Terms of Trade Shocks are Not all Alike*†

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Abstract

When analyzing terms of trade shocks, it is implicitly assumed that the economy responds symmetrically to changes in export and import prices. Using a sample of developing countries our paper shows that this is not the case. We construct export and import prices using commodity and manufacturing price data matched with trade shares and separately identify export price, import price and global demand shocks using sign and narrative restrictions. Our findings indicate that, taken together, export and import price shocks account for around 40 percent of output fluctuations. We also find that global demand shocks, which simultaneously affect export and import prices, are often undetected in the terms of trade measure despite having a large effect on business cycles. We develop a theoretical model which is able to replicate the key empirical findings.

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1 Introduction

Developing countries are vulnerable to fluctuations in the terms of trade. Large swings occur very often and these are thought to generate abrupt changes in a country's trade balance, current account and output (see, for example, Mauro and Becker, 2006). A deterioration in the terms of trade can lead to difficulties in financing current account deficits and a large external debt. While terms of trade shocks are typically viewed as a major source of business cycle fluctuations in emerging and low income countries, the literature has not provided a clear guidance on quantifying how important they are for driving a country's main macroeconomic variables. From a theoretical standpoint, the predictions of business cycle models conclude that between 30 and 50 percent of the variance of output is driven by terms of trade shocks (Mendoza, 1995 and Kose, 2002). However, recent empirical evidence presented in Schmitt-Grohé and Uribe (2018) suggests that terms of trade shocks explain around 10 percent of the variance of output. This has given rise to the so-called "terms of trade disconnect:" terms of trade shocks appear less important in the data than in theory.

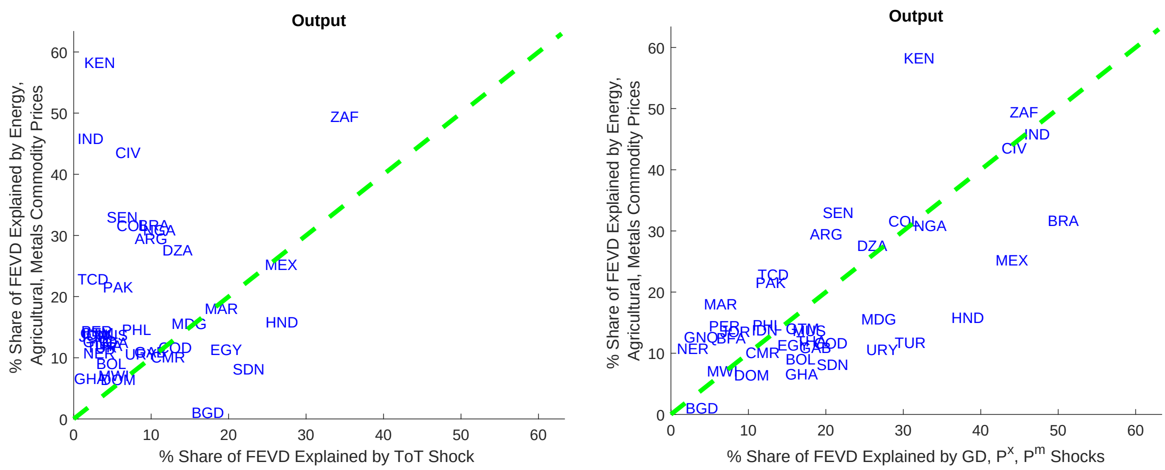
In this paper, we challenge the use of the conventional measure of terms of trade to study output fluctuations and show that the "terms of trade disconnect" is explained by the fact that terms of trade shocks are not all alike. The terms of trade are defined as the ratio between export and import prices. As such, a terms of trade shock may result from a shift in export prices, import prices, or not perfectly offsetting movements in both. When analyzing terms of trade shocks, it is implicitly assumed that the economy responds symmetrically to an increase in export prices and a decline in import prices. We show that this is not the case and document that the effects of a positive export price shock do not mirror the effects of a negative import price shock. This could happen for a number of reasons. For example, if the exportable and importable sectors have different weights in the economy, or due to the shocks having different channels of transmissions. Drechsel and Tenreyro (2018), for instance, highlight the presence of a "borrowing cost channel" associated to shifts in the price of exports. Overall, this implies that the terms of trade shocks which are typically analyzed in the literature fail to capture the individual role of export and import prices in transmitting disturbances to the economy.

Our results suggest that while export price shocks have larger and more persistent effects on the economy, the impact of import price shocks is more muted. The fact that the commodity export share is much higher than the commodity import share is key to understand the heterogeneous results. In addition, global demand shocks, which reflect unexpected changes in global economic activity, are a common shifter of commodity export and import prices. When global demand goes up, there is an increase in demand for all commodities which induces a simultaneous rise in export and import prices but could reflect a small or no shift in the terms of trade.[1] However, since the economy responds asymmetrically to shifts in export and import prices, global demand shocks, while not visible in the terms of trade metric, play an important role for developing countries' business cycles. The documented high correlation between commodity export and import prices is to a large extent explained by the fact that they are driven by the global demand shock.

Our findings have implications for the "terms of trade disconnect." Schmitt-Grohé and Uribe (2018) conjecture that the "disconnect" could be partly driven by the fact that terms of trade shocks may fail to capture the transmission mechanism of world shocks. In a related paper, Fernández, Schmitt-Grohé and Uribe (2017) show that commodity prices are a channel through which world shocks propagate. Their results convey that commodity price shocks explain a sizable proportion of business cycle fluctuations. To illustrate this result, the scatter

[1] Juvenal and Petrella (2015) show that global demand shocks are the main drivers of the co-movement between commodity prices. See also Alquist, Bhattarai, and Coibion(2019); and Delle Chiaie, Ferrara, and Giannone (2017).

Figure 1: Comparison Forecast Error Variance Decomposition



(a) *ToT* Shocks and World Shocks **(b)** World Shocks vs. P^x, P^m and GD Shocks

Notes: The first panel of this Figure compares the forecast error variance decomposition of output, for each country, obtained in Schmitt-Grohé and Uribe (2018) (x-axis) *vis-à-vis* Fernández et al. (2017) (y-axis). The second panel shows a comparison of the forecast error variance decomposition of output, for each country, obtained in our model (x-axis) *vis-à-vis* Fernández et al. (2017) (y-axis).

plot presented in Panel (a) of Figure 1 compares, for each country, the forecast error variance decomposition on impact for output driven by terms of trade shocks (as in Schmitt-Grohé and Uribe, 2018) and driven by world shocks, captured by three commodity prices (as and in Fernández et al. 2017).[2] We notice that most observations are concentrated above the 45 degree line. This indicates that world shocks explain a higher share of output fluctuations than terms of trade shocks.

Our paper proposes an explanation for why the recent empirical evidence is at odds with the predictions of theoretical models. In doing so, we bridge the gap between the literature on the "terms of trade disconnect" and the one suggesting that shocks to world commodity prices explain a large proportion of aggregate fluctuations. In this way, we highlight that a departure from a single commodity price paradigm to allow for a distinction between export and import price disturbances is important for the study of the effects of terms of trade shocks.

The scatter plot in Panel (b) of Figure 1 compares, for each country, the forecast error variance decomposition of GDP on impact in our paper and in Fernández et al. (2017). The figure suggests that the world shocks driving the three commodity price indices are aligned with the three shocks we identify in this paper (export price, import price, and global demand). Therefore, the three shocks that we identify are able to capture the extent to which external shocks affect economic fluctuations in developing countries and at the same time allow us to shed light on the different (or differing) channels of transmission of these shocks. Our results bring the empirical results closer to the predictions of theoretical models, therefore reinforcing the focus of policy makers on terms of trade movements.

In order to identify the shocks of interest we construct a comprehensive time series of country-specific export and import price indices. Specifically, building on the work by Deaton and Miller (1996) and Cashin, Céspedes and Sahay (2004) we calculate these indices using individual commodity and manufacturing prices combined with time-varying sectoral export

[2] We calculate the variance decomposition using our own dataset and the methodology explained in Section 3. The results are in line with those of the papers cited. The three commodity prices are: energy, agriculture and metals.

and import shares.

We identify export price, import price and global demand shocks imposing economically meaningful sign restrictions on the impulse responses of a subset of variables (see Canova and De Nicoló, 2002; and Uhlig, 2005) complemented with narrative based restrictions. The narrative approach (Antolín-Díaz and Rubio-Ramírez, 2018) allows us to narrow the set of the identified model so that it is consistent with a series of pre-specified important events. In order to construct the narrative restrictions, we examined historical documents and newspaper articles to identify episodes of significant commodity price changes that were unrelated to important macroeconomic developments such as natural disasters or weather related shocks. From this analysis we identify a total of 23 commodity price episodes that we use to derive narrative restrictions for export and import price shocks which originate from large exogenous swings in commodity prices. We match the episodes to export price and import price shocks, for each country, by assessing the export and import shares of each commodity for every episode.[3]

We compute the variance decomposition to assess the importance of each shock in driving business cycle fluctuations. Our estimates indicate that, taken together, export price and import price shocks explain from 20 to 40 percent of output on impact and at a 10-year horizon, respectively. Moreover, we find that global demand shocks explain up to 32 percent of the variation in export prices and 41 percent of the variation in import prices while they account for only one-fourth of the variation in the terms of trade. By moving export and import prices in the same direction a large fraction of the impact of global demand cancels out in the terms of trade metric. However, it is relevant to explain business cycles fluctuations through the asymmetric effects of export and import prices.

We illustrate that the aggregate results mask a great deal of heterogeneity across countries and inspect the main drivers behind the different results. For export price shocks, a key characteristic to understand the heterogeneous effects on macroeconomic variables is the extent to which the export share is dominated by commodities. Following an export price shock, the effects on the real economy are more substantial for countries with a larger commodity export share. In addition, output of richer countries tends to be more responsive to export price shocks. The effects on the terms of trade after an export price shock are higher the larger the commodity export share and in countries which exhibit a higher concentration of their commodity export base. Interestingly, countries that have a higher commodity export share exhibit, on average, a larger response of export prices and the terms of trade in response to a global demand shock. The response of output following an import price shock is more homogeneous across countries, with richer economies displaying a smaller response of output.[4]

In order to rationalize our empirical results, we develop a real business cycle model which features three types of goods (nontradable, imports, and exports), two production sectors (nontradable and export) and is able to replicate our key empirical findings. Our model is built on the premise that export price and import price shocks affect the economy of developing countries in distinct ways, reflecting a peculiarity in the structure of these economies. In most of these countries, the export sector accounts for a large share of domestic production and is often concentrated in raw materials. This is especially true in low income countries, as described in Papageorgiou and Spatafora (2012). Production in the export sector is mostly sold abroad and the proportion that is consumed domestically is very small. Shifts in export prices will therefore be mainly channeled to the economy through their impact on the supply side. By contrast, imports consist of manufactured goods, which are largely produced abroad.

[3]For example, we identify a positive oil price shock in 1990 originated in the Persian Gulf War. This episode would serve as a positive export price shock for oil exporting countries such as Algeria.

[4]The homogeneous response of output following an import price shock is confirmed when we analyze the impulse responses by splitting the countries by commodity export and import groups.

Thus, shifts in import prices will predominantly affect the economy though the impact on domestic (final and intermediate) demand.

Our paper contributes to the literature that analyzes the role of terms of trade shocks in explaining business cycle fluctuations in emerging and low income countries. From a theoretical perspective, most papers find that terms of trade shocks are a significant driver of output fluctuations (Mendoza, 1995 and Kose, 2002). From an empirical standpoint, the role of terms of trade shocks is less important in the data than in theory because terms of trade shocks fail to capture the role of individual prices in transmitting world shocks (Fernández et al., 2017 an Schmitt-Grohé and Uribe, 2018). To the best of our knowledge, our paper is the first to exploit the individual role of country-specific export and import prices in transmitting shocks to the economy. Once we depart from the assumption of a single price (the terms of trade) as mediator of disturbances the joint explanatory power of export and import price shocks increases considerably, yielding figures in line with what theoretical models predict. In addition, we find that global demand shocks lead to an increase in both export and import prices and, as a consequence, have a small effect on the terms of trade but a large effect on the economy, mediated by the joint impact on export and import prices.

Our paper is also related to the literature that studies the relationship between terms of trade of developing countries and international prices. Bidarkota and Crucini (2000) construct a proxy of the terms of trade using world commodity prices and trade shares similar to ours and conclude that a country's terms of trade variation is explained by the price volatility of the commodities in which a country specializes. Cashin et al. (2004) analyze if movements in commodity prices explain fluctuations in the real exchange rate of commodity exporting countries, and find that they do for about one-third of their sample. In a related study, Ayres, Hevia and Nicoloni (2020) highlight that fluctuations in commodity prices account for a large fraction of the real exchange rate volatility.

Our study offers some contrasts and similarities with respect to the existing literature. First, from a methodological point of view, we construct our measure of terms of trade using time varying weights following the recommendation of the IMF Import and Export Price Manual. In addition, our measure of export prices, import prices, and terms of trade extends beyond primary commodities to include also manufacturing. This is important, in particular for import prices. Failure to account for the share of manufacturing would inevitably overstate the volatility of import prices. Second, our results suggest that differences in the commodity intensity play an important role in explaining the heterogeneous impact of export and import price shocks. In line with the literature, we find that shocks to export prices (which are largely dominated by raw commodities) explain a large fraction of the variation in the overall terms of trade and the real exchange rate. Moreover, our theoretical model highlights that the higher sensitivity of the real exchange rate to export price shocks is a key determinant of the asymmetric response of the economy to an export price and import price shock.

The paper is organized as follows. Section 2 presents the data and descriptive statistics. Section 3 shows the empirical methodology and identification strategy. Section 4 discusses the baseline results. The extensions are presented in Section 5 and Section 6 includes our theoretical model. Finally, Section 7 concludes. Appendix A describes the macroeconomic and commodity data, while Appendix B includes a test for terms of trade restrictions. Appendix C attends to the construction of narrative series of exogenous price shocks. The empirical evidence on global demand shocks is in Appendix D and Appendix E presents the cross-country and group heterogeneity results. Finally, Appendix F and G include further model details.

2 Data and Descriptive Statistics

Our data set combines information from commodity prices, U.S. producer price indices (PPI), country-specific sectoral export and import shares, and macroeconomic indicators.

We focus on emerging and developing countries as in Schmitt-Grohé and Uribe (2018). The sample is annual and covers the period 1980-2016 for 38 countries. To be included in the sample, a country needs to have at least 30 consecutive annual observations and to belong to the group of poor and emerging countries. The group of emerging and developing countries is defined as all countries with average GDP per capita at PPP U.S. dollars of 2005 over the period 1980-2016 below 25,000 dollars according to the World Bank's World Development Indicators (WDI) database. The countries that satisfy these criteria are: Algeria, Argentina, Bangladesh, Bolivia, Brazil, Burkina Faso, Cameroon, Chad, Colombia, Congo, Cote d'Ivore, Dominican Republic, Egypt, Equatorial Guinea, Gabon, Ghana, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Madagascar, Malawi, Mauritius, Mexico, Morocco, Niger, Nigeria, Pakistan, Peru, Philippines, Senegal, South Africa, Sudan, Thailand, Turkey and Uruguay. The data coverage for each country is listed in Table A.1 of Appendix A.

In what follows we summarize the macroeconomic data used in our analysis, explain the construction of the export and import price indices, and present some descriptive statistics.

2.1 Macroeconomic Data

The country-specific macroeconomic variables are real GDP per capita (Y), real consumption expenditure per capita (C), real gross investment per capita (I), the trade balance as a percentage of GDP (TB), and the real exchange rate (RER). Our empirical measure of the real exchange rate is the bilateral U.S. dollar real exchange rate defined as $RER_t = \frac{E_t P_t^{US}}{P_t}$, where E_t is the official nominal exchange rate, P_t^{US} denotes the U.S. CPI, and P_t is the domestic country consumer price index. Since the real exchange rate is defined as the price of foreign goods in terms of domestic goods, a decrease in RER implies a real appreciation. These variables are obtained from the WDI database with the exception of the CPI from Argentina which is sourced from Cavallo and Bertolotti (2016). We also use an official terms of trade variable sourced from the WDI (ToT^o), based on export and import unit value indices, to compare it with our own estimate. We measure real world GDP using an aggregate sourced from Haver Analytics calculated based on data for 63 countries, expressed at 2010 prices and exchange rates. A full description of the macro data is detailed in Appendix A.1.

2.2 Export and Import Price Indices

We construct country-specific export and import price indices denominated in U.S. dollars (P^x and P^m) using sectoral export and import shares, commodity prices, and U.S. PPI data as a proxy for manufacturing prices.

The weights for the calculation of the price indices are given by the products' export and import shares. In order to calculate these shares, for each country, we obtain a time series of highly disaggregated product export and import values sourced from the MIT Observatory of Economic Complexity.[5] The product data are disaggregated at the 4-digit level and classified according to the Standard International Trade Classification, Revision 2 (SITC Rev. 2). Our sample consists of 988 categories but since we only have price information of 62 categories, the trade shares are reclassified so that we can match the weights with the price data.

For 46 out of the 62 sectors we obtain commodity prices from the World Bank's Commodity Price Data (details in Appendix A.2). For 16 manufacturing categories such as transport

[5] The data can be accessed at https://atlas.media.mit.edu/en/

equipment, machinery and equipment, and textile products and apparel we proxy world prices using sectoral U.S. PPI data sourced from the Federal Reserve Bank of St. Louis FRED. Table A.2 in Appendix A includes the list of the manufacturing industries used and the corresponding North American Industry Classification System (NAICS) code. In order to match the sectoral manufacturing price data with the trade shares, NAICS codes were reclassified to match with the SITC classification.

Using this information, for each country, we compute P^x and P^m following the indications of the IMF Export and Import Prices Manual.[6] In particular, the manual explains that it is possible to calculate a chain index for import and export prices from goods specific prices as follows:

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

where $P^{0:t}$ is the aggregate price index at time t with base price at 0 (i.e. $P^{0:0} = 1$); j denotes the good, which comprises 46 commodities and 16 manufacturing industries; $w_{j,t-1}$ is the weight of good j at time $t-1$, defined as the export or import share of that good in a country's total exports or imports; and $P_j^{t-1:t}$ is good j price index at time t with base price at $t-1$.

Note that since $P_j^{t-1:t} = P_j^{0:t}/P_j^{0:t-1}$, it is possible to use a panel of annual good prices ($P_{j,t}$) and calculate the aggregate price index as:

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

This index allows us to use time varying weights, therefore accounting for changes in a country's composition of exports and imports across time. As we will show in Section 2.3, these changes can be quite significant for some countries.

In our empirical analysis we deflate the export and import price indices by the U.S. consumer price index (CPI), and therefore consider real dollar export and import prices (as in Cashin et al., 2004). The terms of trade of a given country are defined as the relative price of its exports (P^x) in terms of its imports (P^m). Therefore, they can be calculated as: $ToT_t = \frac{P_t^x}{P_t^m}$. As shown in the first column of Table 1, (the quadratically detrended log of) our measure of the terms of trade is positively correlated with official one sourced from WDI: for most of the countries (23 out of 38) the correlation in the detrended data is higher than 0.5.[7]

2.3 A First Glance at the Data

The left panel of Table 2 reports the values of the commodity import and export shares by country for the period 1980-2016 while the right panel describes three commodities which represent the largest proportion of imports and exports during the same period. Tables A.4-A.6 in Appendix A show the same information for the subperiods 1980-1990, 1990-2000, and

[6] `https://www.imf.org/en/Publications/Manuals-Guides/Issues/2016/12/31/Export-and-Import-Price-Index-Manual-Theory-and-Practice-19587`.

[7] Given that we are linking 988 sectors into 62 categories for which we have commodity and manufacturing price data, the correlation is quite remarkable. Also note that the correlations are computed on the quadratically detrended logarithm of the data. Actual series present distinct trends that are also well captured by our measure, and the difference between the (log of the) two series is stationary. Without removing the trend the median correlation is about 0.9 which highlights that our approximation also captures well the low frequency behavior of the terms of trade.

Table 1: Descriptive Statistics

	$Corr(ToT, ToT^o)$	$\sigma(P^x)$	$\gamma_1(P^x)$	$\sigma(P^m)$	$\gamma_1(P^m)$	$Corr(P^x, P^m)$	$\sigma(ToT)$	$\gamma_1(ToT)$
Algeria	90.5	31.6	67.5	6.3	72.8	27.6	30.4	71.0
Argentina	38.8	12.8	65.0	4.7	69.8	91.5	8.6	60.7
Bangladesh	81.2	3.4	60.4	8.5	70.2	54.2	7.2	75.0
Bolivia	67.7	17.7	66.8	5.8	71.8	68.7	14.3	69.4
Brazil	49.0	11.2	66.6	8.6	65.6	90.6	5.0	60.7
Burkina Faso	82.8	17.1	66.4	6.3	64.5	71.9	13.3	65.2
Cameroon	39.6	21.4	64.9	8.1	64.2	78.9	15.8	67.9
Chad	64.5	26.5	57.6	5.0	74.6	80.8	22.7	52.6
Colombia	91.0	18.1	61.1	4.8	66.7	71.6	15.0	59.0
Congo, Dem. Rep.	61.2	16.4	59.7	6.4	66.3	80.6	11.9	57.6
Cote d'Ivoire	38.0	14.0	63.0	10.1	58.5	71.1	9.9	49.2
Dominican Republic	10.2	9.3	47.4	6.3	66.0	50.9	8.2	43.1
Egypt, Arab Rep.	45.3	17.3	58.9	8.6	69.0	53.8	14.6	65.5
Equatorial Guinea	59.1	27.6	59.8	4.5	62.5	57.3	25.3	58.5
Gabon	72.4	28.8	61.9	5.1	75.9	45.1	26.8	63.0
Ghana	74.5	15.3	62.2	6.8	67.4	80.5	10.7	55.2
Guatemala	58.7	10.9	61.7	6.8	63.3	75.8	7.3	45.1
Honduras	55.3	7.5	51.4	7.4	75.0	71.4	5.6	33.0
India	58.7	7.1	68.4	11.3	61.8	91.3	5.6	56.3
Indonesia	82.6	14.9	67.5	9.8	69.6	79.1	9.3	77.5
Jordan	39.3	12.0	53.7	7.9	67.0	91.2	5.8	26.0
Kenya	31.9	11.8	63.5	8.3	61.4	74.4	7.9	42.6
Madagascar	21.8	10.5	51.5	6.0	71.1	74.2	7.2	41.7
Malawi	52.8	10.9	70.5	6.1	68.1	66.9	8.2	51.9
Mauritius	26.2	17.1	58.6	5.9	60.4	46.4	15.3	54.9
Mexico	95.7	7.8	59.3	4.2	69.3	43.4	7.1	68.5
Morocco	35.1	9.7	61.2	8.0	63.3	89.8	4.3	48.5
Niger	21.5	12.3	66.1	6.8	78.2	31.0	12.1	75.9
Nigeria	93.5	33.2	62.7	6.7	75.9	57.4	29.8	63.7
Pakistan	59.1	6.2	66.3	10.3	62.7	59.6	8.3	69.5
Peru	70.0	18.8	72.5	8.1	71.1	94.7	11.4	67.1
Philippines	58.5	5.6	44.5	5.6	53.3	51.5	5.5	43.5
Senegal	23.8	13.2	61.6	9.1	60.4	92.6	5.8	54.7
South Africa	74.1	13.1	73.0	6.4	65.4	93.5	7.5	73.5
Sudan	75.0	20.7	66.2	5.7	58.9	80.6	16.5	64.8
Thailand	41.2	7.9	58.0	8.1	63.5	66.9	6.5	51.8
Turkey	13.0	6.3	60.4	7.5	67.7	81.7	4.3	63.5
Uruguay	82.2	9.7	67.6	9.5	66.1	67.2	7.8	74.6
Median	58.7	12.9	62.0	6.7	66.4	71.7	8.4	58.9
Share of PC #1		73.9		90.2			65.9	

Notes: σ denotes standard deviation, γ_1 is the first order autocorrelation, $Corr$ denotes correlation. All entries are in percentage terms and variables are calculated as the quadratically detrended logarithm of the original data to remove low frequency trends. Therefore, the standard deviations are the standard deviation of the percentage deviations of the series from the trends.

