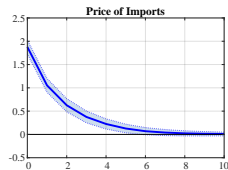
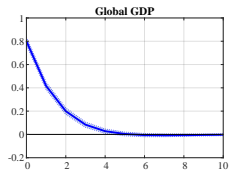
Year	Commodity	Sign	Exporters	Importers
1985	Cereals	-	ARG, BGD, BFA, CIV, GTM, HND, IND KEN, MDG, MAR, PAK, PHL, SEN, ZAF THA, TUR, URY	BRA, BFA, CIV, GTM, HND, IND, JOR MUS, MEX, NGA, PER, SEN
1988	Cereals	+	ARG, BGD, BFA, CIV, GTM, HND, IND KEN, MDG, MAR, PAK, PHL, SEN, ZAF SDN, THA, TUR, URY	DZA, BGD, BOL, BRA, BFA, CMR, TCD COD, CIV, DOM, EGY, HND, JOR, MDG MUS, MAR, NGA, PER, PHL, SEN, SDN
1997	Cereals	-	ARG, BGD, BFA, CIV, GHA, GTM, HND IND, KEN, MDG, MAR, PER, SEN, ZAF SDN, THA, TUR, URY	DZA, BGD, BOL, BRA, BFA, CMR, TCD COD, CIV, DOM, EGY, GNQ, GAB, GTM HND, JOR, MDG, MWI, MUS, MAR, NER PAK, PER, SEN, SDN
2010	Cereals	+	ARG, BFA, CIV, GHA, GTM, HND, KEN MDG, MWI, MUS, MAR, PAK, PER, SEN THA, URY	DZA, BGD, BOL, BFA, CMR, TCD, COL COD, CIV, DOM, EGY, GAB, GHA, GTM HND, JOR, MDG, MUS, MAR, NER, NGA PHL, SEN, SDN
2002	Cocoa	+	GHA	
1986	Coffee	+	COL, CIV, DOM, GNQ GTM, HND, KEN, MDG	
1994	Coffee	+	COL, CIV, GTM, HND, KEN, MDG	
1981	Copper	-	COD, PER, PHL	
1994	Cotton	+	BFA, TCD, PAK, SDN	
2003	Cotton	+	BFA, TCD	
2010	Cotton	+	BFA	
1986	Crude oil	-	DZA, COD, EGY, GAB, IND, IDN MEX, NGA, PER, TUR	BRA, BOL, COD, GNQ, IDN, JOR, MAR NGA, PAK, PHL, SEN, THA, URY
1990	Crude oil	+	DZA, CMR, COL, COD, EGY, GAB, IDN MEX, NGA, PER, TUR	BRA, HND, IND, JOR, KEN, MAR, PAK PHL, THA, TUR, URY
1984	Fertilizers	+	JOR, MAR, SEN	
1982	Iron ore	+	BRA, IND	
2000	Natural gas	+	DZA, BOL	
2005	Natural gas	+	DZA, BOL, IDN	
1988	Soybean	+	ARG, BRA	
1984	Sugar	-	DOM, MWI, MUS, THA	
1993	Timber	+	BOL, CMR, CIV, GNQ, GAB, GHA	
1989	Tobacco	+	MWI	
1993	Tobacco	-	MWI	



Figure: Heterogeneous Effects of  $p^{x,\$}$  and  $p^{m,\$}$  shocks on Output



# IRF to a Global Economic Activity Shock



**Table:** Variance Decomposition: Global Economic Activity Shock

	Export Prices	Import Prices	Terms of Trade	Real Exchange Rate
0	23.76	29.58	15.30	5.74
1	21.82	28.89	16.92	11.45
4	22.88	28.52	20.38	16.24
10	23.60	28.62	20.99	17.53
	Trade Balance	Output	Consumption	Investment
0	7.97	8.85	7.31	8.37
1	11.54	13.09	10.56	13.24
4	14.37	17.70	13.61	17.11
10	15.05	19.16	14.82	18.03