2000-2016, respectively.[8]

From Table 2 it is clear that developing countries depend heavily on commodity exports and that exports are very concentrated on a few commodities while imports are much more disperse. As an illustration, in approximately half of the countries, exports of three main commodities account for more than 50 percent of a country's total exports. In addition, for 70 percent of the countries, total commodity exports represent more than half of their export earnings. By contrast, import shares implied by the sum of the three main commodity imports account for less than 40 percent of total imports. This is not surprising given that developing countries' economies are less diversified and therefore tend to import a wide range of products.

We observe that countries specialize in exports of different groups of commodities. However, many of them depend on exports of crude oil and food.[9] In fact, looking at the figures for the entire period, crude oil is the main export for 10 countries while food is the main export for 7 countries. There are, however, some striking differences across countries. While total

[8] The breakdown of trade shares by subperiods allows us to gauge how countries' import and export structures have changed during the time span we analyze.

[9] Throughout out paper we use cereals as a proxy for food. Evidence suggests that cereals are the most important source of food consumption. This is documented by the FAO and further information can be found here: `http://www.fao.org/docrep/006/Y4683E/y4683e06.htm`.

Table 2: Commodity Imports and Exports (1980-2016)

	Comm. Imp. %	Comm. Exp. %	Main Imports			Main Exports		
Algeria	31.0	91.9	Food	Wheat	Met. & Min.	Crude oil	Natural gas	Fertilizers
Argentina	19.1	71.1	Natural gas	Met. & Min.	Crude oil	Food	Soybean meal	Crude oil
Bangladesh	36.9	17.3	Crude oil	Wheat	Cotton	Food	Other R. M.	Tea
Bolivia	20.9	92.8	Met. & Min.	Crude oil	Wheat	Natural gas	Tin	Gold
Brazil	34.4	55.3	Crude oil	Fertilizers	Food	Iron ore	Coffee	Crude oil
Burkina Faso	29.1	91.7	Food	Crude oil	Met. & Min.	Cotton	Gold	Oils & Meals
Cameroon	31.6	94.5	Crude oil	Food	Met. & Min.	Crude oil	Timber	Cocoa
Chad	21.3	95.0	Food	Wheat	Met. & Min.	Cotton	Crude oil	Other R. M.
Colombia	20.8	74.1	Crude oil	Food	Met. & Min.	Crude oil	Coffee	Coal
Congo, Dem. Rep.	29.1	66.7	Food	Crude oil	Met. & Min.	Copper	Met. & Min.	Crude oil
Cote d'Ivoire	40.0	89.6	Crude oil	Food	Rice	Cocoa	Coffee	Timber
Dominican Republic	29.3	37.0	Crude oil	Food	Met. & Min.	Sugar	Tobacco	Gold
Egypt, Arab Rep.	39.2	68.5	Wheat	Food	Crude oil	Crude oil	Food	Cotton
Equatorial Guinea	31.1	95.2	Met. & Min.	Beverages	Food	Crude oil	Timber	Cocoa
Gabon	23.1	95.6	Met. & Min.	Food	Crude oil	Crude oil	Timber	Met. & Min.
Ghana	28.2	88.4	Crude oil	Food	Met. & Min.	Cocoa	Aluminum	Timber
Guatemala	30.0	63.3	Crude oil	Food	Met. & Min.	Coffee	Food	Sugar
Honduras	28.6	59.5	Crude oil	Food	Met. & Min.	Banana	Coffee	Food
India	41.5	33.7	Crude oil	Gold	Fertilizers	Food	Crude oil	Met. & Min.
Indonesia	34.5	64.1	Crude oil	Met. & Min.	Other Raw Mat.	Crude oil	Natural gas	Food
Jordan	36.6	59.2	Crude oil	Food	Met. & Min.	Fertilizers	Food	Met. & Min.
Kenya	30.4	78.3	Crude oil	Met. & Min.	Palm oil	Tea	Coffee	Food
Madagascar	25.9	69.2	Rice	Met. & Min.	Food	Food	Coffee	Met. & Min.
Malawi	22.5	90.7	Fertilizers	Met. & Min.	Food	Tobacco	Tea	Sugar
Mauritius	28.7	41.6	Food	Crude oil	Met. & Min.	Sugar	Food	Precious
Mexico	20.1	35.4	Met. & Min.	Crude oil	Food	Crude oil	Food	Met. & Min.
Morocco	36.9	49.5	Crude oil	Wheat	Fertilizers	Food	Fertilizers	Orange
Niger	29.0	29.3	Food	Met. & Min.	Tobacco	Crude oil	Met. & Min.	Food
Nigeria	24.5	97.3	Food	Met. & Min.	Crude oil	Crude oil	Natural gas	Cocoa
Pakistan	43.4	25.8	Crude oil	Palm oil	Fertilizers	Rice	Cotton	Food
Peru	30.6	83.5	Crude oil	Wheat	Food	Copper	Zinc	Crude oil
Philippines	28.6	29.2	Crude oil	Food	Wheat	Food	Coconut oil	Copper
Senegal	42.0	78.7	Crude oil	Food	Rice	Food	Oils & Meals	Fertilizers
South Africa	20.4	59.5	Crude oil	Met. & Min.	Food	Gold	Platinum	Coal
Sudan	27.0	96.9	Wheat	Food	Met. & Min.	Crude oil	Cotton	Other R. M.
Thailand	30.5	38.9	Crude oil	Met. & Min.	Food	Food	Rice	Rubber
Turkey	31.9	34.2	Crude oil	Iron ore	Other R. M.	Food	Met. & Min.	Crude oil
Uruguay	31.7	60.5	Crude oil	Food	Fertilizers	Beef	Food	Rice
Median	29.1	66.7						

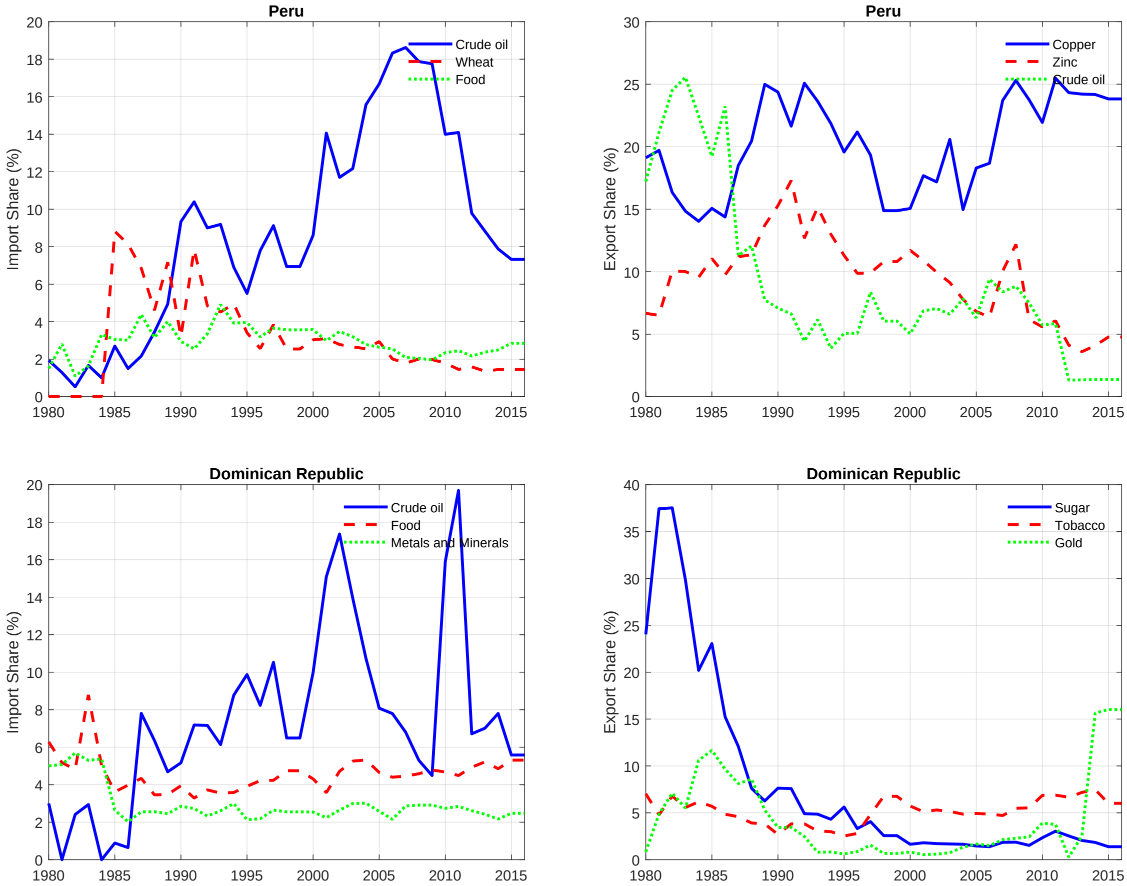
commodity exports represent 17 percent in Bangladesh, they account for 92 percent of total exports for Algeria for the period between 1980 and 2016.

There is a group of countries for which we observe that the main commodities exported and imported shifted significantly across the different periods. Figure 2 shows that up to 1987 crude oil was the main commodity export for Peru, representing over 20 percent of total exports, but afterward copper became the main export with an export share of about 24 percent. Moreover, in the 1990s Peru became a net importer of crude oil, turning into the commodity with the largest import share.

The case of the Dominican Republic also shows some contrasts: up to the 1990s sugar was their main export with a peak export share of 37 percent, and afterward tobacco became the main export with an export share of a little over five percent. This change in the pattern of export specialization is in line with the findings of Daruich, Easterly and Reshef (2019) who document that these specializations are not persistent over time. Interestingly, we find a similar result not only for export but also for import specialization.

There is another group of countries for which the fraction of total exports accounted for by the single most important commodity is very large. Interestingly, even within this group, export shares exhibit some variation in the different subperiods. For example, crude oil has been persistently the most important commodity export for Algeria, but it represented 77 percent of total exports in 1980-1990, 60 percent in 1990-2000, and 59 percent in 2000-2016. Similarly, cotton is consistently the main export for Burkina Faso, with the export shares ranging from 35 to 56 percent in the subperiods analyzed.

Figure 2: Import and Export Shares



Notes: This Figure shows the evolution of import and export shares of the three main commodities imported and exported by Peru and the Dominican Republic for the period 1980-2016.

The information from the tables suggests that many countries depend mainly on crude oil and food imports. For example, crude oil is the main commodity import for Cote d'Ivore in 2000-2016 with an import share of 22 percent. In turn, food is the main commodity import for the Democratic Republic of Congo in 2000-2016 and it accounts for 7 percent of total imports.

The variation in the import and export shares for different commodities over the period analyzed highlights the importance of using time-varying weights when we compute the import and export price indices. The concentration of imports and exports suggests that the terms of trade variation in developing countries may be driven by price fluctuations in key commodities. In addition, the fact that exports of a few commodities represent a such a large share of total exports while the importance of commodity imports is much smaller, presumably indicates that price shocks affecting exports may have different effects on the economy than price shocks affecting imports.

2.4 Descriptive Statistics

Table 1 summarizes the main descriptive statistics for export and import prices data by country. In particular, it shows the correlation between our constructed measure of terms of trade and the official measure; the standard deviation (σ) and the persistence (measured as the first order autocorrelation, γ_1) of export prices, import prices and the terms of trade; and the correlation between export and import prices. At the end of the table we report the median value of each measure and also the share of variance of export prices, import prices and the terms of trade that we are able to explain with the first principal component of the series. All the variables are calculated as the quadratically detrended log of the original data.[10]

Three important observations stand out from this table. First, export prices are more volatile than import prices in all countries except five. The countries exhibiting more volatile import prices are generally those with a high commodity import share. Second, export prices and import prices are highly correlated. Therefore, the volatility of the terms of trade is, on average, smaller than the volatility of export prices. Given these characteristics of the data, it is possible that the individual effects of export and import price shocks on macroeconomic variables would dissipate if we only look at their ratio, as defined by the terms of trade. This high correlation could be partly driven by world disturbances, such as global demand shocks, which could simultaneously move export and import prices in the same direction. Third, export prices and import prices are more persistent than the terms of trade.

The countries that exhibit the highest volatility in export prices are Algeria, Nigeria, and Equatorial Guinea. Interestingly, what these countries have in common is that crude oil is their main commodity export. By contrast, the highest volatility in import prices is present in Cote d'Ivoire, India and Pakistan, which do not share a similar import pattern since their main commodity imports are cocoa, food, and rice, respectively.

The last row of the table shows the percentage of the variability of export prices, import prices and the terms of trade that we are able to explain with the first principal component. We observe that despite the heterogeneity in the individual countries' trade shares, the first principal component explains 74 percent of the variation in export prices and 90 percent in the variation in import prices. However, when we take the ratio of the export and import price indices to compute the terms of trade, the explanatory power of the first principal component is attenuated as it only explains 66 percent in the variation of the terms of trade. This is consistent with the idea that the impact of common shocks are dampened when using a single price measure. Even though the first principal components of export and import prices are very similar, with a correlation of about 0.9, the first principal component of the terms of trade is very different.[11]

In Table 3 we analyze the determinants of the volatility in export and import prices. To this aim, we regress the volatility of export and import prices on key variables which are averaged by countries across the period analyzed so that we perform a cross-sectional estimation. The regressors are the commodity export share; dummy variables which are equal to 1 if a country is an exporter or importer of agriculture, energy or metals; and the Herfindahl index of concentration calculated both for all goods and for all commodities.

The first Panel of Table 3 reports the results for export prices. A higher commodity export share and higher export concentration are associated with higher volatility of export prices. Countries which are energy exporters exhibit, on average, a higher volatility of export prices. By contrast, countries which are agriculture exporters exhibit, on average, a lower volatility in export prices (although the coefficient is rather small). The second Panel of Table 3 shows the results for import prices. As in the case for exports, a higher commodity import share is associated with higher import price volatility. The coefficient on the energy importers dummy is insignificant but the one for agriculture importers dummy is negative and significant, which suggests that these group of countries have, on average, a lower volatility of import prices.

To sum up, given that countries' commodity export shares are much larger than import shares and that the volatility of export prices is higher than that of import prices, the economy

[10]The results are robust to detrending using the HP filter or 2-year growth rates as suggested by Hamilton (2018).

[11]We do not show these results to preserve space they they are available upon request.

Table 3: Determinants of the Volatility of Export and Import Prices

	$\sigma(P^x)$					$\sigma(P^m)$			
Commodity Export Share	0.232***	0.179***	0.152***	0.132***	Commodity Import Share	0.228***	0.224***	0.185***	0.216***
	(0.032)	(0.034)	(0.038)	(0.030)		(0.020)	(0.022)	(0.040)	(0.019)
Agricultural Exporters		-0.030**	-0.012	-0.011	Agricultural Importers		-0.010***	-0.010***	-0.008**
		(0.014)	(0.014)	(0.012)			(0.003)	(0.003)	(0.003)
Energy Exporters		0.059***	0.056***	0.057***	Energy Importers		0.009**	0.014**	0.006
		(0.017)	(0.014)	(0.014)			(0.004)	(0.006)	(0.005)
Metals Exporters		-0.009	0.015	0.023					
		(0.023)	(0.021)	(0.019)					
H Index Exports (all goods)			0.121**		H Index Imports (all goods)			-0.236	
			(0.047)					(0.185)	
H Index Exports (all commodities)				0.139***	H Index Imports (all commodities)				0.069
				(0.038)					(0.049)
R^2	0.590	0.764	0.822	0.841	R^2	0.698	0.801	0.811	0.810

Notes: σ denotes standard deviation; the commodity export and import shares are the same as the ones reported in Table 1; agriculture, energy, and metal exporters or importers denote dummy variables which are equal to 1 if the country falls into these categories; the H index is the Herfindahl index of concentration which can take values from 0 to 1 and it is calculated both for all goods and all commodities separately. In all columns the total number of observations is 38. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

may respond differently to P^x and P^m shocks. Since commodity price exports and imports are highly correlated, by looking at the effects of ToT shocks we may be missing the important role played by world shocks. In addition, we observe that the explanatory power of the first principal component is reduced for the terms of trade in comparison to export and import prices, which suggests that some information may be lost by taking the ratio of both prices. These patterns that we observe in the data provide a motivation for our baseline analysis.

2.5 Impact of Terms of Trade on the Economy

In this section we present some preliminary evidence to further motivate the empirical exercise that follows. It is well know that terms of trade are difficult to measure. In particular, those from developing countries can be subject to substantial statistical errors. One of the contributions of this paper is to build a comprehensive data set of export and import prices which we use to construct our own measure of terms of trade. In Table 1 we have documented that while our ToT tend to be strongly correlated with ToT^o, the two measures remain different and for some countries the difference can be quite large.[12] This leads us to believe that some non-trivial measurement issues could be playing a role in the results. In fact, it is possible that the "terms of trade disconnect" (Schmitt-Grohé and Uribe, 2018) could, at least in part, be explained by the poor measurement of terms of trade in the official statistics. We therefore investigate if the "disconnect" is driven by a measurement issue.

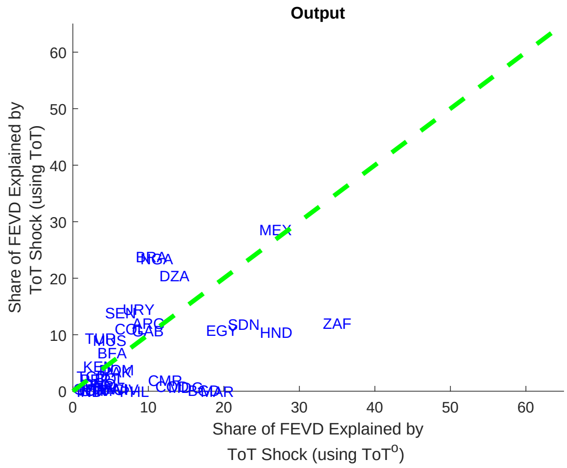
The scatter plot in Figure 3 compares the forecast error variance decomposition on impact for output driven by terms of trade shocks using the official measure (x-axis) *vis-à-vis* our measure (y-axis). Note that most entries in Figure 3 are below the diagonal, which means that the forecast error variance decomposition of our ToT measure is larger than the one that uses the official ToT^o. However, we still find that on average, terms of trade shocks explain about 10 percent of the factor error variance decomposition of output for both measures.[13] This result is broadly in line with the limited share of variance attributed to ToT shocks in Schmitt-Grohé and Uribe (2018). The same result holds when we do this exercise on the other macro variables.

Empirical models of the terms of trade are postulated on the untested assumption that a shift in the price of exports impacts the economy exactly in the same way as a shift in the price of imports, with an opposite sign. In other words, a simultaneous increase of the same

[12] For Sudan, for example, the official measure is constant from 1982 to 2000.

[13] Each country is weighted according to their GDP (PPP).

Figure 3: Forecast Error Variance Decomposition: ToT and ToT^o Shocks



Notes: The Figure compares the forecast error variance decomposition of output, for each country, obtained using the official measure of the terms of trade (x-axis) *vis-à-vis* our measure computed as the ratio between export and import prices (y-axis).

magnitude in the price of exports and imports has no impact on the aggregate economy, as it leaves the terms of trade unaffected. Having constructed separate proxies for the price of exports and imports, this is a prediction that we can now test on the data. Table B.1 (in Appendix B) shows that this prediction is strongly rejected by the data.

Overall, our analysis is consistent with the idea that a single measure of world prices like the terms of trade provides insufficient information to uncover the channels through which world shocks are transmitted to the economy (Fernández et al., 2018) and calls for an empirical framework that allows us to separately identify independent components of terms of trade shocks, reflecting shifts in the price of exports and price of imports. We turn to this in the next section.

3 Econometric Method

We follow the practice of the empirical literature on the impact of terms of trade shocks (see e.g. Schmitt-Grohé and Uribe, 2018), as well as the theoretical studies (see e.g. Mendoza, 1995), and assume that import prices, export prices, and the measure of global economic activity are exogenous with respect to the macroeconomic variables for the developing countries under investigation. This "small open economy" assumption implies that there is no impact from the current or lagged country specific macroeconomic variables to the "foreign block" of variables, $\mathbf{z}_t = [GD_t, P_t^x, P_t^m]'$. Therefore, 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:[14]

$$\mathbf{z}_t = \mathbf{a} + \mathbf{A}_1 \mathbf{z}_{t-1} + \mathbf{A}_0^{-1} \mathbf{u}_t, \tag{3}$$

where $\mathbf{A}_0^{-1}$ captures the contemporaneous impulse response of the shocks to the foreign block and $\mathbf{u}_t \sim N(0, I)$. In the next subsection we describe the identification restrictions used to identify the structural shocks in equation (3). In order to retrieve the impact of the shocks $\mathbf{u}_t$

[14] A specification with a single lag is the one favored by the data and we use this specification in this section to ease the exposition. The results are unchanged if we allow for a two-lag specification of the model. Note that we are also assuming that the VAR is fundamental and therefore the shocks can be retrieved from orthogonal rotations of the reduced form VAR residuals (Fernández-Villaverde, Rubio-Ramírez, Sargent and Watson, 2007).

to the macroeconomic variables of each country we use a simple regression approach in line with Kilian (2008, 2010).

Let us define $x_{i,t}$ as a generic country-specific variable where each i denotes a different macroeconomic aggregate of interest, defined as Y, C, I, RER, and TB. The exogeneity of the "foreign block" of variables implies that that we can consistently estimate the impact of these variables to the generic country-specific variable, $x_{i,t}$, using a simple regression approach:

$$x_{i,t} = \rho_0 + \rho_1 x_{i,t-1} + \gamma_0 \mathbf{z}_t + \gamma_1 \mathbf{z}_{t-1} + \varepsilon_{i,t}, \tag{4}$$

where the structural innovation $\varepsilon_{i,t}$ is serially uncorrelated (see, e.g., Cooley and LeRoy, 1985). The 1×3 vector of coefficients γ_j captures the impact (including the direct and indirect effects) of a shift in the "global variables" $\mathbf{z}_t$ (Pesaran and Smith, 2014). Under strict exogeneity, there is no current or lagged feedback from $x_{i,t}$ to $\mathbf{z}_t$ and we can retrieve the impact of the shocks of interest onto the macroeconomic variables combining (3) with (4):

$$x_{i,t} = c_0 + \gamma_0 \mathbf{A}_0^{-1} \mathbf{u}_t + \sum\nolimits_{j=1}^{\infty} \rho_1^{-j} \left(\gamma_0 + \gamma_1 \mathbf{A}_1\right) \mathbf{A}_1^{-j} \mathbf{A}_0^{-1} \mathbf{u}_{t-j} + \sum\nolimits_{j=0}^{\infty} \rho_1^{-j} \varepsilon_{i,t}. \tag{5}$$

Confidence intervals for these impulse responses are constructed by bootstrap methods following Goncalves and Kilian (2004). The single-equation regression approach taken in this paper has three main advantages with respect to specifying a fully fledged VAR with exogenous variables for the macroeconomic variables of each single country. First, given that equations (3) and (4) are relatively parsimonious, they have a reduced estimation error on short samples and are also more robust to structural change. Second, given that equation (4) is estimated variable by variable, it can easily handle cases where different variables start (or end) at different years over the estimation sample. Finally, Choi and Chudik (2019) highlight that the iterated approach to recovering impulse responses used in this paper tends to outperform direct approaches, particularly for small samples. At the same time, the specification in equation (5) can retrieve a large variety of shapes for the impulse response functions to the shocks identified.

The estimated responses which we will analyze in Section 4 provide a measure of the expected response of macroeconomic variables to exogenous global shocks based on historical data. They represent consistent estimates of the causal effects of a percentage change in global demand, export price, and import price shocks. When constructing the export price and import price series, we kept track of the time variation in the exports and import shares. To the extent that changes in those also result from time-varying effects of global shocks into the economy, the impulse responses retrieved should be understood as capturing the average effect of the country-specific endogenous responses that occurred at the time of exogenous global demand, export price and import price shocks. Given that that the heterogeneity across countries is important, we estimate the responses country-by-country but, for presentation purposes, we show the mean response weighted by each country's size proxied by their GDP (PPP).

3.1 Identification

We identify P^x, P^m and global demand (GD) shocks using sign restrictions as in Faust (1998), Canova and De Nicoló (2002), and Uhlig (2005). The advantage of this approach is that the sign restrictions are minimalist and therefore likely to be in line with a wide range of models and beliefs accepted by researchers. However, there are cases in which the sign restrictions method could yield structural parameters with different implications for the impulse responses, elasticities, historical decompositions, or variance decompositions. Some of these may be hard to reconcile with economic theory. In order to limit these cases, we follow Antolín-Díaz and

Rubio-Ramírez (2018) and incorporate narrative sign restrictions, which allow us to constrain the structural parameters at the time of salient historical events in such a way that the structural shocks are in line with the selected narrative.

The sign restrictions for each shock are summarized in Table 4. A P^x shock is defined as an unanticipated increase in the the export price index which leads to an exchange rate appreciation and an increase in GDP. A P^m shock denotes an unanticipated increase in the import price index which leads to an exchange rate depreciation and contraction in GDP. In order to better disentangle positive shocks to P^m *vis-à-vis* negative shocks to P^x, we also include restrictions on the absolute relative response of P^m and P^x to P^x and P^m shocks (see De Santis and Zimic, 2018). Specifically, we impose that in response to a $P^x(P^m)$ shock, the effect of import prices (export prices) on impact, as well and as its peak response, cannot be larger (in absolute value) than the response of export prices (import prices). This restriction limits the possibility of confounding a negative P^x shock with a positive P^m shock and *vice versa*. Moreover, with these restrictions we ensure that a positive $P^x(P^m)$ shock can be interpreted as a positive (negative) ToT shock. Note that shocks to import or export prices refer to shocks to these prices that are not caused by changes in global demand.

Table 4: Sign restrictions

Shock/Variable	Global GDP	GDP	Price of Exports	Price of Imports	Real Exchange Rate
P^x		+	+		−
P^m		−		+	+
GD	+	+	+	+	

Notes: Blank entries denote that no sign restriction is imposed. The sign restrictions are imposed only on impact. We also include relative response restrictions such that the $P^x(P^m)$ shock cannot have a larger impact on $P^m(P^x)$ both on impact and at its maximum impact.

The predictions associated with P^x and P^m shocks are in line with the basic predictions of a terms of trade shock in a standard Real Business Cycle model such as the one described in Schmitt-Grohé and Uribe (2017).[15] In these models, a positive P^x shock would appear as an increase in the terms of trade and a positive P^m shock as a decline in the terms of trade. Let us concentrate on the P^x shock focusing on the variables for which we imposed a sign restriction (taking into account that a similar reasoning applies in the case of a P^m shock). The exchange rate appreciation implies that the country is relatively more expensive with respect to the rest of the world. This happens both through substitution and income effects. An increase in export prices leads to a substitution of importable and nontraded goods for exportable goods. The increase in export prices also leads to an income effect whereby households feel richer and therefore increase their demand for all goods, including nontradables. This pushes nontrable goods prices up, consistent with an exchange rate appreciation. The expansion in the exportable goods and nontradable sectors would typically lead to an increase in GDP.

We leave the response of the trade balance unrestricted because the literature does not give an unambiguous prediction for this variable. On the one hand, the Harberger-Laursen-Metzler (HLM) effect would predict that a rise in the terms of trade would improve the trade balance (see Harberger, 1950 and Laursen and Metzler, 1950). On the other hand, the Obstfeld-Razin-Svensson (ORS) effect argues that if the positive terms of trade shock is perceived as persistent it could reverse the relation and lead to a deterioration in the trade balance (see Obstfeld, 1982 and Svensson and Razin, 1983).[16]

[15] See Chapter 7 for further details.

[16] The idea behind this effect is that households would have incentives to save to smooth consumption if the shock is perceived to be transitory in which case the trade balance would improve given that consumption increases by less than income. However, if the shock is perceived to be persistent, the trade balance would tend

Global demand shocks are included to incorporate any shifts in global demand that do not directly originate from exogenous shifts in countries' export or import prices. A GD shock may be driven by unexpected changes in global economic activity. Higher growth triggers an increase in demand for all commodities, which would drive up both export and import prices. This is in line with evidence in Juvenal and Petrella (2015) and Jacks and Stuermer (2018). In addition, a buoyant world economy tends to boost individual country's GDP. They may also capture the impact of fluctuations in global financial conditions on developing countries.

Note that from the sign restrictions, a GD shock could potentially be confounded with a P^x shock. Therefore, the narrative restrictions play a crucial role to disentangle the shocks of interest. For each of the countries in the sample, we use the Great Recession as a prototype GD shock. In particular, we impose that in 2009 the GD shock is negative and it is the largest contributor to the innovations to global GDP.[17] Given that this period is associated with large swings in commodity prices, and therefore also import and export prices for the countries under investigation, imposing this narrative restriction reduces the chance that we end up attributing part of the impact of the global recession to export price and import price shocks.

We also impose narrative restrictions to P^x and P^m shocks by looking at episodes of large exogenous variations of specific commodity prices and link them to each country's series of export and import prices guided by their trade shares. This was done in three steps. First, we carefully examined Food and Agriculture Organization (FAO) reports, publications from the International Monetary Fund and the World Bank, newspaper articles, academic papers and a number of online sources to identify episodes of substantial commodity price changes that were unrelated to the state of the economy such as natural disasters or weather shocks. A total of 23 episodes were identified and are detailed in Appendix C. Second, we then classified each episode as a negative or positive price shock, depending on the direction of the price change. As a last step, we associate a particular event to a P^x (P^m) shock if the export (import) share of the particular country for the specific year and commodity (or commodity group) is larger than 7 percent.[18] Table 5 provides a summary of the narrative restrictions imposed.

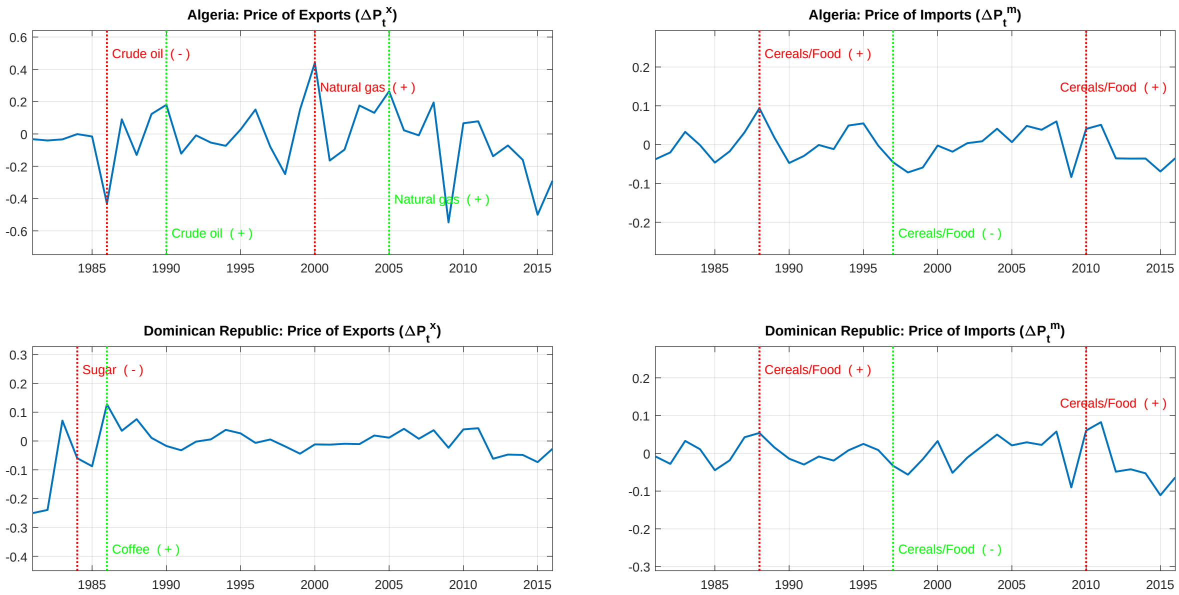
Figure 4 provides a visual illustration of the narrative restrictions for the example of two countries, Algeria and the Dominican Republic. The graphs show the variation in export and import prices (in blue) while the vertical lines identify the commodity price episodes for each country. Let us start with the case of Algeria, where we identify four export price shocks and three import price shocks. On the export front, the shocks consist of two crude oil price disturbances in 1986 and 1990, and two natural gas shocks in 2000 and 2005. The negative oil price shock in 1986 originated in an increase in Saudi Arabia oil production while the positive oil shock in 1990 was caused by the Persian Gulf War. The negative natural gas price shock in 2000 was caused by a natural gas crisis in California and the shock in 2005 was due to Hurricane Katrina. In 1986 and 1990 oil represented 75 and 64 percent of Algeria's total exports, respectively. In turn, natural gas represented 29 percent of total exports both in 2000 and 2005. Therefore, we use the negative price shock of 1986 and the positive price shocks of 1990, 2000 and 2005 as part of the narrative. Turning our focus to imports, we identify two positive food/cereals price shocks in 1988 and 2010 originated in droughts and severe weather conditions, respectively and a negative food/cereals price shock in 1997 generated by favorable unexpected forecasts of production. We use these shocks as part of the narrative since during this period food/cereal imports represented between 16 and 19 percent of Algeria's import

to respond less and even turn negative.

[17] Although the start of the global financial crisis is typically dated in September 2008, which coincides with the bankruptcy of Lehman Brothers, we inspect our data on global GDP and the largest contraction in economic activity takes place in 2009. We therefore used 2009 to date the recession. Our results remain robust to using 2008 as an alternative date for the recession.

[18] The results remain robust to the use of a different threshold.

Figure 4: Example of Narrative Restrictions



Notes: The figure shows the evolution of the change in export and import prices for Algeria (top panel) and the Dominican Republic (bottom panel) as well as the narrative restrictions (red and green vertical lines).

base.

Let us now concentrate on the case of the Dominican Republic. Focusing on exports, we identify a negative price shock for sugar in 1984 originated in a situation of oversupply driven by the decision of Pepsico Inc. and Coca-Cola Company to stop using sugar for their drinks. In 1986 there was a positive coffee price shock generated by droughts in key producing areas. Since in 1984 sugar represented 30 percent of Dominican Republic's total exports while in 1986 coffee accounted for 8 percent of the country's exports, we used the negative export price shock of 1984 and positive export price shock in 1986 as part of the narrative restrictions for this country. Turning our attention to import prices, the shocks identified are the same food/cereals shocks as in the case of Algeria. In all these years food/cereals represent about 8 percent of total imports in the Dominican Republic. Therefore, we categorize these shocks as import price shocks for this country.

Table 5 details all episodes used for each country for exporters (P^x shock) and importers (P^m shock). Note that in some cases, an event could be simultaneously used as positive P^x and P^m shock. Such is the case with the positive oil price shock of 1990, caused by the Persian Gulf War. This episode would serve as a positive P^x shock for oil exporting countries such as Algeria and Nigeria, while it would imply a positive P^m shock for oil importing countries such as Uruguay. Note that when an event is due to country-specific weather or political conditions, we exclude such event from that country. For example, the cocoa price shock of 2002 driven by an attempted coup in Cote d'Ivoire was not used in the narrative for this country. Appendix C describes each event used in the narrative approach in detail and summarizes the country-specific assumptions.

4 Baseline results

Figure 5 shows the impulse responses to a positive P^x (in blue) and a negative P^m (in red) shock, where in both cases the shocks are normalized so as to correspond to an increase in P^x

Table 5: 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, COL, 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	

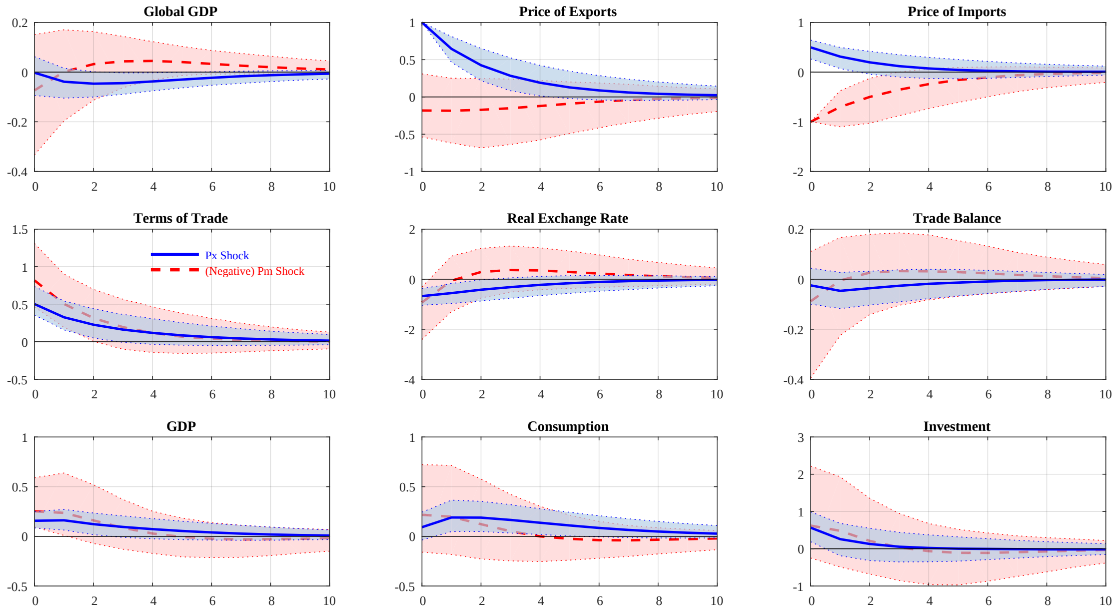
Notes: The table lists each of the episodes identified as generating large exogenous variations in commodity prices and indicates for which countries it was used as a narrative restrictions to identify export and import price shocks.

and a fall in P^m. The figures show the mean impulse responses weighted by each country's size proxied by their GDP. We observe that an improvement in export prices leads to an increase in domestic GDP, private consumption and investment. In particular, a 1 percent increase in export prices causes an increase of 0.2 percent of GDP on impact while private consumption increases 0.15 percent. Investment shows a larger expansion (0.45 percent). The terms of trade improve by about 0.5 percent on impact while the real exchange rate appreciates around 0.6 percent. The effects on global GDP are negative and small.

The broad comovement of the main macroeconomic aggregates (domestic GDP, consumption and investment) is consistent with a variety of models which emphasize how terms of trade movements are a key source of fluctuation for small open economies (e.g., Mendoza, 1995). In response to a positive terms of trade shock, there can be an income effect whereby households feel richer and therefore demand more consumption goods. The improvement in the terms of trade may also boost investment, particularly in the exportable goods sector.

The effects of an improvement in the terms of trade on the trade balance is ambiguous from a theoretical point of view. On the one hand, the higher export prices could induce an increase in the production of exportable goods, in which case the trade balance would improve, in line

Figure 5: Impulse Responses to an Export and Import Price Shock: All Countries



Notes: The figure shows the impulse responses to a positive P^x shock (in blue) and negative P^m shock (in red) for all countries using a VAR with sign and narrative restrictions. The solid lines denote the mean response weighted by each country's size proxied by their GDP (PPP) and the dashed lines represent the 16^{th} and 84^{th} percentile error bands.

with the HLM effect. On the other hand, if there is a substitution effect from more expensive exportable goods to cheaper importable goods, the trade balance could worsen. In addition, the income effect operating through an increase in consumption could lead to a deterioration in the trade balance. The ORS effect predicts a negative effect of terms of trade improvements on the trade balance. In the data we do not observe a significant response of the trade balance to a P^x shock, which suggests that for some countries the HLM effect is at play while for others the ORS effect is dominating.

From Figure 5 it follows that a 1 percent increase in import prices leads to a decline in domestic GDP of about 0.28 percent. By contrast, the effect on the trade balance is not significant. In addition, the terms of trade deteriorate by about 0.8 percent on impact while the real exchange rate displays a short-lived effect, depreciating about 0.6 percent on impact. The effects on global GDP are, on impact, positive but insignificant. Whereas the point estimates of the impulse responses highlight that the main macroeconomic aggregates comove also after a P^m shock, the responses of consumption and investment are not statistically significant. Therefore, P^m shocks are not the mirror image of P^x shocks. The asymmetric response of the economy to a P^x and P^m shocks should not come as a surprise. All the countries under analysis display large differences in terms of of import and export specialization. While exports are concentrated on a few key commodities, imports are more diversified. Therefore, it is expected that P^x shocks affect the economy different from P^m shocks.

Note that while P^x shocks have a persistent effect on the real exchange rate, P^m shocks have a more limited and short-lived impact. This turns out to be consistent with what we find in the theoretical model.

One way to assess the importance of a particular shock in driving business cycles is to compute the variance decomposition. Table 6 shows the share of the variance of all the variables in the VAR explained by P^x and P^m shocks. As highlighted above, when thinking about terms of trade shocks it is important to distinguish their origin, as they are, in general,

Table 6: 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	62.18	4.73	27.31	31.71	43.45	33.44	14.30	3.17
1	61.68	5.95	28.33	30.70	43.19	32.44	18.28	5.01
4	58.77	9.15	29.92	29.82	42.71	31.41	22.89	9.26
10	57.42	10.78	31.03	29.68	42.94	31.23	24.80	11.34
	Trade Balance		**Output**		**Consumption**		**Investment**	
	P^x	P^m	P^x	P^m	P^x	P^m	P^x	P^m
0	8.29	7.35	12.19	7.56	8.56	6.71	10.11	4.70
1	11.87	9.34	17.35	10.36	14.64	9.19	12.09	7.34
4	16.88	12.00	22.58	13.22	22.34	12.66	15.40	10.93
10	18.92	13.38	24.83	14.74	24.59	14.26	17.33	12.55

Notes: The table shows the forecast error variance decomposition of all the variables in the VAR for P^x and P^m shocks on impact, at a 1-year, 2-year, 4-year and 10-year horizons. Reported are mean values weighted by each country's size proxied by their GDP (PPP).

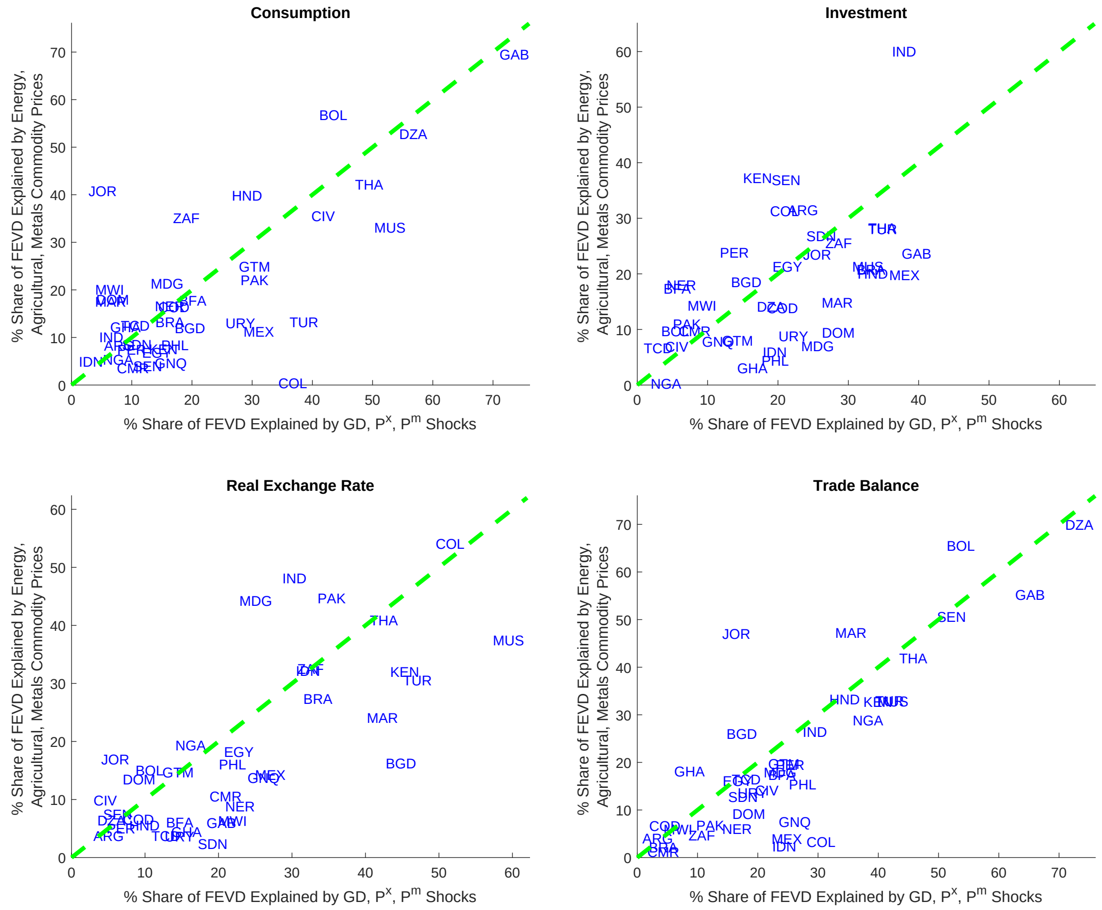
a combination of P^x and P^m shocks. Therefore, in order to assess the share of variance explained by terms of trade shocks, we look at the joint effect of P^x and P^m shocks.

Some interesting results follow from the Table. First, the estimates indicate that ToT shocks, defined as the combination of P^x and P^m shocks, account for the largest share of the volatility of the main macroeconomic variables. In particular, they explain from 20 to 40 percent of domestic GDP on impact and at a 10-year horizon, respectively. A similar result is obtained for consumption, where both socks explain from 15 to 39 percent of its variation on impact and at a 10-year horizon. In addition, P^x and P^m shocks explain up to 30 percent of investment. Interestingly, the effects of P^x shocks tend to be larger than those of P^m shocks. For example, P^x shocks account for almost twice the volatility of domestic GDP, consumption and the real exchange rate in the long-run. The large role played by P^x and P^m shocks for real exchange rate fluctuations is related to the findings of Ayres et al. (2020). The fact that P^x is more important can in part be due to the higher commodity share (and therefore would be consistent with Cashin et al. (2004)) This illustrates that these shocks are not transmitted to the economy in the same way.

Second, P^x shocks have a larger impact on import prices than the reverse because P^x shocks tend to have a larger impact on aggregate economic activity than P^m shocks. The latter reflect mostly shifts in the price of manufacturing goods (which explain the main bulk of imports). These changes in global economic activity subsequently lead to an increase in import prices.

Appendix D contains the empirical evidence on global demand shocks. The main finding is the following. We observe that a positive GD shock is associated with high-demand pressures which lead to an increase in both export and import prices. This happens because GD shocks reflect an increase in demand for all industrial commodities triggered by the state of the global business cycle and drive the price of commodities which are bundled into export and import prices upwards. This result is in line with the findings of Juvenal and Petrella (2015) who show that the co-movement between commodity prices is driven by global demand shocks. Given that positive global demand shocks lead to an increase in both export and import prices, it is not surprising that the impact on the terms of trade is small and actually insignificant at all horizons. These findings highlight our point that world disturbances like a GD shock would tend to yield a small effect on terms of trade because of the simultaneous increase in export and import prices. However, the effects on the economy could be significant: a GD shock is associated with a robust increase in GDP, investment and a fall in the real exchange rate. Therefore, our results are also consistent with the presence of other shocks (e.g. financial)

Figure 6: Comparison Forecast Error Variance Decomposition
(P^x, P^m and GD vs. World Shocks)



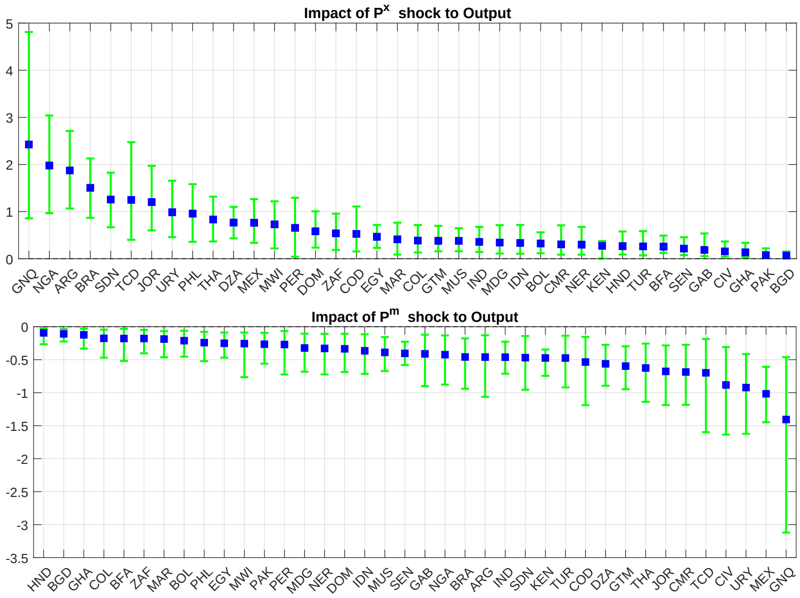
Notes: This Figure shows a comparison of the forecast error variance decomposition of main economic variables, for each country, in our model (x-axis) *vis-à-vis* Fernández et al. (2017) (y-axis) using our own data and the methodology explained in Section 3.

playing an important role for the dynamic of the business cycle in developing economies. See, for example Chang and Fernández (2013); and Neumeyer and Perri (2005).

Fernández et al. (2017) show that world shocks, summarized by three commoditiy indices, matter for business cycle fluctuations. Therefore, the terms of trade do not fully capture the transmission of global shocks to the economy. The scatter plots of Figure 6, which complement those of Figure 1, compare, for each country, the forecast error variance decomposition of consumption, investment, the real exchange rate, and the trade balance in our paper *vis-à-vis* Fernández et al. (2017). The scatter plots show that our model explains a comparable share of the variance decomposition for the main economic variables. This is not surprising since the three commodity indices in Fernández et al. (2017) overlap with the main commodity export and import prices and the fact that commodity prices, and metal prices in particular, are often considered an indicator of global economic activity (see, for example, Caldara, Iacoviello, Molligo, Prestipino and Raffo, 2020).

The advantage of our methodology is that it allows us to characterize the main channels of transmission of world disturbances. The plots highlight that for some countries, world shocks are by far the most dominant source of business cycle fluctuations. We find that ToT shocks, defined as a combination of P^x and P^m shocks are key to understand the dynamics

Figure 7: Heterogeneous Effects of P^x and P^m shocks on Output



Notes: The figure shows the impact impulse response (blue square) on output (in %) for each country in the sample to a one standard deviation shock in P^x and P^m. The green lines represent 16th and 84th percentile error bands.

of developing countries business cycles. In particular, P^x shocks seems to be, on average, more important, especially at longer horizons (i.e. P^x shocks have a more persistent effect to the economy). Moreover, shifts in aggregate economic activity are associated with a boom in domestic business cycles, and account for about one-fourth of the aggregate volatility at a medium horizon.

4.1 Cross-Country Heterogeneity

The aggregate results summarized in the previous section mask a great deal of heterogeneity across countries. Figure 7 shows the impact impulse response (blue square) of output, for each country, to a one standard deviation shock in P^x and P^m. A few observations stand out from these charts. First, the effects of P^x shocks on output tend to be larger than those stemming from P^m shocks. Second, the impact of P^m shocks appears to be more homogeneous across countries. Third, with only a few exceptions, the ten countries which exhibit the largest response of output after a P^x shock are not the same as those experiencing higher output changes following a P^m shock. This highlights that the asymmetric effect of P^x and P^m shock is not only an aggregate phenomena but also holds at the country-level.[19]

In Table 7 we analyze the determinants of the impact impulse responses for output, the trade balance and the terms of trade in response to P^x and P^m shocks. Specifically, we regress the impact impulse response, defined as a 1 standard deviation shock in P^x (or P^m) multiplied by 100, on key variables which are averaged by countries across the period analyzed so that we perform a cross-sectional estimation robust to outliers.[20] We run this "robust" regression because otherwise outliers can drive the overall results (see Verardi and Croux, 2009). The regressors are the GDP per capita (PPP), the commodity export (import) share (as reported in Table 1), dummy variables which equal 1 if a country is agriculture, energy or metal exporter

[19] Appendix E.1 attends to the heterogeneous effects of *GD* shocks on export prices, import prices, and output.

[20] The results are comparable if we analyze the cumulative response or the peak response.

Table 7: Determinants of the Impulse Responses to P^x and P^m Shocks

	IRF Y to a P^x Shock			IRF TB to a P^x Shock			IRF ToT to a P^x Shock		
GDP Per Capita (PPP)	0.045	0.276***	0.276***	0.002	-0.158	-0.250***	-0.803	-0.418	0.132
	(0.068)	(0.025)	(0.0216)	(0.155)	(0.325)	(0.085)	(0.610)	(0.315)	(0.415)
Commodity Export Share	-0.001	0.005***	0.005***	0.008	0.004	0.004***	0.071***	0.084***	0.088***
	(0.004)	(0.001)	(0.001)	(0.006)	(0.004)	(0.001)	(0.015)	(0.013)	(0.0083)
H Index Exports (commodities)			-0.0144			0.168			5.638***
			(0.170)			(0.239)			(1.281)
Comm. Groups Dummies		✓	✓		✓	✓		✓	✓

	IRF Y to a P^m Shock			IRF TB to a P^m Shock			IRF ToT to a P^m Shock		
GDP Per Capita (PPP)	-0.042	-0.157***	-0.151***	0.369***	0.415***	0.372***	0.158**	0.0396	0.0276
	(0.036)	(0.036)	(0.042)	(0.117)	(0.047)	(0.051)	(0.065)	(0.052)	(0.125)
Commodity Import Share	-0.002	-0.003	-0.003	0.023***	-0.030***	-0.024***	-0.045***	-0.150***	-0.148***
	(0.007)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)	(0.009)	(0.037)	(0.030)
H Index Imports (commodities)			0.785			-0.475			-2.724
			(1.238)			(0.669)			(16.100)
Comm. Groups Dummies		✓	✓		✓	✓		✓	✓

Notes: The commodity export and import shares are the same as the ones reported in Table 1; the H index is the Herfindahl index of concentration which can take values from 0 to 1 and it is calculated for all commodities; Comm. Group Dummies denote that the regression includes dummy variables which are equal to 1 if the country is an agriculture, energy, and metal exporter or importer. In all columns the total number of observations is 38 and the regression is robust to outliers. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

(or importer), and the Herfindahl index of concentration.

The upper panel displays the results for the P^x shock. The variable that is systematically statistically significant in all cases is the commodity export share. The results suggest that countries that have a higher commodity export share exhibit, on average, a larger response of output, the trade balance and the terms of trade in response to a P^x shock. We find the response of the terms of trade after a P^x shock is larger, on average, for energy exporters as well as for countries that exhibit a higher concentration. In addition, countries with a higher GDP per capita display a larger response of output a P^x shock. The lower panel shows the results for the P^m shock. Countries with a higher commodity import share exhibit a smaller response of the terms of trade. The estimation reveals that countries with higher GDP per capita show a smaller response of output in response to a P^m shock.

Overall, the results indicate that export characteristics, and in particular the share of commodity exports, are key to understand the cross-sectional differences across countries. The aggregate results mask a great degree of cross-country heterogeneity. Specifically, the impact of global disturbances could be different depending on the pattern of export and import specialization across countries. In the next section we investigate this.

5 Extensions

We analyze the effects of P^x, P^m, and GD shocks by grouping the countries according to whether they are exporters or importers of main commodity groups. For exporters, we split the countries into agriculture (food and beverages), energy, manufacturing, metals and minerals (including precious metals) and agriculture raw materials (plus fertilizers).[21] For importers, we divide the countries into agriculture (food and beverages), energy, and manufacturing.

[21]We bundled precious metals into the metals category as otherwise we would have no countries in the precious metals exporters category. This happens because precious metals exports do not represent a large enough share of exports. Therefore, we can think of this group as related to mining activity and including both industrial and precious metals. In addition, we included fertilizers into the agriculture raw materials group because otherwise we were left with a very small group on its own.

Details about the sample split as well as the impulse responses by group are presented in Appendix E.2.

Two main results stand out: (i) There is heterogeneity in the responses across commodity groups where exporters and importers react differently to each shock; and (ii) within each commodity group P^x and P^m shocks do not mirror each other. This reinforces the idea that not all terms of trade shocks are alike.

Part of the heterogeneity observed in the impulse responses can reflect different patterns of specialization among the different commodity groups (e.g. agricultural production is clearly more labor intensive than energy). We observe that the impact of each shock depends on the commodity group and on whether the country is an exporter or importer of that commodity. The variance decomposition suggests that export price shocks explain the largest share of the variation of output for agriculture and energy exporters while the smallest share of the variance of output pertains to the manufacturing exporters group. Interestingly, the the effects of the import price shocks on output are more homogeneous across importer groups.

When we look at the responses to a GD shock for energy exporters and importers we note that this group has a higher elasticity with respect to global demand (i.e. these commodity prices move more than the ones in other groups after a global demand shock). In both cases, the price response is higher than the one for the whole sample of countries, which implies that export and import prices in countries specialized in energy tend to react more than the average. In both cases the terms of trade tend to move in the same direction as energy prices. Specifically, in the aggregate results for all countries, following a global demand shock, the effects on the terms of trade are roughly zero, whereas they move down significantly for energy importers (i.e. they follow the inverse pattern of import prices, that is energy prices). By contrast, for energy exporters the terms of trade go up but the effect is not statistically significant. Interestingly, in response to a global demand shock, the trade balance moves in the direction of the terms of trade, consistent with the HLM effect, for energy importers. In particular, the trade balance deteriorates (persistently) for energy importers (Figure E.7, Appendix E) but yields no statistically significant result for energy exporters (Figure E.4, Appendix E). The large effect in the energy commodity groups could be partly related to the fact that exports are very concentrated in the energy commodities, which have a relatively low degree of substitutability.

6 The Model

In order to rationalize our empirical findings, we develop a medium-scale model. Our model features three types of goods (nontradable, imports and exports), but only two production sectors (nontradable and exportable). As in Catão and Chang (2013), exports are produced domestically (but entirely consumed abroad) and imports are produced abroad.[22] Firms in the nontradable and export sectors use imported intermediates as production inputs.

These stark characterizations of the economy are useful to focus on the key differences between the export and import sectors which are helpful to explain the asymmetric response of the economy to a shift in export and import prices. These simplifications also reflect the economic structure of a typical developing country which can be characterized as follows: (i) an important export sector typically specialized in raw commodities or simple manufacturing goods which are largely sold abroad; and (ii) an import sector composed of more sophisticated manufacturing goods which are not produced domestically. This description is consistent with Papageorgiou and Spatafora (2012).[23]

[22] The assumption that imports are entirely produced abroad is not central to our result and is made mainly for analytical tractability.

[23] See also Hausmann et al. (2014).

A central assumption of the model is that exports cannot be demanded domestically. This modelling choice entails assuming away the substitutability between imports and exports in final demand.[24] As a result, exports cannot be consumed domestically and final good imports can only be substituted (or complemented) with nontradable goods. This assumption allows us to introduce exogenous and independent import and export price shocks and map the model to the empirical analysis presented in Section 4.

6.1 Household

The economy is populated by a representative household that maximizes life-time utility

$$\mathcal{U}_t = \mathbb{E}_0 \sum\nolimits_{t=0}^{\infty} \beta^t U\left(c_t, h_t\right),$$

where $\mathbb{E}_t$ denotes an expectation operator using information up to time t and the period utility function is defined as

$$U\left(c_t, h_t\right) = \frac{\left(c_t - \chi h_t^{\varphi}\right)^{1-\sigma} - 1}{1-\sigma}.$$

Here c_t is an aggregate consumption bundle, σ denotes the inverse of the inter-temporal elasticity of substitution, χ is a disutility parameter, and φ is the inverse of the Frisch elasticity of labor supply. We follow Greenwood, Hercowitz, and Huffman (1988) in specifying household's preferences. The variable h_t is a CES labor aggregator as in Horvath (2000):

$$h_t = \left[(1-\phi_h)^{-\frac{1}{\kappa}} \left(h_t^n\right)^{\frac{1+\kappa}{\kappa}} + \phi_h^{-\frac{1}{\kappa}} \left(h_t^x\right)^{\frac{1+\kappa}{\kappa}}\right]^{\frac{\kappa}{1+\kappa}}, \tag{6}$$

where ϕ_h denotes the steady state share of labor in the export sector and κ is a parameter controlling the elasticity of substitution between labor types (h_t^j for $j = \{n, x\}$). When $\kappa = 0$, labor is prevented from moving across sectors. When $\kappa \to \infty$, workers devote all time to the sector paying the highest wage. Hence, at the margin, all sectors pay the same hourly wage and perfect labor mobility is attained.[25] For $\kappa < \infty$ hours worked are not perfect substitutes. An interpretation is that workers have a preference for diversity of labor and would choose to work closer to an equal number of hours in each sector, even in the presence of wage discrepancies.[26] We will show that this complementarity in labor is important for generating a greater degree of comovement between producing sectors after export and import price shocks.

The representative household maximizes their lifetime utility subject to a sequence of budget constraints of the form:

$$c_t + q_t d_{t-1} + \sum_{j\in(n,x)} i_t^j = \frac{q_t}{1+r_t}\left(d_t - \frac{\psi}{2}\left(d_t - d\right)^2\right) + \sum_{j\in(n,x)} w_t^j h_t^j + \sum_{j\in(n,x)} r_t^j k_t^j + \pi_t, \tag{7}$$

where d_t denotes the stock of debt (expressed in terms of the foreign good), $q_t = RER_t$ is the real exchange rate, the associated interest rate is r_t, and w_t^j are the wages in sector $j = \{n, x\}$ (deflated by the overall price index). The variable π_t denotes profits accruing to the nontradable sector (deflated by the overall price index). i_t^j and k_t^j denote the sectoral investment and capital stock respectively, and r_t^j is the associated sectoral return on capital

[24] This assumption eliminates the tradable aggregator which exists in model which feature substitutability of imports and export in domestic absorption, such as the standard MXN model (Mendoza, 1995 and Schmitt-Grohé and Uribe, 2018).

[25] To see this, recall that the equilibrium relationship that governs the labor mobility across sectors requires that: $(w_t^n/w_t^x)^{\kappa} = (\phi_h/(1-\phi_h))(h_t^n/h_t^x)$.

[26] This CES aggregator implies that labor market frictions are neutralized in the steady state, so that the inefficiency associated with sectoral wage discrepancies is only temporary.

investment. To ensure the stationarity of the equilibrium process for external debt, we follow Schmitt-Grohé and Uribe (2003) and introduce portfolio adjustment costs. We denote the steady state of a variable by dropping the time subscript.

The sector-specific capital stock accumulates according to

$$k_t^n = i_t^n + (1-\delta) k_{t-1}^n - \frac{\phi_h}{2} \left(k_t^n - k_{t-1}^n\right)^2, \tag{8}$$

$$k_t^x = i_t^x + (1-\delta) k_{t-1}^x - \frac{\phi_x}{2} \left(k_t^x - k_{t-1}^x\right)^2, \tag{9}$$

where $\frac{\phi_j}{2}\left(k_t^j - k_{t-1}^j\right)^2$ are sector-specific capital adjustment costs.

The first order conditions for the household's problem are:

$$\lambda_t = \left(c_t - \chi h_t^{\varphi}\right)^{-\sigma}, \tag{10}$$

$$\lambda_t = \chi\varphi h_t^{\varphi-1} \left(\frac{h_t^n}{(1-\phi_n) h_t}\right)^{\frac{1}{\kappa}}, \tag{11}$$

$$\lambda_t = \chi\varphi h_t^{\varphi-1} \left(\frac{h_t^x}{\phi_n h_t}\right)^{\frac{1}{\kappa}}. \tag{12}$$

$$\lambda_t \left[1 + \phi_n \left(k_t^n - k_{t-1}^n\right)\right] = \mathbb{E}_t \beta \lambda_{t+1} \left[(1-\delta) + \phi_n \left(k_{t+1}^n - k_t^n\right) + r_{t+1}^n\right], \tag{13}$$

$$\lambda_t \left[1 + \phi_x \left(k_t^x - k_{t-1}^x\right)\right] = \mathbb{E}_t \beta \lambda_{t+1} \left[(1-\delta) + \phi_x \left(k_{t+1}^x - k_t^x\right) + r_{t+1}^x\right], \tag{14}$$

$$q_t \lambda_t \left(1 - \psi \left(b_t - b\right)\right) = \mathbb{E}_t \left[\beta \left(1 + r_t\right) q_{t+1} \lambda_{t+1}\right]. \tag{15}$$

6.1.1 Internal Demand for Goods

Let a_t denote an absorption bundle that is made of importables (a_t^m) and nontradable goods (a_t^n)

$$a_t = \left[(1-\nu)^{\frac{1}{\eta}} \left(a_t^n\right)^{\frac{\eta-1}{\eta}} + \nu^{\frac{1}{\eta}} \left(a_t^m\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}},$$

where η is the elasticity of substitution between nontradable goods and imported goods and $(1-\nu)$ the degree of home bias. The first order conditions are:

$$a_t^n = (1-\nu) \left(p_t^n\right)^{-\eta} a_t \tag{16}$$

and

$$a_t^m = \nu \left(p_t^m\right)^{-\eta} a_t, \tag{17}$$

where p_t^n denotes the price of the nontradable good relative to the aggregate price index and p_t^m the price of imports expressed in units of the home good.

By replacing individual demands into the absorption aggregator, we get the following expression

$$1 = \left[(1-\nu) \left(p_t^n\right)^{1-\eta} + \nu \left(p_t^m\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}, \tag{18}$$

where p_t^n and p_t^m denote the nontradable and export prices expressed in units of the home good.

In principle, any sort of asymmetry across sectors (e.g. different production functions, asymmetries in the adjustment costs or in the preferences towards the two goods) is enough to generate a different response of the overall economy to an exogenous shift in export and import prices. However, two key assumptions of our modelling framework are: (i) the absence of substitutability between exports and imports in domestic demand and; (ii) the share of exportable goods absorbed domestically is zero. These assumptions are needed to break the tight link between price of exports and imports that exists in the standard MXN model (see Schmitt-Grohé and Uribe, 2018).

In that setting, export/import substitutability, coupled with the fact the real exchange rate is equal to the relative price of the tradable composite good in terms of final goods, implies a tight link between the price of exports and imports in units of foreign goods prices. In fact, only the ratio between the two (i.e. the terms of trade) can be assumed to be independent. In other words, in the standard MXN framework only one price (of exports or imports) expressed in terms foreign output can be taken as exogenous, the other one will be defined by the equilibrium relationship of the model and therefore would be endogenous.[27]

6.2 Firms

The supply side of the economy is composed of two sectors. The nontradable goods sector operates under imperfect competition while the export and import markets are perfectly competitive.[28] Both sectors use intermediate inputs in production, which creates an intermediate input channel so that shifts in the price of imports will also have a direct impact on the supply side of the economy.[29] The latter helps generate a comovement across sectors in the presence of idiosyncratic shocks (such as, for instance, a shock to the price of exports).

6.2.1 Nontradable Producing Sector

There is continuum of firms $i \in [0,1]$ operating in the nontradable sector under monopolistic competition. Nontradable goods are produced using labor, capital services and imported intermediates (m_t^n),

$$y_t^n(i) = z_n \iota_n \left(h_t^n(i)\right)^{\alpha_n} \left(k_{t-1}^n(i)\right)^{\gamma_n} \left(m_t^n(i)\right)^{\mu_n}$$

where z_n is the sector-specific technology level, α_n is the labor share, γ_n denotes the capital share, μ_n is the imported intermediate share and $\iota_n = \frac{1}{\alpha_n^{\alpha_n} \gamma_n^{\gamma_n} \mu_n^{\mu_n}}$. Note that, while capital is costly to adjust and labor mobility is not perfect across sectors, demand for intermediate inputs is not subject to any adjustment costs. Each firm i faces the following demand schedule

$$y_t^n(i) = \left(\frac{p_t^n(i)}{p_t^n}\right)^{-\epsilon} y_t^n,$$

[27] In the MXN model, the relative price of tradable goods (and the real exchange rate) can be derived by combining the tradable Armington aggregator with the domestic allocations of exports and imports. In such setting, the real exchange rate, export and import prices (denominated in terms of the foreign good) are endogenous. It can be easily shown that, if export and import prices are exogenous objects as in our empirical analysis, they together cannot satisfy the relationship pinning down the relative price of tradable goods. To see this, it is worth recalling some of the keys equations in the MXN model. Let us define χ_x as the export share in the tradable composite, then the substitution between the two goods, together with an Armington-type aggregator implies that the composite prices of tradables is defined in log-linearized form as $p_t^\tau = \chi_x p_t^x + (1-\chi_x) p_t^m$. Substituting the definition of the log-linearized price of imports and exports in units of foreign goods, $p_t^x = P_t^x + RER_t$ and $p_t^m = P_t^m + RER_t$, and recalling that $p_t^\tau = RER_t$, we get that $\chi_x P_t^x + (1-\chi_x) P_t^m = 1$, which implies that P_t^x cannot fluctuate independently from P_t^m.

[28] Assuming monopolistic competition in the nontradable sector is useful in order to pin down the steady state of the model analytically and has otherwise no material impact on the quantitative analysis.

[29] See Dorich et al., 2013; and Burgess et al., 2013 for examples of open economy models in which imports are used as intermediate materials in production.

where ϵ is the elasticity of substitution across varieties. Each firm i in the nontradable sector maximize profits given by

$$\pi_t^n(i) = p_t^n(i)\left(\frac{p_t^n(i)}{p_t^n}\right)^{-\epsilon} y_t^n - w_t^n h_t^n(i) - r_t^n k_{t-1}^n(i) - p_t^m m_t^n(i),$$

subject to equation (6.2.1). Since firms behave competitively in factor markets in equilibrium, we get the usual demand function for inputs

$$\frac{\epsilon-1}{\epsilon}\alpha_n \frac{y_t^n(i)}{h_t^n(i)} = \frac{w_t^n}{p_t^n},$$

$$\frac{\epsilon-1}{\epsilon}\gamma_n \frac{y_t^n(i)}{k_{t-1}^n(i)} = \frac{r_t^n}{p_t^n},$$

$$\frac{\epsilon-1}{\epsilon}\mu_n \frac{y_t^n(i)}{m_t^n(i)} = \frac{p_t^m}{p_t^n},$$

where $\frac{\epsilon-1}{\epsilon}$ denotes a constant mark-up due to monopolistic competition.[30]

6.2.2 Exportable Producing Sector

Exportable goods are produced using labor, capital and imported intermediates (m_t^x)

$$y_t^x = z_x \iota_x \left[(h_t^x)^{\alpha_x}\left(k_{t-1}^x\right)^{\gamma_x}(m_t^x)^{\mu_x}\right], \tag{19}$$

where z_x is the sector-specific technology level, α_x the labor share, γ_x the capital share, μ_x the exported intermediate share and $\iota_x = \frac{1}{\alpha_x^{\alpha_x}\gamma_x^{\gamma_x}\mu_x^{\mu_x}}$. Firms in the export sector maximize profits given by

$$\pi_t^x = p_t^x y_t^x - w_t^x h_t^x - r_t^x k_{t-1}^x - p_t^m m_t^x,$$

where p_t^x denotes the price of exports expressed in terms of home output. Firms behave competitively in the product and factor markets. We therefore get the following input demands:

$$\alpha_x \frac{y_t^x}{h_t^x} = \frac{w_t^x}{p_t^x}, \tag{20}$$

$$\gamma_x \frac{y_t^x}{k_{t-1}^x} = \frac{r_t^x}{p_t^x}, \tag{21}$$

$$\mu_x \frac{y_t^x}{m_t^x} = \frac{p_t^m}{p_t^x}. \tag{22}$$

Note that the demand for imported intermediates, equation (22), is equal to the inverse of the terms of trade, $\frac{p_t^m}{p_t^x}$. All else equal, a rise in the terms of trade will increase the demand for imports in the export sector.

6.3 Aggregation and Market Clearing

We assume that all firms in the nontradable sector are symmetric in equilibrium, which in turn means that $y_t^n = y_t^n(i)$, $k_t^n = k_t^n(i)$, $m_t^n = m_t^n(i)$, $h_t^n = h_t^n(i)$ and $p_t^n = p_t^n(i)$.

In equilibrium, the demand for factor inputs equals their supply. At the aggregation stage,

[30] We do not consider price stickiness for two main reasons: a) to stay close to the real business cycle tradition and b) because the model is calibrated to annual frequencies.

the following equilibrium condition can be derived:

$$
\begin{aligned}
y_t^n &= a_t^n, &(23)\\
a_t &= c_t + i_t, &(24)\\
i_t &= i_t^n + i_t^x, &(25)\\
m_t &= a_t^m + m_t^n + m_t^x. &(26)
\end{aligned}
$$

Value added can be defined as:

$$y_t = p_t^n y_t^n + p_t^x y_t^x - p_t^m \left(m_t^n + m_t^x\right). \tag{27}$$

Combining the household budget constraint with firms' profits yields the market clearing conditions above and the economy-wide budget constraint:

$$q_t d_{t-1} - \frac{q_t}{1+r_t}\left(d_t - \frac{\psi}{2}\left(d_t - d\right)^2\right) = p_t^x y_t^x - p_t^m m_t. \tag{28}$$

We assume that the country interest rate is

$$r_t = r^* + s_t, \tag{29}$$

where

$$s_t = s. \tag{30}$$

The model structure implies that the prices of exports and imports in real units of US dollars (i.e. P_t^x, P_t^m) and global demand (GD_t) are exogenous and follow a VAR which characterizes the exogenous evolution of P_t^x, P_t^m and GD_t. Thus,

$$X_t = AX_{t-1} + B\varepsilon_t, \tag{31}$$

where

$$X_t = \left[\ln\left(GD_t/GD\right), \ln\left(P_t^x/P^x\right), \ln\left(P_t^m/P^m\right)\right]'$$

denotes the vector of shocks, A and B are (3×3) coefficient matrices and ε_t a (3×1) vector of $i.i.d$ shocks. This is the model counterpart of the foreign block postulated in equation (3).

6.4 The Law of One Price and Terms of Trade

Note that the Law of One Price (LOOP) holds for export and imports (there is full pass through from world prices to the price of domestic exports and imports). Therefore, the following relationships hold:

$$P_t^x = \frac{p_t^x}{q_t} \tag{32}$$

and

$$P_t^m = \frac{p_t^m}{q_t}. \tag{33}$$

We define the terms of trade as the ratio between export and import prices.

$$ToT_t = \frac{P_t^x}{P_t^m}. \tag{34}$$

6.5 Observables

In the model, the main aggregates are expressed in units of final goods, i.e. GDP, consumption, investment, and the trade balance. The data used in the empirical analysis, however, are not expressed in the same terms. A meaningful comparison of the model predictions with data requires expressing theoretical and empirical variables in the same units. Following Schmitt-Grohé and Uribe (2018), we define GDP, consumption, investment and the trade balance in constant prices as

$$Y_t = p^n y_t^n + p^x y_t^x - p^m \left(m_t^n + m_t^x\right), \tag{35}$$

$$C_t = \frac{c_t}{y_t} Y_t, \tag{36}$$

$$I_t = \frac{i_t}{y_t} Y_t, \tag{37}$$

$$TB_t = \frac{\left(\frac{q_t P_t^x y_t^x}{y_t} - \frac{q_t P_t^m m_t}{y_t}\right) Y_t}{y}. \tag{38}$$

6.6 Model Calibration and Estimation

The calibration of the model targets a set of moments and normalizations. Tables 8 and 9 summarize the calibration and estimation results, respectively. The steady state of the model is derived algebraically in Appendix F.6.

One period in the model corresponds to one year in the data. The equilibrium conditions (6)–(38) evaluated at the steady state represent a system of 38 equations with 38 unknowns and 17 structural parameters, namely, z_x, δ, φ, χ, β, σ, η, κ, ϕ_n, α_n, α_x, γ_n, γ_x, μ_n, μ_x, $r^* + s$, d. Note that the structural parameters ψ, the elements of A and B and ϕ_j for $j = \{n, m\}$ do not appear in the steady-state system.

Therefore, we must add the following 15 calibration restrictions. (1) We set $\sigma = 2$, which is a common value in business-cycle analysis. (2) $\varphi = 1.455$. This value implies a sectoral Frisch elasticity of labor supply of 2.2, which is the number assumed in the one-sector model studied in Mendoza (1991). (3) The depreciation rate of physical capital is $\delta = 0.1$, which is a standard value. (4) $r^* + \bar{s} = 0.0535$ in line with Fernández et al. (2017). (5) $\beta = 1/(1 + r^* + \bar{s})$. This condition ensures that the steady-state level of debt coincides with the parameter d. (6) The median value of the exports-to-GDP ratio in our sample of emerging and developing countries is 21%. Therefore, we impose $x/y = 0.21$. (7) In our sample of 38 countries, the median trade balance-to-GDP ratio is -5%, or $(x - m)/y = -0.05$. (8) The median investment-to-GDP ratio in our sample is 24.4%. Thus, we impose $i/y = 0.244$. (9) It is generally assumed that in emerging and developing countries the nontradable sector is more labor intensive than the export or import producing sectors. We follow Schmitt-Grohé and Uribe (2018) and set the share of capital in the export sector to be 1.4 larger than in the nontradable sector. (10)–(11) The values of μ_n and μ_x are calibrated using the world input-output matrices, with the resulting median values being 0.11 and 0.09 respectively.[31] (12)–(13) $\gamma_n = 1 - \alpha_n - \mu_n$ and $\gamma_x = 1 - \alpha_x - \mu_x$. (14) the parameter ϕ_h is set such that wages are equal in the steady state. (15) The real exchange rate is normalized to 1. Finally, parameters η and κ are estimated. This

[31] The input-output tables are sourced from `http://www.wiod.org/database/wiots16`. For each country, we construct the sum of imported intermediate inputs and gross output for each of the sectors. Since we do not have data for all the countries in our sample, we use the *rest of the world country* as representative of each of the missing countries. If the country exists in the database we construct the sum of imported intermediate inputs as the sum of intermediate inputs for all other countries. For the countries that are missing we need to decide what we refer to as *imported intermediate inputs*. We assume that only the intermediate inputs from the other existing countries (typically advanced or large developing countries) are imported.

completes the calibration strategy of the 17 parameters appearing in the set of steady-state equilibrium conditions.

Table 8: Model Calibration

Calibrated Structural Parameters								
σ	δ	r^*+s	φ	β	γ_x/γ_n	μ_n	μ_x	ϵ
2	0.1	0.0535	1.455	$\frac{1}{1+r^*+\bar{s}}$	1.4	0.11	0.09	6
Moment Restrictions								
s_i	s_x	s_{tb}	q					
0.21	0.24	-0.05	1					
Implied Parameters								
χ	ν	ϕ_h	$\bar{d}$	z_x	α_n	α_x	γ_n	γ_x
0.81	0.20	0.36	-8.71	0.63	0.59	0.50	0.30	0.41
Estimated Parameters								
ψ	η	κ	ϕ_n	ϕ_x	A	B		
*	*	*	*	*	**	**		

Notes: $s_i \equiv i/y$, $s_x \equiv x/y$ and $s_{tb} \equiv (x-m)/y$, where $y \equiv y_n + y_x - (m_n + m_x)$. *These estimates are chosen to match the responses of the real exchange rate, the trade balance to GDP ratio, output, consumption and investment. **The estimates of the A and B matrices are estimated to match the shock process of the empirical median impulse responses of all countries.

We estimate the model using Bayesian techniques for the median country to illustrate the transmission mechanism of export and import price shocks. We adopt Bayesian methods and compute the log-likelihood using prior information and data (the distance between theoretical and empirical impulse responses) as in Christiano, Eichenbaum, and Trabandt (2016). Bayesian methods are fully invested in the likelihood principle: all evidence about a DSGE is contained in its likelihood conditional on data, $\mathscr{Y}_T$. We therefore construct the likelihood function as a function of the distance between theoretical and empirical distance response functions.[32] The likelihood function is maximized at the mode by choosing the minimum distance between theoretical and empirical impulse responses (over 11 periods) for the following aggregates: the real exchange rate, the trade balance, output, consumption and investment.

In order to estimate the structural parameters of the model for the hypothetical median country, we first estimate (at the mode) the 18 elements of matrices A and B that are consistent with the median empirical impulse responses (for all countries) of the shock process (GD_t, P_t^m

[32]Bayesian estimation exploits the fact that the posterior distribution equals the model likelihood, $\mathcal{L}(\mathscr{Y}_T|\Theta)$, multiplied by the econometrician's prior on the model parameters, $\mathcal{P}(\Theta)$. The log-likelihood can be expressed as follows:

$$\begin{aligned}\ln \mathcal{P}(\Theta|\mathscr{Y}_T) \quad \propto \quad & \left(\frac{N}{2} - \ln\left(\frac{1}{2\pi}\right) - \frac{1}{2}\ln\left|\widehat{V}\right| - \frac{1}{2}\left(\widehat{\Psi} - \Psi_\Theta\right)'\left(\widehat{V}\right)^{-1}\left(\widehat{\Psi} - \Psi_\Theta\right)\right) - \\ - \quad & \zeta\left(\sum_{k=1}^{9} \mathbb{1}_k \left|\widehat{\Psi}(k) - \Psi_\theta(k)\right|^2\right) + \ln \mathcal{P}(\Theta), \end{aligned} \tag{39}$$

where $\widehat{\Psi}$ is a vector of empirical impulse responses, N the number of rows of the vector, $\widehat{\Psi}_\Theta$ a vector of theoretical impulse responses, $\widehat{V}$ a weighting matrix containing the variances of the empirical impulse responses, $\mathbb{1}_k$ are indicator functions associated with each sign restriction, k is the location in the theoretical vectors of the sign restriction, ζ a penalty parameter and $\left|\widehat{\Psi}(k) - \Psi_\Theta(k)\right|$ the absolute distance between the empirical and theoretical impulse responses. We set this parameter $\zeta = 10,000$ so that larger deviations are heavily penalized.

and P_t^x) by minimising the distance between these three impulse responses. The priors used to estimate these parameters at the mode are reasonably flat.

As a first step, we estimate the parameters of the model to match the average impulse responses across countries. This exercise is helpful to understand the key mechanisms driving the shocks transmission in our theoretical model. As a second step, we seek to see whether the model can match the importance of terms of trade shocks at the country-level performing a cross-country exercise in line with Schmitt-Grohé and Uribe (2018)

When matching the impulse responses, we make sure that the parameters of the exogenous process only reflect the information of the foreign block of variables. In particular, A and B are chosen so as to match the impulse responses to a global demand, export and import price shocks. The remaining parameters (ψ, κ, η, ϕ_n and ϕ_x) are then chosen to match the impulse responses of the domestic variables.

We find that for the median hypothetical country the mode estimate of ψ is 1.06, which is slightly higher than (but in line with) the median estimate in Schmitt-Grohé and Uribe (2018). The elasticity of substitution between nontradable and imported final goods is lower at 0.24 than the estimates surveyed by Akinci (2011), which is around 0.5 in emerging and developing income countries. The estimated value of κ is low and consistent with the idea that substitutability of the labor input is limited.[33] The investment adjustment cost parameter is negligible in the export sector, whereas it is higher and consistent with a reasonable capital adjustment cost in the nontradable sector, $\phi_n = 8.28$. Table 9 summarizes the mode estimates of the structural parameters for the hypothetical median country (as well as the location of the priors). These estimates suggests that there is a high degree of complementarity in labor and good markets. This complementarity helps reinforce the wealth effects that are generated by term of trade shocks.

Table 9: Prior Information and Mode Estimates

Parameter	Description	Distribution	Prior Mean	Standard Deviation	Mode Estimate	s.d.
ψ	debt adjustment costs	Gamma	3	2.5	1.06	1.21
η	elasticity of subs. between final n and m	Inv. Gamma	0.5	2	0.24	0.09
κ	elasticity of subs. between labor types	Inv. Gamma	1	2	0.48	0.18
ϕ_n	inv. adjustment cost in sector n	Gamma	5	10	8.28	6.55
ϕ_x	inv. adjustment cost in sector x	Gamma	5	10	0.00	0.00

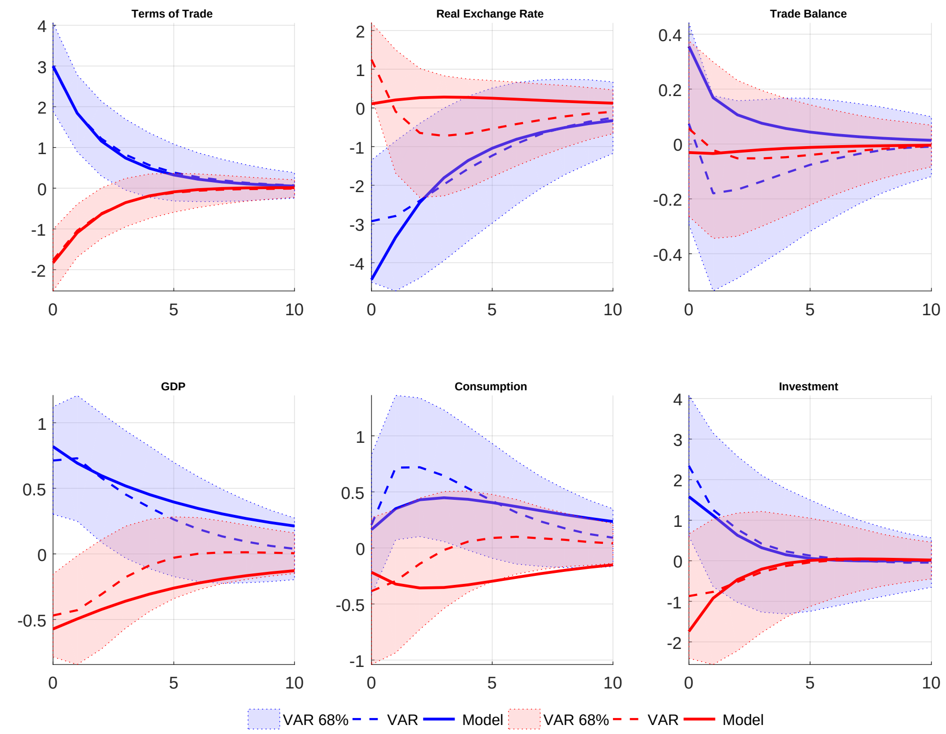
6.7 Model Impulse Responses

Figure 8 shows the theoretical impulse responses (with values estimated at the mode) alongside their empirical counterparts in response to both export price and import price shocks, respectively. In addition, Figure 10 shows the responses of other model variables to help unpack the transmission mechanisms at play.

Figure 8 shows (in solid blue) that the model is able to the replicate the key empirical findings associated with a positive export price shock. First, as in the empirical analysis, import prices denominated in foreign units rise after an export price shock. Second, the figure shows that the terms of trade improve exogenously. Third, the model is able to match the expansion of exports alongside imports and, because imports increase by less than exports, the trade balance improves. The export price shock generates a considerable boost in the trade

[33] This findings suggests that labor is more specialized in the export sector tends than in the nontradable sector.

Figure 8: Impulse Responses to an Export and Import Price Shock: Model vs. All Countries



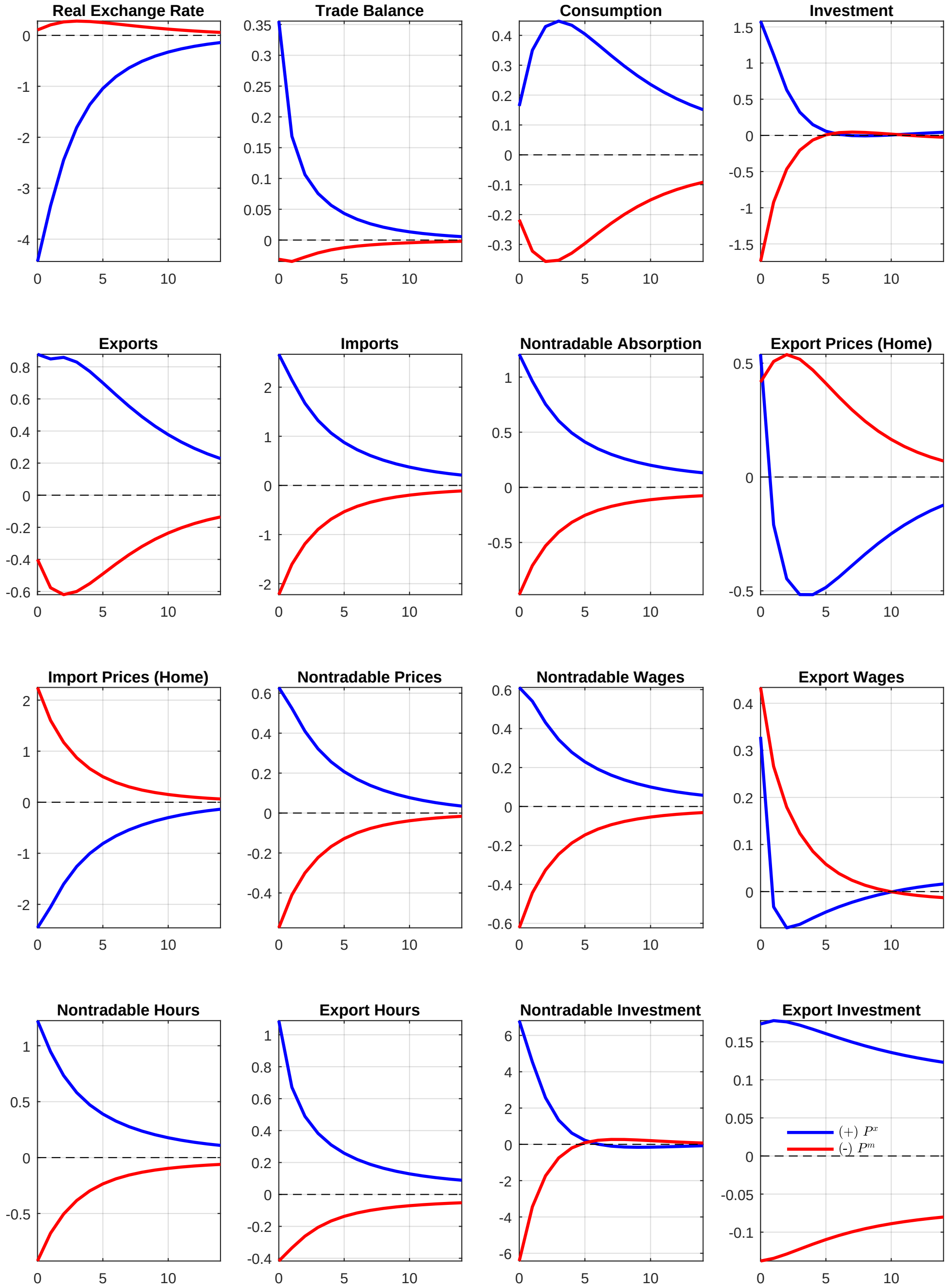
Notes: The figure shows the impulse responses to a positive P^x shock (in blue) for all countries in the VAR and in the model using mode estimates. The responses to a positive P^m shock (in red) for all countries in the VAR and in the model using mode estimates. The dashed lines denote the mean response weighted by each country's size proxied by their GDP (PPP) and the dotted lines represent the 16$^{\text{th}}$ and 84$^{\text{th}}$ percentile error bands.

balance, which is in line with the HLM effect (not present in the data since the trade balance response is insignificant). As the demand for goods in the median country increases, the real exchange rate appreciates *vis-à-vis* the US. This means that, while export prices denominated in terms of home output increase on impact, import prices in the country's our terms fall largely due to the appreciation of the exchange rate. Fourth, the model is able to match the expansion in GDP, consumption and investment observed in the data.

Figure 10 shows (in blue) that, after an export price shock, the demand for capital and labor in the export sector increases (together with factor prices). The expansion in exports is long-lived and attained through a higher use of the factors of production. The shock induces a positive wealth effect, which is magnified by the strong complementarity prevalent in labor and good markets. The supply of labor to the nontradable sector also increases as a result of limited labor market mobility. This, in turn, results in higher relative prices, output and absorption in the nontradable sector. The combination of these effects generate large and persistent effects on quantities.

Let us now turn to assessing the response of the exchange rate after an export price shock. Using equation (17) and the law of one price, $p_t^m = q_t P_t^m$, we obtain a relationship between the price of nontradable goods, the real exchange rate and import prices denominated in terms

Figure 9: Model Impulse Responses to an Export and Import Price Shock



Notes: The figure shows the impulse responses of model variables to a positive export price shock (in blue) and to a negative import price shock (in red). The impulse responses are not normalized.

of the foreign good, which is defined as:

$$1 = \left[(1-\nu) \left(p_t^n\right)^{1-\eta} + \nu \left(q_t P_t^m\right)^{1-\eta} \right]^{\frac{1}{1-\eta}}.$$

This relationship together with the uncovered interest rate parity condition pins down the behavior of the exchange rate.[34] Note that, although import prices affect the exchange rate directly, in equilibrium the relative price of nontradable goods responds to both of these exogenous price movements. A positive impulse to export prices leads to an exchange rate depreciation. The extent of this depreciation is dictated by the response of nontradable prices, which in equilibrium depends on export prices. A positive shock generates a strong wealth effect (in part due to the strong complementarity across sectors), which tends to boost prices in the nontradable sector. This means that overall prices go up and the real exchange rate must appreciate. All else equal, a rise in export prices generates more incentives for export production and a rise in import prices lowers the demand for intermediate imported inputs and final demand of imports.

In line with the VAR evidence, a positive import price shock increases export prices slightly and deteriorates the terms of trade. Figure 8 shows that one key difference with respect to the positive export price shock (in blue) is that the import price shock (in red) has a more negligible impact on the real exchange rate and the trade balance. However, the rise in import prices leads to a contraction in GDP, consumption and investment. These patterns are qualitatively very similar (in absolute terms) to those in response to an export price shock.

Figure 10 illustrates (in red) that a rise in the import prices induces firms in the export and nontradable sectors to demand less imported intermediates. At the same time, there is a lower demand for final imported goods (and for nontradable goods). This, in turn, leads to an contraction in labor demand in both sectors (with wages only falling in the nontradable sector).

A positive import price shock generates a negative wealth effect, which reduces prices in the nontradable sector (i.e., for a given level of the real exchange rate, a positive increase in import prices leads to a drop in the relative price of nontradable goods). However, since export prices go up only slightly, this means the overall effect on prices is neutralised and the real exchange rate responds very little. All else equal, a rise in import prices tends to lower the demand for intermediate imported inputs and final imports, whilst an increase in export prices pushes up exports. Since export prices increase by less than import prices after a positive import price shock, the response of the trade balance is more muted. The deterioration in the terms of trade (coming from the rise in import prices) tends to generate more reallocation of resources across sectors (relative to the export price shock) because the impact on sectors is more asymmetric, hitting the nontradable sector more than the export sector.

We conclude that, although qualitatively similar, these two shocks generate, in light of the asymmetric economic structure, stark predictions in terms of the responses of the trade balance and the exchange rate, as well as different reallocation patterns across sectors. The asymmetry in the real exchange rate and the terms of trade is in part driven by the fact that:(i) import price shocks affect imports at the intermediate and final levels; and (ii) most importantly, the model exhibits different degrees of complementarity/substitutability between exports and nontradable goods, and imports and nontradable goods.

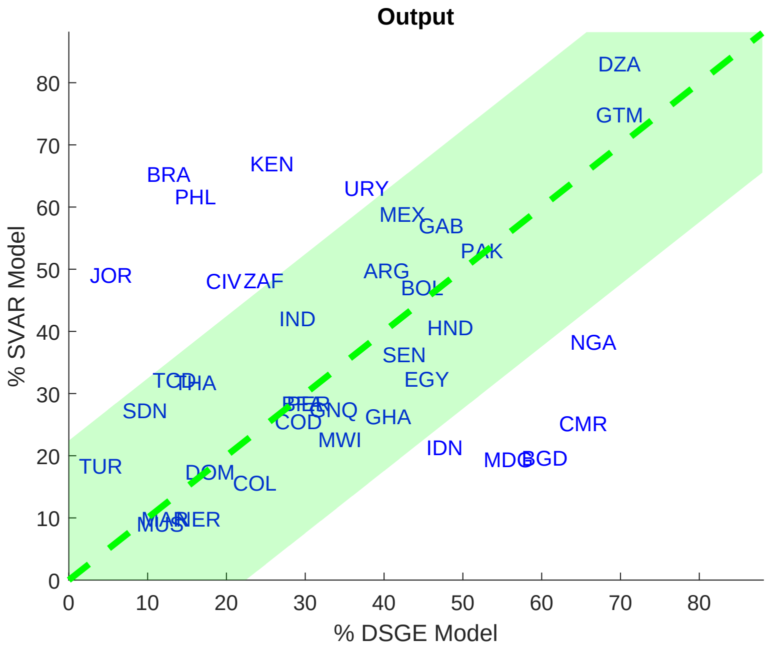
6.8 Cross-Country Analysis (tbc)

7 Conclusion

Using a unique data set of commodity and manufacturing prices combined with time-varying sectoral export and import shares we analyze the role of export price, import price, and global

[34] This is consistent with Catão and Chang (2013) where the behavior of the exchange rate is linked to the price of home goods and import prices denominated in terms of foreign goods. This relationship implies that when P_t^m is fixed (i.e. after a shock to the price of exports) RER_t needs to offset all changes in p_t^n (i.e. moves in opposite direction to it). On the contrary, a shift in P_t^m needs to be offset by either a change in p_t^n or a movement in RER_t (or a combination of the two).

Figure 10: Variance of Output Explained By ToT Shocks: SVAR Versus DSGE Model



Notes: Variance shares explained by the combination of P^x and P^m shocks, expressed in percent.

demand shocks identified combining sign restrictions and a narrative approach.

By breaking down terms of trade shocks into export price and import price shocks, we obtain some novel results. First, we show that the economy responds differently to export and import price shocks. While the effects of export price shocks seem to generate larger and more persistent effects on macro variables, the impact of import price shocks is more subdued. Second, taken together, export and import price shocks explain up to 40 percent of output fluctuations in the long run, which is in line with the predictions of a wide range of theoretical models but at odds with recent empirical evidence based on a single commodity price measure (like the terms of trade). Therefore, we argue that the so called "terms of trade disconnect" could be partly attributed to the fact that not all terms of trade shocks are alike.

Our empirical model allows for an additional world disturbance driven by global demand shocks, which is responsible for the documented strong correlation between import and export prices. Given that global demand shocks push export and import prices in the same direction, a large fraction of their impact on the underlying prices cancels out if we analyze a single commodity price like the terms of trade.

We extend our baseline analysis to assess how the impact of global disturbances differs depending on the pattern of export and import specialization across countries. Our results highlight that there is substantial heterogeneity. For export price shocks, this heterogeneity is driven by the size of the commodity export share: the larger the commodity export share, the larger the effect of export price shocks on business cycle variables.

Our empirical framework shows that terms of trade shocks are important and that their swings can have substantial effects on the economy. When we analyze the transmission of terms of trade shocks from the lens of a theoretical model, we find that our empirical findings are confirmed by theory.

A number of macroeconomic implications can be drawn from our results. First, policy makers' concern about fluctuations in the terms of trade seems to be well founded: movements in the terms of trade have substantial effects on business cycle variables. Second, given that a large share of developing country's business cycles is driven by global disturbances, it is important that policies are implemented to mitigate the potential negative impact of these shocks. For example, a country may benefit from running a counter-cyclical fiscal policy during commodity price booms as described in Céspedes and Velasco (2014). Our results highlight that business cycle variables of countries with more concentration in exports in one commodity, such as energy exporters, react more to export price shocks. Therefore, promoting policies aimed at a more diversified export sector could mitigate the disruption generated by terms of trade volatility.

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Appendix A Data

Our data set includes information on macroeconomic indicators, commodity prices, producer price indices (PPI), and country-specific sectoral export and import shares. This appendix describes the sources of data used in the paper.

A.1 Macroeconomic Data Sources

The country-specific macroeconomic data are from the World Bank's World Development Indicators (WDI) database. Specific details of these series are listed below:

Country-specific macro data:

1. GDP per capita in local currency units. Indicator code: NY.GDP.PCAP.KN
2. Gross capital formation as % of GDP. Indicator code: NE.GDI.TOTL.ZS
3. Imports of goods and services as % of GDP. Indicator code: NE.IMP.GNFS.ZS
4. Exports of goods and services as % of GDP. Indicator code: NE.EXP.GNFS.ZS
5. Household final consumption expenditure as % of GDP. Indicator code: NE.CON.PETC.ZS
6. GDP per capita, PPP (constant 2005 international $). Indicator code: NY.GDP.PCAP.PP.KD
7. Consumer Price Index (2010=100). Indicator code: FP.CPI.TOTL
8. Official Exchange Rate (LCU per US$, period average). Indicator code: PA.NUS.FCRF

The WDI database does not include CPI data for Argentina. We therefore sourced the CPI for Argentina from Cavallo and Bertolotti (2016).

The mean impulse responses reported in the paper are a weighted by the country's GDP. The GDP used for the weighting is the GDP, PPP (constant 2011 international $), with indicator code NY.GDP.MKTP.PP.KD.

The criteria for a country to be included in the sample is similar to the one in Schmitt-Grohé and Uribe (2018). In particular, a country needs to have at least 30 consecutive annual observations and to belong to the group of poor and emerging countries. The group of poor and emerging countries is defined as all countries with average GDP per capita at PPP U.S. dollars of 2005 over the period 1980-2016 below 25000 dollars according to the WDI database.

A total of 41 countries satisfy this criteria: Algeria, Argentina, Bangladesh, Bolivia, Brazil, Burkina Faso, Cameroon, Chad, Colombia, Congo, Cote d'Ivore, Dominican Republic, Egypt, Equatorial Guinea, Gabon, Ghana, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Madagascar, Malawi, Malaysia, Mauritius, Mexico, Morocco, Niger, Nigeria, Pakistan, Panama, Peru, Philippines, Senegal, South Africa, Sudan, Thailand, Tunisia, Turkey and Uruguay. However, our final sample has 38 countries as we exclude Malaysia, Panama, and Tunisia. The reason for excluding these countries is that our constructed terms of trade measure does not mimic the terms of trade data from the WDI. Coincidentally, Schmitt-Grohé and Uribe (2018) highlight that Panama has faulty terms of trade data and therefore they exclude it from their sample. We are not sure if the same is happening with the other two countries but we prefer to remain conservative and discard the countries for which our measure of terms of trade is not a good approximation of the official measure. Table A.1 reports the data coverage for each country.

World data:

Real world GDP at 2010 prices and 2010 exchange rates is sourced from Haver Analytics and includes the following countries: United States, Japan, Germany, France, United Kingdom, Italy, Canada, Spain, Netherlands, Australia, Switzerland, Belgium, Sweden, Austria, Denmark, Norway, Finland, Greece, Portugal, Ireland, New Zealand, Luxembourg, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, Uruguay, Venezuela, Macao, India, Indonesia, Malaysia, Pakistan, People's Republic of China-Mainland, People's Republic of China-Hong Kong, Philippines, Singapore, South Korea, Taiwan, Thailand, Vietnam, Poland, Czech Republic, Hungary, Slovakia, Slovenia, Estonia, Lithuania, Latvia, Russia, Ukraine, Romania, Bulgaria, Croatia, Albania, Kazakhstan, Israel, Turkey and South Africa. Real world GDP is calculated by Haver Analytics based on data from national statistical offices starting in 2001. Data from 1980 through 2000 are linked by Haver Analytics using the growth rates of the real world GDP series in the World Development Indicators (WDI) database. The indicator code for this series is A001GDPD@IMFWEO.

A.2 Export and Import Price Indices

As explained in the main text, we calculate country-specific export and import price indices denominated in US dollars using sectoral export and import shares, commodity prices, and sectoral U.S. PPI data as a proxy for manufacturing prices.

The weights for the calculation of export and import price indices are given by the products' trade shares. In order to calculate the trade shares, for each country, we obtain a time series of highly disaggregated product export and import values sourced from the MIT Observatory of Economic Complexity.[1] This dataset combines data from the Center for International Data from Robert Feenstra and UN COMTRADE. The product trade data are disaggregated at the 4-digit level and classified according to the Standard International Trade Classification, Revision 2 (SITC Rev. 2). Our sample consists of 988 categories but since we only have price information for 62 categories, the trade shares have to be reclassified so that we can match trade and price data. We therefore match the trade shares associated with each of the 988 categories with 46 commodity and 16 industry classifications for which we have price information. The matched information is then used to recalculate export and import shares for a total of 62 categories.[2] The sources of price data are detailed in Tables A.2 and A.3. Note that the manufacturing industries are classified according to the North American Industry Classification System (NAICS) code. In order to match the sectoral manufacturing price data with the trade shares, NAICS codes were reclassified to match with the SITC classification.

Once we have the series of weights obtained from the trade shares and prices for each of the categories, we calculate, for each country, the export and import price indices.

[1] The data can be accessed at https://atlas.media.mit.edu/en/

[2] The number of categories is dictated by the price data.

Table A.1: Macro Data Coverage

Country	Data
Algeria	1980 - 2016
Argentina	1987 - 2016
Bangladesh	1986 - 2016
Bolivia	1980 - 2016
Brazil	1980 - 2016
Burkina Faso	1980 - 2016
Cameroon	1980 - 2016
Chad	1983 - 2015
Colombia	1980 - 2016
Congo, Dem. Rep.	1980 - 2013
Cote d'Ivoire	1980 - 2016
Dominican Republic	1980 - 2016
Egypt, Arab Rep.	1980 - 2016
Equatorial Guinea	1985 - 2016
Gabon	1980 - 2016
Ghana	1980 - 2013
Guatemala	1980 - 2016
Honduras	1980 - 2016
India	1980 - 2016
Indonesia	1980 - 2016
Jordan	1980 - 2016
Kenya	1980 - 2015
Madagascar	1980 - 2016
Malawi	1980 - 2016
Mauritius	1980 - 2015
Mexico	1980 - 2016
Morocco	1980 - 2016
Niger	1980 - 2015
Nigeria	1981 - 2015
Pakistan	1980 - 2016
Peru	1980 - 2016
Philippines	1980 - 2016
Senegal	1980 - 2016
South Africa	1980 - 2016
Sudan	1980 - 2015
Thailand	1980 - 2016
Turkey	1980 - 2016
Uruguay	1982 - 2015

Notes: This table shows the data coverage for each of the countries included in our sample.

Table A.2: List of commodities

Commodity	Definition	Source
Crude oil	Average between Brent, Dubai and WTI	World Bank Commodity Price Data
Coal	Australian	World Bank Commodity Price Data
Natural gas	Natural gas index (average of Europe, US and Japan)	World Bank Commodity Price Data
Cocoa	International Cocoa Organization indicator	World Bank Commodity Price Data
Coffee	Average between arabica and robusta	World Bank Commodity Price Data
Tea	Average between Kolkata, Colombo and Mombasa	World Bank Commodity Price Data
Coconut oil	Philippines/Indonesia, bulk, c.i.f. Rotterdam	World Bank Commodity Price Data
Copra	Philippines/Indonesia, bulk, c.i.f. N.W. Europe	World Bank Commodity Price Data
Palm oil	Malaysia, 5% bulk, c.i.f. N. W. Europe	World Bank Commodity Price Data
Soybeans	US, c.i.f. Rotterdam	World Bank Commodity Price Data
Soybean oil	Crude, f.o.b. ex-mill Netherlands	World Bank Commodity Price Data
Soybean meal	Argentine 45/46% extraction, c.i.f. Rotterdam	World Bank Commodity Price Data
Barley	US	World Bank Commodity Price Data
Maize	US	World Bank Commodity Price Data
Rice	5% broken, white rice (WR), f.o.b. Bangkok	World Bank Commodity Price Data
Wheat	US, no. 1, hard red winter	World Bank Commodity Price Data
Banana	US import price, f.o.t. US Gulf ports	World Bank Commodity Price Data
Orange	navel, EU indicative import price, c.i.f. Paris	World Bank Commodity Price Data
Beef	Australia/New Zealand, c.i.f. U.S. port (East Coast)	World Bank Commodity Price Data
Chicken	Broiler/fryer, Georgia Dock, wholesale	World Bank Commodity Price Data
Sheep	New Zealand, wholesale, Smithfield, London	World Bank Commodity Price Data
Meat	Average of beef, chicken and sheep	World Bank Commodity Price Data
Sugar	World, f.o.b. at greater Caribbean ports	World Bank Commodity Price Data
Tobacco	General import , cif, US	World Bank Commodity Price Data
Cotton	Index	World Bank Commodity Price Data
Rubber	Any origin, spot, New York	World Bank Commodity Price Data
Aluminum	London Metal Exchange	World Bank Commodity Price Data
Iron ore	Spot in US dollar	World Bank Commodity Price Data
Copper	London Metal Exchange	World Bank Commodity Price Data
Lead	London Metal Exchange	World Bank Commodity Price Data
Tin	London Metal Exchange	World Bank Commodity Price Data
Nickel	London Metal Exchange	World Bank Commodity Price Data
Zinc	London Metal Exchange	World Bank Commodity Price Data
Gold	UK	World Bank Commodity Price Data
Platinum	UK	World Bank Commodity Price Data
Silver	UK	World Bank Commodity Price Data
Beverages	Index, 2010=100	World Bank Commodity Price Data
Food	Index, 2010=100	World Bank Commodity Price Data
Oils and Meals	Index, 2010=100	World Bank Commodity Price Data
Grains	Index, 2010=100	World Bank Commodity Price Data
Timber	Index, 2010=100	World Bank Commodity Price Data
Other Raw Mat.	Index, 2010=100	World Bank Commodity Price Data
Fertilizers	Index, 2010=100	World Bank Commodity Price Data
Metals and Minerals	Index, 2010=100	World Bank Commodity Price Data
Base Metals	Index, 2010=100	World Bank Commodity Price Data
Precious Metals	Index, 2010=100	World Bank Commodity Price Data

Notes: The first column of this table shows the list of all commodities used for the calculation of export and import prices, the second column displays the definition used for each commodity price, and the last column shows the the data source.

Table A.3: List of Manufacturing Industries

Industry	NAICS Code	Definition	Source
MUV Index		Index, nominal	World Bank
Processed Foods and Feeds	311, 312	PPI Index	FRED
Textile products and apparel	313, 314, 315	PPI Index	FRED
Hides, skins, leather, and related products	316	PPI Index	FRED
Chemicals and allied products	325	PPI Index	FRED
Rubber and plastic products	326	PPI Index	FRED
Lumber and wood products	321	PPI Index	FRED
Pulp, paper, and allied products	322, 323	PPI Index	FRED
Metals and metal products	331, 332	PPI Index	FRED
Machinery and equipment	333	PPI Index	FRED
Electronic components and accessories	334	PPI Index	FRED
Electrical equipment, appliances, and component manufacturing	335	PPI Index	FRED
Furniture and household durables	337	PPI Index	FRED
Nonmetallic mineral products	327	PPI Index	FRED
Transportation equipment	336	PPI Index	FRED
Miscellaneous products	339	PPI Index	FRED

Notes: The first column of this table shows the list of manufacturing sectors used to calculate export and import prices, the second column describes the NAICS code associated with each manufacturing group, the third column displays the definition used for each producer price index, and the last column shows the data source. Since all indices from the World Bank dataset have a base 2010=100 and those from the Federal Reserve Bank of St. Louis FRED have a base of 1982=100, we rebased the latter ones to 2010=100.

Table A.4: Commodity Info: 1980 - 1989

	Comm. Imp. %	Comm. Exp. %	Main Imports						Main Exports					
Algeria	29.7	97.5	Met. & Min.	6.5	Food	5.0	Wheat	4.8	Crude oil	76.7	Natural gas	19.8	Beverages	0.3
Argentina	25.0	76.2	Natural gas	5.1	Crude oil	3.5	Met. & Min.	2.4	Food	10.0	Soybean meal	7.2	Soybeans	7.0
Bangladesh	42.5	36.2	Wheat	8.5	Crude oil	7.7	Cotton	5.9	Other R. M.	13.2	Food	11.9	Tea	4.8
Bolivia	17.2	96.0	Met. & Min.	6.2	Wheat	4.1	Food	2.6	Natural gas	39.4	Tin	25.6	Gold	6.4
Brazil	46.5	59.3	Crude oil	21.1	Wheat	5.1	Fertilizers	3.3	Coffee	11.1	Iron ore	9.2	Soybean meal	6.9
Burkina Faso	30.0	94.0	Food	8.4	Met. & Min.	4.7	Crude oil	4.6	Cotton	35.0	Oils & Meals	20.3	Gold	14.8
Cameroon	22.7	96.8	Met. & Min.	6.1	Crude oil	3.6	Food	3.5	Crude oil	49.3	Cocoa	14.5	Coffee	13.9
Chad	21.6	93.4	Food	5.6	Wheat	2.7	Rice	2.1	Cotton	79.0	Crude oil	5.9	Other R. M.	5.1
Colombia	23.7	82.6	Crude oil	8.1	Met. & Min.	2.7	Food	2.3	Coffee	50.0	Crude oil	10.9	Banana	7.1
Congo, Dem. Rep.	21.0	80.8	Crude oil	6.6	Food	4.1	Met. & Min.	3.3	Copper	37.3	Crude oil	13.7	Coffee	12.4
Cote d'Ivoire	35.2	93.7	Crude oil	11.4	Food	8.9	Met. & Min.	4.5	Cocoa	31.5	Coffee	24.1	Timber	15.2
Dominican Republic	27.3	61.0	Food	4.9	Met. & Min.	3.9	Fertilizers	3.0	Sugar	21.3	Coffee	8.9	Gold	7.2
Egypt, Arab Rep.	35.8	89.3	Wheat	6.5	Food	5.2	Met. & Min.	3.7	Crude oil	72.8	Cotton	7.8	Aluminum	2.8
Equatorial Guinea	36.5	94.7	Fertilizers	7.2	Food	6.3	Beverages	6.2	Cocoa	45.0	Timber	31.3	Orange	6.0
Gabon	17.5	93.4	Met. & Min.	6.8	Food	3.1	Crude oil	1.6	Crude oil	74.1	Timber	10.3	Met. & Min.	7.1
Ghana	28.4	94.7	Crude oil	6.1	Aluminum	5.5	Food	5.0	Cocoa	53.0	Aluminum	22.7	Timber	7.3
Guatemala	29.8	82.3	Crude oil	8.4	Met. & Min.	4.1	Food	3.9	Coffee	37.2	Food	10.6	Cotton	8.0
Honduras	22.6	90.2	Crude oil	5.3	Food	4.8	Met. & Min.	4.1	Banana	35.8	Coffee	22.3	Food	9.9
India	34.1	44.6	Crude oil	9.4	Fertilizers	4.8	Met. & Min.	2.2	Food	7.4	Crude oil	6.4	Iron ore	5.7
Indonesia	33.5	91.0	Crude oil	15.8	Met. & Min.	3.3	Rice	2.0	Crude oil	52.0	Natural gas	14.8	Timber	4.9
Jordan	39.0	71.1	Crude oil	13.5	Food	5.8	Met. & Min.	3.7	Fertilizers	44.5	Food	9.7	Crude oil	4.1
Kenya	29.5	87.5	Crude oil	13.2	Met. & Min.	2.9	Palm oil	2.4	Coffee	33.5	Tea	23.8	Food	9.5
Madagascar	31.7	91.7	Rice	12.2	Crude oil	5.4	Met. & Min.	3.7	Food	40.8	Coffee	32.8	Met. & Min.	5.2
Malawi	10.9	96.0	Met. & Min.	3.7	Food	1.8	Fertilizers	0.9	Tobacco	57.2	Tea	19.3	Sugar	10.2
Malaysia	31.3	71.0	Crude oil	11.5	Food	3.9	Met. & Min.	2.9	Crude oil	19.0	Timber	15.0	Rubber	13.0
Mauritius	23.9	58.9	Food	7.3	Met. & Min.	3.2	Other R. M.	1.9	Sugar	52.5	Food	2.9	Tea	1.6
Mexico	23.7	62.8	Met. & Min.	3.5	Maize	2.3	Other R. M.	2.2	Crude oil	43.2	Food	5.7	Coffee	2.2
Morocco	37.7	67.0	Crude oil	9.2	Wheat	4.5	Fertilizers	4.0	Fertilizers	27.4	Food	17.9	Orange	8.9
Niger	22.8	14.3	Met. & Min.	4.1	Food	3.8	Crude oil	3.5	Met. & Min.	7.1	Crude oil	2.8	Other R. M.	1.0
Nigeria	25.6	99.3	Food	6.2	Crude oil	6.0	Met. & Min.	4.9	Crude oil	95.7	Cocoa	2.1	Other R. M.	0.3
Pakistan	45.2	39.2	Crude oil	20.3	Fertilizers	3.8	Tea	3.0	Cotton	13.6	Rice	9.7	Food	4.7
Panama	20.6	49.2	Crude oil	8.5	Food	3.0	Met. & Min.	2.9	Banana	18.8	Food	12.7	Crude oil	5.5
Peru	25.8	88.7	Met. & Min.	3.6	Wheat	3.6	Food	2.8	Crude oil	18.4	Copper	17.7	Zinc	10.0
Philippines	32.0	54.4	Crude oil	13.9	Food	2.9	Met. & Min.	2.3	Coconut oil	8.0	Food	7.6	Copper	7.0
Senegal	36.3	92.4	Food	8.0	Crude oil	6.1	Rice	5.1	Food	35.7	Oils & Meals	18.5	Fertilizers	17.4
South Africa	12.5	65.6	Met. & Min.	3.5	Other R. M.	1.5	Food	1.2	Coal	10.4	Gold	9.1	Platinum	8.9
Sudan	33.0	96.0	Crude oil	7.3	Wheat	5.9	Food	4.2	Cotton	35.3	Other R. M.	16.3	Grains	8.8
Thailand	30.3	66.2	Crude oil	11.3	Food	2.9	Met. & Min.	2.8	Food	22.9	Rice	11.8	Rubber	7.4
Tunisia	33.2	56.9	Crude oil	11.4	Met. & Min.	3.5	Wheat	2.9	Crude oil	32.0	Fertilizers	10.1	Food	9.7
Turkey	37.2	59.0	Crude oil	21.5	Fertilizers	2.3	Iron ore	1.9	Food	14.6	Grains	7.7	Crude oil	7.7
Uruguay	31.9	61.4	Crude oil	12.7	Other R. M.	2.6	Fertilizers	2.6	Gold	15.9	Beef	12.6	Other R. M.	9.9
Median	29.7	82.3		7.3		3.9		3.0		35.3		11.9		7.1

Table A.5: Commodity Info: 1990 - 1999

	Comm. Imp. %	Comm. Exp. %	Main Imports						Main Exports					
Algeria	36.9	85.6	Food	8.4	Wheat	8.0	Met. & Min.	3.2	Crude oil	60.6	Natural gas	23.9	Fertilizers	0.3
Argentina	18.1	69.7	Met. & Min.	2.7	Food	2.1	Crude oil	2.0	Food	11.8	Soybean meal	9.0	Crude oil	8.4
Bangladesh	31.9	15.6	Wheat	5.0	Crude oil	4.9	Food	3.8	Food	9.3	Other R. M.	2.8	Fertilizers	1.2
Bolivia	22.6	91.2	Wheat	4.8	Met. & Min.	3.7	Food	3.3	Natural gas	17.4	Tin	11.4	Gold	8.8
Brazil	30.6	49.3	Crude oil	7.9	Food	3.9	Coal	2.5	Iron ore	7.9	Coffee	4.9	Soybean meal	4.9
Burkina Faso	27.8	92.2	Food	6.9	Crude oil	5.2	Met. & Min.	3.5	Cotton	55.5	Gold	16.7	Food	7.4
Cameroon	28.8	96.4	Met. & Min.	4.7	Food	4.6	Crude oil	4.0	Crude oil	40.0	Timber	21.0	Cocoa	8.6
Chad	25.6	95.3	Wheat	5.5	Food	3.9	Met. & Min.	3.8	Cotton	83.0	Other R. M.	11.1	Oils & Meals	0.6
Colombia	21.4	72.8	Crude oil	3.8	Food	2.6	Met. & Min.	2.3	Coffee	22.1	Crude oil	21.8	Banana	7.2
Congo, Dem. Rep.	26.3	53.9	Food	5.4	Wheat	4.4	Met. & Min.	2.8	Copper	16.2	Met. & Min.	12.3	Crude oil	10.4
Cote d'Ivoire	30.6	90.0	Food	9.6	Crude oil	6.2	Met. & Min.	3.3	Cocoa	38.9	Timber	11.0	Coffee	10.8
Dominican Republic	26.2	24.6	Crude oil	7.6	Food	4.0	Met. & Min.	2.6	Sugar	4.7	Tobacco	4.0	Precious	3.6
Egypt, Arab Rep.	38.1	70.0	Wheat	9.2	Food	4.0	Timber	3.5	Crude oil	52.9	Food	4.8	Cotton	3.0
Equatorial Guinea	43.1	94.1	Beverages	9.2	Met. & Min.	7.5	Food	6.5	Timber	54.3	Crude oil	23.5	Cocoa	10.5
Gabon	22.6	97.0	Food	5.5	Met. & Min.	4.6	Beef	1.8	Crude oil	73.3	Timber	14.7	Met. & Min.	8.0
Ghana	24.3	80.2	Met. & Min.	4.5	Crude oil	4.0	Food	3.4	Cocoa	33.9	Aluminum	17.4	Timber	11.5
Guatemala	29.9	59.5	Crude oil	9.9	Food	4.4	Met. & Min.	3.0	Coffee	20.7	Food	10.0	Sugar	8.2
Honduras	29.8	57.2	Crude oil	10.2	Food	5.7	Met. & Min.	3.0	Banana	17.1	Food	15.9	Coffee	14.2
India	36.1	30.2	Crude oil	12.3	Fertilizers	3.7	Gold	2.8	Food	5.1	Met. & Min.	3.7	Iron ore	2.8
Indonesia	28.8	54.7	Crude oil	8.7	Met. & Min.	2.8	Other R. M.	2.5	Crude oil 16.1	Natural gas	10.7	Food	5.6	
Jordan	34.0	71.1	Food	5.8	Sugar	3.8	Wheat	3.6	Fertilizers	55.4	Food	5.1	Sheep	3.3
Kenya	24.0	80.6	Crude oil	4.3	Met. & Min.	2.9	Sugar	2.2	Tea	25.9	Coffee	19.2	Food	17.6
Madagascar	22.1	74.9	Food	4.7	Met. & Min.	3.7	Crude oil	2.3	Food	42.8	Coffee	13.4	Met. & Min.	4.6
Malawi	22.1	90.8	Fertilizers	5.3	Met. & Min.	4.4	Maize	2.7	Tobacco	67.2	Tea	9.4	Sugar	5.5
Mauritius	25.4	34.0	Food	6.3	Crude oil	4.0	Met. & Min.	2.7	Sugar	26.3	Food	3.3	Precious	1.6
Mexico	20.6	28.0	Met. & Min.	4.5	Food	2.6	Crude oil	2.1	Crude oil	14.0	Food	4.3	Met. & Min.	2.5
Morocco	38.9	46.1	Crude oil	11.0	Wheat	3.9	Fertilizers	3.0	Food	19.4	Fertilizers	13.0	Orange	5.3
Niger	29.5	20.3	Food	6.2	Sugar	3.6	Met. & Min.	3.5	Crude oil	15.6	Cotton	0.9	Food	0.8
Nigeria	20.0	98.3	Food	4.3	Met. & Min.	4.0	Crude oil	2.8	Crude oil	93.8	Cocoa	1.7	Rubber	0.8
Pakistan	42.7	18.9	Crude oil	12.7	Wheat	5.3	Palm oil	5.2	Cotton	6.8	Food	2.9	Rice	2.6
Peru	32.9	82.0	Crude oil	8.1	Wheat	4.0	Food	3.6	Copper	20.6	Zinc	12.6	Food	8.6
Philippines	27.9	27.5	Crude oil	10.5	Food	2.8	Met. & Min.	1.7	Food	6.8	Copper	3.4	Coconut oil	3.2
Senegal	40.0	86.6	Food	8.1	Crude oil	5.9	Rice	5.7	Food	44.6	Oils & Meals	14.2	Fertilizers	11.2
South Africa	15.4	64.7	Met. & Min.	2.9	Crude oil	2.3	Food	1.3	Gold	13.6	Platinum	9.2	Coal	8.6
Sudan	29.5	95.8	Wheat	8.1	Food	6.3	Met. & Min.	3.2	Cotton	29.1	Grains	17.9	Other R. M.	17.4
Thailand	25.2	34.2	Crude oil	8.6	Met. & Min.	3.3	Food	2.7	Food	14.4	Rice	4.4	Rubber	3.6
Turkey	33.3	30.6	Crude oil	11.2	Iron ore	3.0	Other R. M.	2.6	Food 10.3	Met. & Min.	3.5	Tobacco	2.8	
Uruguay	26.6	51.7	Crude oil	8.2	Food	2.9	Met. & Min.	2.4	Beef	11.8	Food	11.5	Rice	6.8
Median	26.6	69.7		6.2		4.0		2.8		20.6		10.3		5.5

Table A.6: Commodity Info: 2000 - 2016

	Comm. Imp. %	Comm. Exp. %	Main Imports						Main Exports					
Algeria	28.4	92.2	Food	6.3	Wheat	5.6	Met. & Min.	3.5	Crude oil	59.3	Natural gas	31.8	Fertilizers	0.3
Argentina	16.1	68.9	Met. & Min.	2.5	Natural gas	2.4	Crude oil	1.7	Soybean meal	12.4	Food	9.8	Crude oil	9.2
Bangladesh	36.6	7.3	Crude oil	5.6	Cotton	4.8	Palm oil	4.1	Food	4.4	Other R. M.	1.1	Fertilizers	0.4
Bolivia	22.0	91.7	Crude oil	5.9	Food	3.4	Met. & Min.	3.3	Natural gas	35.9	Soybean meal	9.3	Zinc	6.8
Brazil	29.5	56.5	Crude oil	11.2	Fertilizers	3.5	Food	2.2	Iron ore	10.7	Crude oil	6.6	Soybeans	6.2
Burkina Faso	29.3	89.9	Crude oil	5.5	Food	5.1	Met. & Min.	3.1	Cotton	49.1	Gold	23.4	Grains	6.7
Cameroon	38.5	92.0	Crude oil	14.3	Food	5.4	Met. & Min.	3.3	Crude oil	43.8	Timber	16.2	Cocoa	10.9
Chad	18.6	95.8	Met. & Min.	5.1	Food	3.5	Wheat	3.5	Crude oil	65.8	Cotton	23.3	Other R. M.	5.4
Colombia	18.8	69.9	Food	3.0	Met. & Min.	2.1	Crude oil	2.0	Crude oil	32.1	Coal	13.2	Coffee	6.4
Congo, Dem. Rep.	35.4	66.0	Food	7.1	Met. & Min.	5.3	Crude oil	5.0	Met. & Min.	25.4	Copper	21.1	Crude oil	12.5
Cote d'Ivoire	48.3	86.9	Crude oil	22.2	Rice	7.5	Food	6.5	Cocoa	41.8	Crude oil	13.1	Food	6.1
Dominican Republic	32.3	30.1	Crude oil	9.9	Food	4.8	Met. & Min.	2.6	Tobacco	5.8	Gold	4.3	Precious	3.6
Egypt, Arab Rep.	41.8	55.4	Wheat	5.4	Crude oil	5.3	Food	4.1	Crude oil	22.2	Natural gas	7.7	Food	7.7
Equatorial Guinea	20.9	96.2	Met. & Min.	7.9	Beverages	4.0	Food	2.6	Crude oil	82.8	Natural gas	9.4	Timber	3.0
Gabon	26.8	96.1	Food	5.4	Met. & Min.	5.0	Crude oil	2.7	Crude oil	73.2	Timber	12.0	Met. & Min.	9.8
Ghana	30.4	89.6	Crude oil	8.9	Food	4.7	Met. & Min.	3.7	Cocoa	37.0	Gold	13.4	Crude oil	9.0
Guatemala	30.2	54.3	Crude oil	9.7	Food	5.0	Met. & Min.	2.7	Food	12.1	Coffee	9.5	Sugar	7.6
Honduras	31.4	42.7	Crude oil	9.9	Food	6.5	Met. & Min.	2.5	Coffee	12.9	Food	10.8	Banana	3.9
India	49.0	29.5	Crude oil	19.7	Gold	9.0	Coal	3.1	Crude oil	4.9	Food	3.5	Precious	3.3
Indonesia	38.5	53.7	Crude oil	18.4	Food	2.6	Met. & Min.	2.3	Crude oil	9.5	Natural gas	8.2	Coal	7.7
Jordan	36.8	45.3	Crude oil	11.5	Food	4.8	Met. & Min.	2.1	Fertilizers	25.6	Food	7.7	Met. & Min.	2.7
Kenya	34.7	71.4	Crude oil	15.8	Palm oil	3.1	Met. & Min.	2.3	Tea	19.6	Food	16.1	Other R. M.	14.6
Madagascar	24.8	52.6	Met. & Min.	4.9	Food	4.7	Rice	2.8	Food	33.5	Met. & Min.	4.8	Nickel	4.6
Malawi	29.7	87.5	Fertilizers	6.1	Crude oil	4.5	Tobacco	3.7	Tobacco	56.2	Sugar	8.4	Tea	7.7
Malaysia	22.7	26.3	Crude oil	6.0	Food	2.3	Met. & Min.	1.9	Crude oil	6.8	Natural gas	5.2	Palm oil	4.8
Mauritius	33.4	35.9	Food	9.8	Crude oil	6.8	Met. & Min.	2.9	Sugar	15.4	Food	13.0	Precious	2.4
Mexico	17.7	23.6	Met. & Min.	4.1	Crude oil	2.6	Food	2.0	Crude oil	12.2	Food	3.3	Met. & Min.	2.5
Morocco	35.3	41.1	Crude oil	11.1	Natural gas	3.6	Wheat	3.1	Food	16.7	Fertilizers	11.5	Crude oil	3.0
Niger	32.4	43.4	Food	6.9	Tobacco	3.9	Palm oil	3.0	Crude oil	18.9	Met. & Min.	15.3	Food	2.3
Nigeria	26.5	95.5	Food	6.3	Wheat	3.7	Met. & Min.	3.6	Crude oil	85.4	Natural gas	6.2	Cocoa	1.2
Pakistan	42.7	21.9	Crude oil	18.6	Palm oil	4.2	Food	2.2	Rice	6.9	Food	3.6	Crude oil	2.0
Panama	12.7	43.7	Crude oil	3.7	Food	2.4	Met. & Min.	2.1	Food	12.8	Banana	9.7	Crude oil	5.9
Peru	32.2	81.3	Crude oil	13.0	Met. & Min.	2.8	Food	2.6	Copper	21.4	Gold	15.9	Food	9.5
Philippines	27.1	15.4	Crude oil	11.4	Food	3.0	Wheat	1.3	Food	3.1	Copper	1.7	Banana	1.7
Senegal	46.6	65.9	Crude oil	16.0	Rice	6.7	Food	6.1	Food	32.0	Crude oil	6.9	Oils & Meals	5.6
South Africa	28.1	53.0	Crude oil	15.8	Met. & Min.	2.1	Food	1.5	Platinum	10.3	Gold	7.6	Coal	6.5
Sudan	22.0	97.9	Met. & Min.	4.4	Food	4.4	Wheat	3.6	Crude oil	61.8	Gold	17.9	Grains	5.2
Thailand	33.8	25.7	Crude oil	14.6	Met. & Min.	3.5	Gold	2.7	Food	7.5	Rubber	3.3	Crude oil	2.6
Turkey	28.0	21.7	Crude oil	7.4	Iron ore	3.3	Gold	2.7	Food 6.2	Met. & Min.	4.5	Crude oil	2.0	
Tunisia	27.1	27.8	Crude oil	7.9	Natural gas	2.9	Met. & Min.	2.7	Crude oil	11.1	Food	7.2	Fertilizers	4.8
Uruguay	34.6	65.0	Crude oil	16.0	Food	3.9	Fertilizers	2.6	Beef	16.3	Food	13.0	Soybeans	7.5
Median	30.2	56.5		7.9		4.2		2.7		19.6		9.5		5.4

Appendix B Terms of Trade Restrictions

There is certain consensus in the literature that the resolution of the "disconnect" is likely to involve a combination of better empirical and theoretical models as means to interpret the data (Schmitt-Grohé and Uribe, 2018). Standard empirical models of terms of trade implicitly assume that the impact of an increase in export prices is the same as an equal size decrease in import prices. Since we have calculated separate statistics for export and import prices this is something that we can test in the data. In particular, for each variable of interest in the data set, we run the following regression in a panel framework:[3]

$$x_{ci,t} = a_0 + a_1 x_{ci,t-1} + \sum_{j=0}^{1} b_j^x P_{c,t-j}^x + \sum_{j=0}^{1} b_j^m P_{c,t-j}^m + D_c + \upsilon_{ci,t}, \tag{B.1}$$

where $x_{ci,t}$ is the log of the variable of interest i (quadratically detrended) for country c in year t; $P_{c,t}^x$ and $P_{c,t}^m$ are the log of export and import prices (quadratically detrended) for country c at time t, respectively; and D_c is a country fixed effect. Robust standard errors are adjusted for clustering at the country-year level. Noting that $ToT_{c,t} = P_{c,t}^x - P_{c,t}^m$ the regression above becomes particularly convenient to test the following hypothesis:

Hypothesis 1: *A positive shift in terms of trade has the same impact on the economy whether that originates from a positive shift in the price of exports or to a negative shift in the price of imports.* This restriction can be written as

$$H_0 : b_j^x = -b_j^m \text{ for } j = 0, 1.$$

The odd columns in Table B.1 show the results of the F-test for this hypothesis for each variable of interest. In all cases we reject the null hypothesis, which motivates the independent analysis of export and import prices.

It is also possible that foreign shocks that are hidden in the terms of trade statistics play an important role. This would be the case for global demand shocks, which imply a movement of export and import prices in the same direction. We test whether global demand matters for the small open economy beyond its impact on export and import prices extending the regression in (B.1) by directly including a measure of the global business cycle as follows:

$$x_{ci,t} = a_0 + a_1 x_{ci,t-1} + \sum_{j=0}^{1} b_j^x P_{c,t-j}^x + \sum_{j=0}^{1} b_j^m P_{c,t-j}^m + \sum_{j=0}^{1} b_j^g Y_{t-j}^g + D_c + \upsilon_{ci,t}, \tag{B.2}$$

where Y^g is the log of global GDP (quadratically detrended). As before, robust standard errors are adjusted for clustering at the country-year level. In this setting, we can test the following hypothesis:

Hypothesis 2: *The one world price specification assumes that the only foreign variable that matters of the transmission of world shocks is the terms of trade. This is a combination of the first hypothesis and the hypothesis that global demand shocks are transmitted only through their impact on export and import prices.* This restriction implies

[3] The panel structure allows us to increase the power of the test we perform to evaluate the restrictions.

Table B.1: Testing Terms of Trade Restrictions

	Output		Consumption		Investment		Trade Balance		Real Exchange Rate	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
F-test	9.29	9.66	5.57	4.54	12.9	8.35	6.73	5.02	35.38	21.9
	(0.000)***	(0.000)***	(0.004)**	(0.001)**	(0.000)***	(0.000)***	(0.001)**	(0.000)***	(0.000)***	(0.000)***

Notes: Odd columns report the result of the F-test for Hypothesis 1. Even columns include the F-test for Hypothesis 2. *p-values* in parenthesis. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

$$H_0 : b_j^x = -b_j^m \text{ and } b_j^g = 0; \text{ for } j = 0, 1.$$

The even columns of Table B.1 show the results of the F-test for this hypothesis, where in all cases we reject the null hypothesis.[4] These results suggest that in order to capture the transmission of foreign shocks in developing countries, an appropriate empirical model should contain two main ingredients: (i) a separate role for export and import prices, and (ii) alternative channels of transmissions of global disturbances that are not "visible" in the terms of trade statistics such as global demand shocks.

[4]The hypothesis that the global demand coefficient is equal to zero (without any restriction on export and import prices) is also rejected by the data.

Appendix C Narrative Approach

This appendix documents the construction of a narrative series of exogenous price shocks for the commodities analyzed. We examined historical documents to identify episodes of large commodity price changes that were unrelated to the state of the economy (i.e. were not demand driven). We then classified this episode as a negative or positive price shock, depending on the direction of the price change. This will ultimately translate into a negative or positive export or import price shock, for each country, depending on whether the country is an exporter or importer of that commodity.

The series were constructed by using a number of sources: Food and Agriculture Organization (FAO) reports, publications from the International Monetary Fund (IMF) and the World Bank (WB), newspaper articles, academic papers and a number of online sources. This was a painstaking task and we took careful attention to details. In order to establish some rules at the time of selecting the dates, we followed the criteria listed below.

1. The event has to be important enough to affect a commodity market at a global level. Examples of these are natural disasters or weather related shocks in key areas where the commodity is produced, and unanticipated news on the volume of global production or demand of commodities.

2. The event should have an unambiguous effect on the price of the commodity.

3. The event has to be unrelated to important macroeconomic developments such as the global financial crisis or a US recession. This aims at eliminating endogenous responses of commodity prices to the state of the economy.

By using this criteria we were able to identify 23 episodes of exogenous commodity price shocks that are unrelated to business cycle fluctuations. Of these events, 17 are favorable commodity price shocks and 6 are negative price shocks. In what follows we document the dates selected, organizing the commodities in the following subgroups: (1) Agriculture: Food and Beverage Commodities, (2) Agriculture: Raw Materials, (3) Fertilizers, (4) Metals and Mineral Commodities. At the end of this section, we document some country-specific assumptions.

C.1 Agriculture: Food and Beverage Commodities

i. Coffee

Year of Event: 1986.
Type of Event: Positive price shock.

A report from the International Coffee Organization (ICO) states that in 1986 Arabicas were in short supply following a drought in Brazil which triggered a large price increase.[5] In fact, our data show that between 1985 and 1986 Arabica coffee prices increased from 3.23 dollars per kilo to 4.29 dollars per kilo.

According to the IMF Primary Commodities Report from May 1987, “a prolonged period of dry weather in 1985 in the major coffee producing states of Parana, Sao Paulo, and Minas Gerais seriously disrupted and greatly reduced the flowering of coffee trees, which normally occurs between mid-September and early November. The rains that occurred in early November and in early December were insufficient to reverse the damage caused ot the 1986 crop. The 1986 crop in Brazil (April 1986-March 1987) was about 11 million 60-kilogram bags compared

[5] Report available at: `http://www.ico.org/news/icc-111-5-r1e-world-coffee-outlook.pdf`.

with the 26-28 million bag harvest which might have been expected with normal weather on an off-year int he two-year Brazilian production cycle." The same report highlights that coffee prices in 1986 averaged two thirds above those in the third quarter of 1985.

Newspaper Articles. A number of newspaper articles document the severity of the drought and the consequences on prices. An example is listed below.

Drought Damages Brazilian Coffee, The Washington Post (January 29, 1986):[6]

"A six-month drought has destroyed more than half of Brazil's coffee crop, leaving many local farmers devastated while promising large financial gains for speculators with coffee beans to hoard, as the cost of a cup of coffee rises around the world."

Year of Event: 1994.
Type of Event: Positive price shock.

According to a report from the International Coffee Organization (ICO), climate shocks which affected coffee prices were recorded in Brazil in 1994.[7] Our data are in line with this observation given that we observe that Arabica coffee prices increased from 1.56 dollars per kilo in 1993 to 3.31 in 1994.

Newspaper Articles. A newspaper article from the New York Times documents that the climate shock of 1994 in Brazil is related to a frost. Some important aspects of the article are quoted in what follows.

New Frost Hits Brazilian Coffee, New York Times (July 11, 1994):[8]

"Frost struck in Brazil's biggest coffee-growing state early today, and farmers said the effects were harsher than a freeze that hit two weeks ago."

"(...)Coffee prices soared after the previous cold snap late last month, which destroyed one-third of next year's crop. Brazil is the largest coffee producer, accounting for about a quarter of world production. A threat to its crop can drastically affect world coffee prices(...)."

ii. Cereal[9]

Year of Event: 1985.
Type of Event: Negative price shock.

Peersman (2018) documents that favorable weather in North America and exceptionally good cereal harvest in Western Europe in the fourth quarter of 1984 led to a decline in cereal prices. A report from the FAO indicates that "In developed countries food and agricultural production has gone up between 5% and 5.5%. Much of this increase is a consequence of the North American recovery from the sharp decline of 1983, reflecting both increased plantings and favorable weather. Western Europe also had exceptionally good harvests of cereals, and

[6] Article available at: `https://www.washingtonpost.com/archive/politics/1986/01/29/drought-damages-brazilian-coffee/94a07436-4f78-4f46-b4e7-d3924b13a2e3/?utm_term=.4fd4b80da637`.

[7] Report available at: `http://www.ico.org/news/icc-111-5-r1e-world-coffee-outlook.pdf`.

[8] Article available at: `https://www.nytimes.com/1994/07/11/business/new-frost-hits-brazil-coffee.html`.

[9] In our sample, we use cereal as a proxy for the category "food" as we observe that many countries are net food importers and evidence suggests that cereals are by far the most important source of food consumption. This fact is documented by the FAO and further information can be found at `http://www.fao.org/docrep/006/Y4683E/y4683e06.htm`.

some progress was made in the USSR and Eastern Europe."[10] Our data reveal a decline in grain prices from 1984 to 1985, when the index went from 63.27 to 53.54.

Year of Event: 1988.
Type of Event: Positive price shock.

As it will be explained below, in 1988 we observe positive price shocks for wheat, corn and soybean, therefore implying a positive price shock for cereal.

Year of Event: 1997.
Type of Event: Negative price shock.

As documented in Peersman (2018), in 1996 the FAO issued a favorable forecast for world 1996 cereal output.[11] The largest increase was expected in coarse grains output, mostly in developed countries. Overall, global cereal production increased by 7.8 percent that year and this translated into lower prices. Our data show that the cereal price index experienced a sharp reduction from 1996 to 1997, going from 83.61 to 64.76.

Year of Event: 2010.
Type of Event: Positive price shock.

Peersman (2018) documents that cereal output was seriously affected by adverse weather conditions in key producing countries in Europe. A group of countries that includes the Russian Federation, Kazakhstan and Ukraine suffered from a heatwave and droughts while the Republic of Moldova had floods. According to a report from the FAO, "International prices of grain have surged since the beginning of July in response to drought-reduced crops in CIS exporting countries and a subsequent decision by the Russian Federation to ban exports."[12]

iii. Cocoa

Year of Event: 2002.
Type of Event: Positive price shock.

According to a report from the International Cocoa Organization, the increase in cocoa prices in 2002 was largely due to an attempted coup on 19th September in Cote d'Ivore, which is the leading cocoa producing country. Uncertainty over potential disruptions emanating from the sociopolitical crisis and civil war pushed prices to a 16-year high at 2.44 dollars per tonne in October 2002.[13] Our data show that between 2001 and 2002 cocoa prices increased from 1.07 dollars per kilo to 1.78 dollars per kilo.

Newspaper Articles. A newspaper article from the New York Times documents the cocoa price increase originated in Cote d'Ivore in 2002. Some important aspects of the article are quoted below.

War Inflates Cocoa Prices But Leaves Africans Poor, New York Times (October 31, 2002):[14]

"As civil war raged in Ivory Coast, the world's biggest cocoa producer, speculative traders here and in New York sent prices this month to 17-year highs."

[10] Available at: `http://www.fao.org/docrep/017/ap664e/ap664e.pdf`.
[11] The FAO document is available at: `http://www.fao.org/docrep/004/w1690e/w1690e02.htm#I2`.
[12] Available at: `http://www.fao.org/docrep/012/ak354e/ak354e00.pdf`.
[13] `https://www.icco.org/about-us/international-cocoa-agreements/cat_view/30-related-documents/45-statistics-other-statistics.html`.
[14] Article available at: `https://www.nytimes.com/2002/10/31/business/war-inflates-cocoa-prices-but-leaves-africans-poor.html`.

iv. Corn

Year of Event: 1988.
Type of Event: Positive price shock.

The severe drought that affected the Farm Belt had a significant impact on corn prices in the 1988/1989 crop years. According to Karrenbrock (1989) corn yields were the most affected by the drought.[15] Our data feature a clear increase in corn prices from 1987 to 1988. In particular, prices went from 75.70 per tonne in 1987 to 106.89 per tonne in 1988.

Newspaper Articles. A newspaper article from the Los Angeles Times and another article from the New York Times document the severity of the drought and the impact on corn prices. Some important aspects of the articles are quoted below.

Commodities : Grain Prices Skyrocket in Response to Drought Report, Los Angeles Times (July 14, 1988):[16]

"Grain and soybean futures prices blasted out of their recent slump Wednesday in response to the government's report of severe drought damage to crops and forecasts for more hot, dry weather in the Farm Belt."

"Besides slashing its 1988 corn production estimate by 29% to a five-year low of 5.2 billion bushels, the USDA estimated soybean plantings this year at 58.52 million acres, a figure below the market's expectations, analysts said."

"(...) corn was 10 cents to 27.5 cents higher, with July at $3.335 a bushel; oats were 10 cents to 25.5 cents higher, with July at $3.045 a bushel, and soybeans were 30 cents to 69 cents higher, with July at $9.485 a bushel."

Drought Cutting U.S. Grain Crop 31% This Year, Los Angeles Times (August 12, 1988):[17]

"The Agriculture Department estimated that this nation's corn harvest might total no more than 4.47 billion bushels, down 2.6 billion bushels from last year."

"Analysts predicted that prices of corn and soybeans would rise sharply Friday."

v. Wheat

Year of Event: 1988.
Type of Event: Positive price shock.

A report from the FAO highlights some facts that are useful to understand the positive price shock in 1988.[18] Relevant aspects of the report are quoted below:

"World production of wheat fell again in 1988 to an estimated 511 million tons, slightly less than int he previous year but considerably below the last peak of 538 million tons in 1986. This decline was mainly the result of smaller crops in North America, where the wheat area decreased further and the principal growing areas suffered from the worst drought in half a

[15] `https://research.stlouisfed.org/publications/review/1989/05/01/the-1988-drought-its-impact-on-district-agriculture/`.

[16] Article available at: `http://articles.latimes.com/1988-07-14/business/fi-8706_1_grain-prices`.

[17] Article available at: `https://www.nytimes.com/1988/08/12/business/drought-cutting-us-grain-crop-31-this-year.html`.

[18] Commodity Review and Outlook 1988-89, Food and Agriculture Organization of the United Nations, page 53.

century. But there were declines in wheat production in Central and South America as well (...)"

Our data indicate that wheat prices went from 112.90 dollars per metric ton in 1987 to 145.20 dollars per metric ton in 1988.

vi. Soybeans

Year of Event: 1988.
Type of Event: Positive price shock.

The World Bank "Price Prospects for Major Primary Commodities, 1988-2000" documents that in 1988 there were droughts in the USA which severely affected soybean production.[19] In order to put the severity of the drought into perspective, it is important to mention that the report explains that in 1980 the United States produced 65 percent of the world's soybeans, and prices were close to a historical high at $296 per tonne. Therefore, it is not surprising to conclude that such a severe drought in a key area of production had the capacity to significantly affect total production and prices. Our data depict a sharp increase in soybean prices in 1988, going from 215.75 per tonne in 1987 to 303.50 in 1988.

Newspaper Articles. A newspaper article from Los Angeles Times supports the analysis. The key point is detailed below.

Commodities: Grain Prices Skyrocket in Response to Drought Report, Los Angeles Times (July 14, 1988):[20]

"Grain and soybean futures prices blasted out of their recent slump Wednesday in response to the government's report of severe drought damage to crops and forecasts for more hot, dry weather in the Farm Belt."

vii. Sugar

Year of Event: 1984.
Type of Event: Negative price shock.

According to a FAO report, sugar prices declined in 1984 to their lowest level in 13 years, reflecting a situation of oversupply.[21] Our data show that prices declined by 40 percent in 1984. Interestingly, in 1984 Pepsico Inc. and Coca-Cola Company decided to stop using sugar in favor or a corn based sweetener for their drinks, which was associated with a fall in current and future consumption of sugar.

Newspaper Articles. Some articles are informative to illustrate the importance of the change in sweetener for the two giants of the soft-drink industry for the sugar market. We include an example below.

Coke, Pepsi to use more con syrup, New York Times (November 7, 1984):[22]

"For the sugar industry, the announcements mark the end of its involvement with soft drinks (...)"

[19] http://documents.worldbank.org/curated/en/443751468739336774/Summary-energy-matals-and-minerals.
[20] Article available at: http://articles.latimes.com/1988-07-14/business/fi-8706_1_grain-prices.
[21] http://www.fao.org/3/a-ap664e.pdf
[22] Article available at: https://www.nytimes.com/1984/11/07/business/coke-pepsi-to-use-more-corn-syrup.html.

C.2 Agriculture: Raw Materials

i. Cotton

Year of Event: 1994.
Type of Event: Positive price shock.

A report from the U.S. International Trade Commission describes that the 1994 cotton price increase was driven by a decline in production in key production areas such as China, India, and Pakistan.[23] The decline in production in China is explained by bad weather and a bollworm infestation.

A study from the National Cotton Council of America explains that the price increase is also partly due to a recovery in world cotton consumption following the stagnation that resulted from the dissolition of the Soviet Union in the early 1990s.[24]

Our data indicate that cotton prices declined from 1.28 dollars per kilo in 1993 to 1.76 dollars per kilo in 1994.

Year of Event: 2003.
Type of Event: Positive price shock.

MacDonald and Meyer (2018) analyze the challenges faced when forecasting cotton prices in the long run. The article highlights that in 2003 there was a severe weather damage to cotton crops in China which resulted in a surge in cotton prices. In addition, an article from the National Cotton Council of America highlights that in the 2003 season, ‘’(...) USDA's forecast put world sticks at their lowest level since 1994/95, raising the specter of a world cotton shortage for the first time in nearly a decade.”[25]

Our data show that cotton prices increased from 1.02 dollars per kilo in 2002 to 1.40 dollars per kilo in 2003.

Year of Event: 2010.
Type of Event: Positive price shock.

Janzen, Smith and Carter (2018) analyze the extent to which cotton price movements can be attributed to comovement with other commodities vis-à-vis cotton specific developments. They point at the fact that in 2010-2011 cotton was scarce as a consequence of a negative supply shock generated by lower than average planted crops and negative weather shocks in the USA and Pakistan. This led to an increase in the price of cotton. The authors explain that this boom-bust appears to be cotton-specific, unlike other cases in which a set of macroeconomic factors drive the price of a broad range of commodities.

Our data confirm the findings of the paper. In fact, cotton prices increased from 1.38 dollars per kilo in 2009 to 2.28 dollars per kilo in 2010.

ii. Timber

Year of Event: 1993.
Type of Event: Positive price shock. Sohngen and Haynes (1994) explain that the 1993

[23] Article available at: `https://books.google.com/books?id=OZFDf6qLEosC&pg=SA3-PA5&lpg=SA3-PA5&dq=cotton+prices+1994&source=bl&ots=vi6JuOeGer&sig=DX9iSSIDP__dPIGTNKEfBO3FkSA&hl=en&sa=X&ved=2ahUKEwiJkOOWztneAhVkneAKHWFOCWs4ChDoATADegQIBRAB#v=onepage&q=cotton\%20prices\%201994&f=false`.
[24] Article available at: `https://www.cotton.org/issues/2005/upload/WorldCottonMarket.pdf`.
[25] Article available at: `https://www.cotton.org/issues/2005/upload/WorldCottonMarket.pdf`.

price spike was driven by the environmentally friendly policies that President Clinton issued to protect forests which limited the timber harvests.[26] The application of such policies in confirmed in the list of environmental actions taken by President Clinton and Vice President Al Gore and are documented in the White House Archives.[27] Our data reveal that the timber price index increased from 72.41 in 1992 to 100.58 in 1993.

Newspaper Articles. A newspaper article from the Washington Post documents this episode and describes how the environmental policy was viewed as a threat to the woods product industry.

Clinton to Slash Logging (July 2, 1993):[28]*.*

"To protect the region's wildlife and old-growth forests, the administration plan will allow for average timber harvests over the next decade of 1.2 billion board feet per year. That is about half the level of the last two years, and only a third of the average rate between 1980 and 1992, when annual harvests swelled as high as 5.2 billion board feet."

iii. Tobacco

Year of Event: 1989.
Type of Event: Positive price shock.

In a report from the FAO, it is explained that in 1989 tobacco prices in Malawi remained buoyant due to a shortage of this type of tobacco.[29] Our data show a 31 percent increase in the price of tobacco between 1988 and 1989.

Year of Event: 1993.
Type of Event: Negative price shock.

A report from the FAO highlights that the worldwide increase in competition for exports in 1993 led to a substantial fall in tobacco prices.[30] Our data reveal that tobacco prices declined 22 percent between 1992 and 1993.

C.3 Energy Commodities

i. Crude Oil

Year of Event: 1986.
Type of Event: Negative price shock.

The period of oil price decline which finalized in a large drop in 1986 is referred to in Hamilton (2013) as "the great price collapse." In particular, in 1986 Saudi Arabia abandoned the effort to keep oil prices high by reducing oil production which originated a very large oil supply shock. With Saudi Arabia increasing oil production, the price of oil declined from $27 a barrel in 1985 to $12 a barrel in 1986.

[26] Article available at: https://www.fs.fed.us/pnw/pubs/pnw_rp476.pdf.

[27] Available here https://clintonwhitehouse4.archives.gov/CEQ/earthday/ch13.html.

[28] https://www.washingtonpost.com/archive/politics/1993/07/02/clinton-to-slash-logging/f2266e63-f45f-4f88-bd1f-5f1a1edd820f/

[29] Commodity Review and Outlook 1993-1994, Food and Agriculture Organization of the United Nations, page 135. Available at https://books.google.co.uk/books?id=xwNp0dp0siEC&pg=PA154&lpg=PA154&dq=world+commodity+tobacco+prices+1993&source=bl&ots=Hm48B0nax6&sig=frnhLU3FFikaxD1d-Ngq_GfC6Uc&hl=en&sa=X&ved=2ahUKEwip09mhu6TeAhVM2qQKHU4CBM84ChDoATAGegQIAhAB#v=onepage&q=world\%20commodity\%20tobacco\%20prices\%201993&f=false.

[30] Commodity Review and Outlook 1993-1994, Food and Agriculture Organization of the United Nations, page 156.

Year of Event: 1990.
Type of Event: Positive price shock.

As explained in Hamilton (2013), this is the period marked by the first Persian Gulf War. Oil production in Iraq collapsed when the country invaded Kuwait in August 1990. The reduction in oil production together with the uncertainty that the conflict may spill over into Saudi Arabia led to the oil price almost doubling within a few months.

ii. Natural Gas

Year of Event: 2000.
Type of Event: Positive price shock.

The Energy Information Administration (EIA) documents the California energy crisis of 2000-2001.[31] In terms of natural gas, a report from the Task Force on Natural Gas Market Stability finds that "the 2000-2001 California natural gas crisis resulted in major part from a perfect storm of sudden demand increase, impaired physical capacity, natural gas diversion, and inadequate storage fill. The quick summary is as follows: Low hydroelectric availability in 2000, coupled with a modest increase in overall power needs resulted in a substantial increase in gas-fired generation usage, with little preparation."[32] A study from the Federal Reserve Bank of San Franciso documents the natural gas price increase in 2000.[33] Our data show that the natural gas price index jumped from 39.78 in 1999 to 73.85 in 2000.

Year of Event: 2005.
Type of Event: Positive price shock.

An article from the "Oil and Gas Journal" highlights that the effects of Hurricanes Katrina and Rita were the main source of the price increase. Some details of the article are quoted below.[34]

"The combined effects of the 2004 and 2005 hurricane seasons had an impact across all sectors of the US gas industry. Hurricane Ivan, which made landfall in September 2004, caused more long-term gas production interruptions than any previous hurricane, but its impacts were dwarfed by Hurricanes Katrina (landfall Aug. 29, 2005) and Rita (Sept. 24, 2005). The combined effects of Hurricanes Katrina and Rita were by far the most damaging in the history of the US petroleum industry."

A report from the Federal Energy Regulatory Commission highlights the following:[35]

"The pump was primed for significant energy price effects well before Hurricanes Katrina and Rita hit the Gulf Coast production areas in September. The Gulf storms exacerbated already tight supply and demand conditions, increasing prices for fuels in the United States further after steady upward pressure on prices throughout the summer of 2005. Most of this was due to increased electric generation demand for natural gas caused by years of investment in gas-fired generation and a significantly warmer-than-average summer. Supply showed some weakness despite increasing numbers of active drilling rigs. The result was broadly higher energy prices."

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[31] https://www.eia.gov/electricity/policies/legislation/california/subsequentevents.html

[32] http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/Introduction\%20to\%20North\%20American\%20Natural\%20Gas\%20Markets_0.pdf.

[33] https://www.frbsf.org/economic-research/publications/economic-letter/2001/february/economic-impact-of-rising-natural-gas-prices/#subhead3.

[34] https://www.ogj.com/articles/print/volume-104/issue-36/general-interest/us-gas-market-responds-to-hurricane-disruptions.html.

[35] https://www.ferc.gov/EventCalendar/Files/20051020121515-Gaspricereport.pdf.

Our natural gas index data shows a clear spike in 2005, going up from 95.39 in 2004 to 142.40 in 2005.

Newspaper Articles. The increase in natural gas prices in the aftermath of the hurricanes received media attention. An example from NBC News is included in what follows.[36]

"Gas prices in cities across the United States soared by as much as 40 cents a gallon from Tuesday to Wednesday, a surge blamed on disruptions by Hurricane Katrina in Gulf of Mexico oil production."

C.4 Fertilizers

Year of Event: 1984.
Type of Event: Positive price shock.

According to a report from the FAO, the demand for fertilizers rebounded in 1984, leading to a price increase.[37] This observation is supported by the "Proceedings of the 34th Annual Meeting of the Fertilizer Industry Round Table 1984."[38] Our data reveal a considerable increase in fertilizer prices in 1984. Specifically, the index went from 29.47 in 1983 to 36.62 in 1984.

C.5 Metals and Mineral Commodities

i. Copper

Year of Event: 1981.
Type of Event: Negative price shock.

A report from the US Department of the Interior titled "Metal Prices in the United States through 1998" highlights that in 1981 copper prices were low due to a large growth in US and world production combined with rising inventories. Our data feature this price decline. In fact, our data show that copper prices went down from 1774.91 per tonne in 1980 to 1262.73 in 1981.

ii. Iron ore

Year of Event: 1982.
Type of Event: Positive price shock

According to "Metal Prices in the United States through 1998" iron ore production in the U.S. fell from 73.4 million tons in 1981 to 36.0 million tons in 1982. This decline in production was accompanied by a price increase, which we observe in our data. In fact, prices went up from 28.09 per dry metric ton in 1981 to 32.50 per dry metric ton in 1982.

C.6 Country-Specific Assumptions

In order to implement the narrative restrictions, a number of adjustments were necessary. In what follows we list the country-specific assumptions and clarify some events characteristics.

- The rule for associating a particular event to an export or import price shock is given by whether the country is an exporter or importer of that commodity. Following this rule,

[36] http://www.nbcnews.com/id/9146363/ns/business-local_business/t/pump-prices-jump-across-us-after-katrina/#.W3NQbehKiUk.
[37] http://www.fao.org/3/a-ap664e.pdf.
[38] http://www.firt.org/sites/default/files/pdf/FIRT1984.pdf.

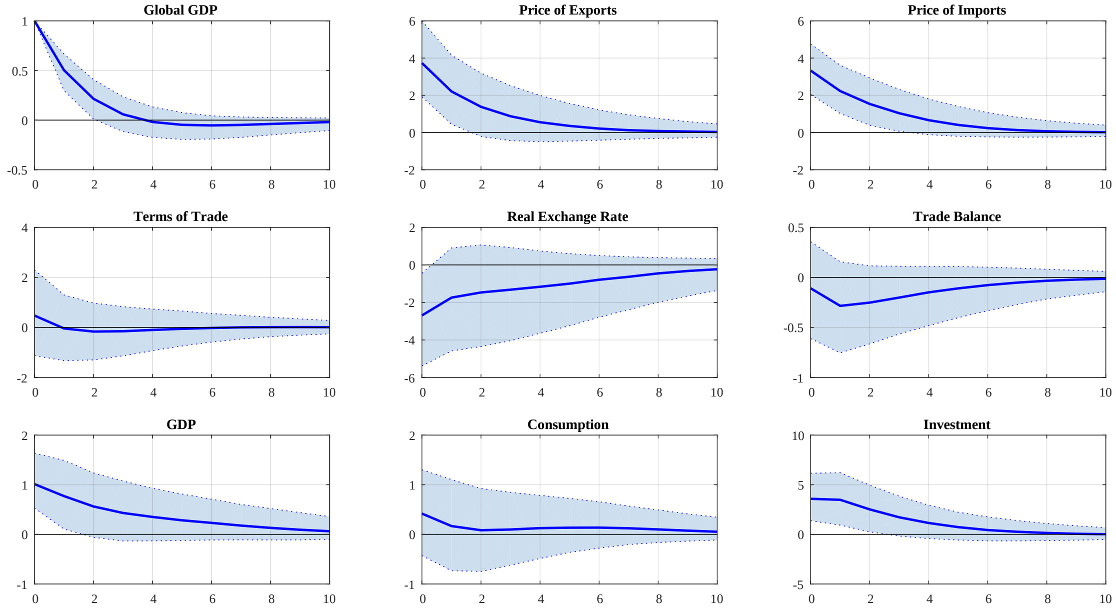
there are two cases in which the narrative restrictions translate into a positive export price shock originated in one commodity and a negative export price shock stemming from another commodity for the same year. Specifically, for Cameroon and Congo in 1986 we have a combination of a positive export price shock originated from coffee and a negative export price shock originated from crude oil. In this case, we attributed the sign of the export price shock according to the commodity that represents the larger weight in the export share. Since both for Cameroon and Congo oil exports represent a higher share than coffee exports in that year, the oil price shock dominates the coffee price shock, and therefore the coffee price shock is eliminated from the narrative.

- When an event is due to weather conditions or political events of a specific country, we exclude such event for that country. These cases are:
  - The coffee price shock in 1986 which was caused by droughts in Brazil. We therefore did not use this shock as part of the narrative restrictions for Brazil.
  - The cocoa price shock of 2002 was driven by an attempted coup in Cote d'Ivoire. Given that the country was suffering the consequences of a civil war with rising tensions we did not use the 2002 date for the narrative restrictions in this country.

- Some countries are exporters and importers of certain commodities in the same year. When this happens an event would serve both as an export price and import price shock. In our sample these happens for two events involving three countries:
  - The negative oil price shock in 1986 implies a negative export price shock and a negative import price shock for Indonesia and Nigeria.
  - The positive oil price shock in 1990 serves as a positive export price shock and a positive import price shock for Turkey.

Appendix D Empirical Evidence on Global Demand Shocks

Figure D.1: Impulse Responses to a Global Demand Shock: All Countries



Notes: The figure shows the impulse responses to a global demand shock for all countries using a VAR with sign and narrative restrictions. The red solid lines denote the mean response weighted by each country's size proxied by their GDP (PPP) and the dashed lines represent the 16^{th} and 84^{th} percentile error bands.

Table D.1: Forecast Error Variance Decomposition: Global Demand Shock

	Export Prices	Import Prices	Terms of Trade	Real Exchange Rate
0	33.08	40.98	23.11	12.21
1	32.37	40.97	24.37	15.21
4	32.08	40.27	25.88	18.79
10	31.79	39.30	25.83	19.93
	Trade Balance	**Output**	**Consumption**	**Investment**
0	10.65	17.99	8.60	15.72
1	16.18	20.52	11.26	22.06
4	20.39	23.35	14.19	25.55
10	21.22	24.02	15.61	25.68

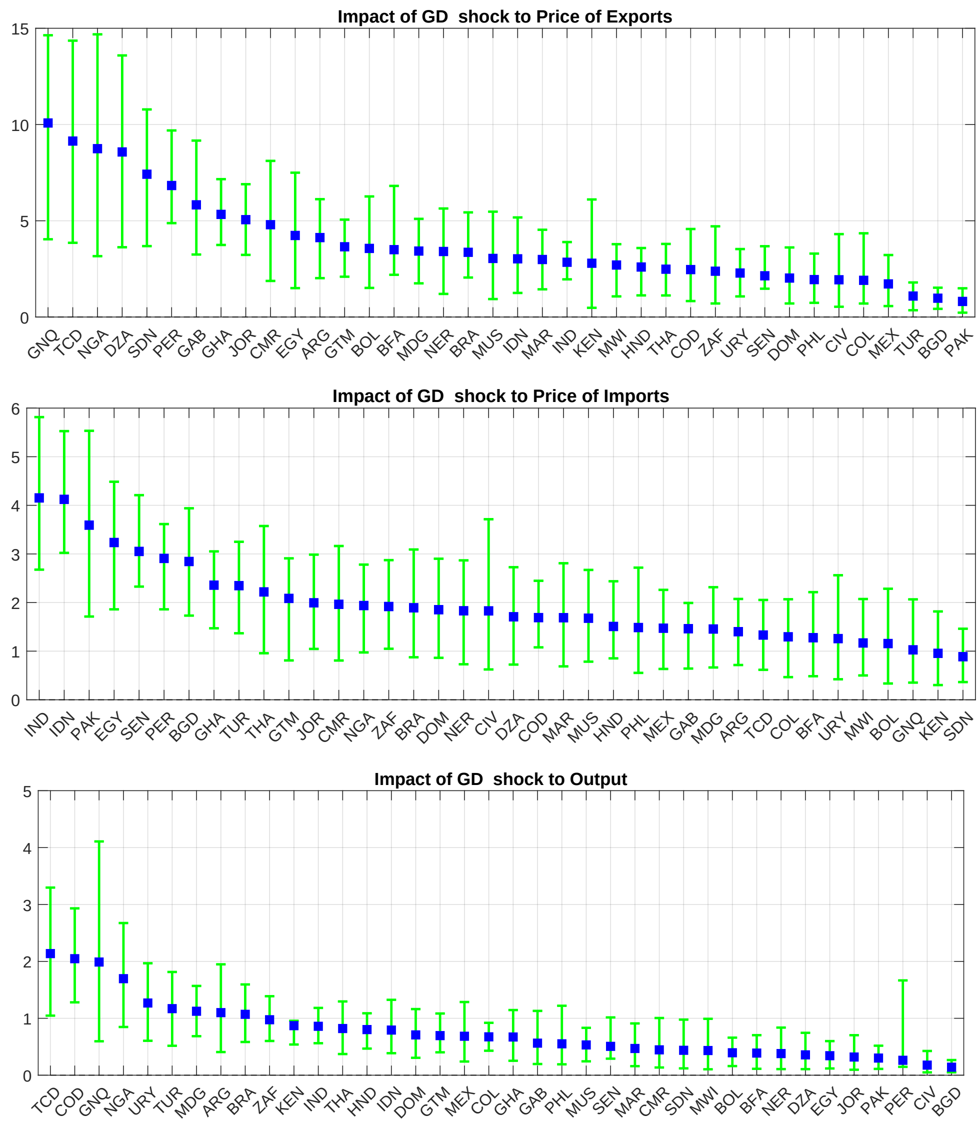
Notes: The table shows the forecast error variance decomposition of all the variables in the VAR for *GD* shocks on impact, at a 1-year, 2-year, 4-year and 10-year horizons. Reported are mean values weighted by each country's size proxied by their GDP (PPP).

Appendix E Cross-Country and Group Heterogeneity

E.1 Cross-Country Heterogeneity

Figure E.1 depicts the impact impulse response (blue square) of export prices, import prices and output to a one standard deviation shock in GD. We observe that the effects on export prices are higher than on import prices. Interestingly, the countries with the largest increase in export prices following a GD shock do not coincide with those showing the largest increase in import prices. The impact on output is heterogeneous across countries but large.

Figure E.1: Heterogeneous Effects of GD Shocks on Export Prices, Import Prices and Output



Notes: The figure shows the impact impulse response (blue square) on export prices, import prices and output (in %) for each country in the sample to a one standard deviation shock in GD. The green lines represent 16th and 84th percentile error bands.

Table E.1 shows the estimates of the determinants of the impact impulse responses of export prices, import prices, the terms of trade, output and the trade balance to a GD shock for the cross-section of countries.[39] Since in this case we are looking at the impact of one shock we

[39] As before, the impact impulse response is defined as a 1 standard deviation shock in GD multiplied by 100

Table E.1: Determinants of the Impulse Responses to a Global Demand Shock

	IRF P^x	IRF P^m	IRF ToT	IRF Y	IRF TB
GDP Per Capita (PPP)	0.566**	0.059	0.462	0.058	-0.096
	(0.218)	(0.035)	(0.663)	(0.039)	(0.089)
Commodity Export Share	0.046***	-0.004	0.059***	-0.002	0.001
	(0.009)	(0.003)	(0.007)	(0.001)	(0.003)
Commodity Import Share	0.064**	0.033***	-0.019	-0.016**	-0.005
	(0.030)	(0.006)	(0.176)	(0.007)	(0.010)

Notes: The commodity export and import shares are the same as the ones reported in Table 1 of the main text. In all columns the total number of observations is 38 and the regression is robust to outliers. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

use as regressors the GDP per capita (PPP), the commodity export share and the commodity import share.[40] We find that countries which have a higher commodity export share exhibit, on average, a larger response of export prices and the terms of trade after a GD shock. By contrast, the results suggest that countries which have a higher commodity import share display a larger response of import prices and export prices after a GD shock.

E.2 Analysis by Export and Import Group

We analyze the effects of P^x, P^m, and GD shocks by grouping the countries according to whether they are exporters or importers of main commodity groups. For exporters, we split the countries into agriculture (food and beverages), energy, manufacturing, metal and minerals (including precious metals) and agriculture raw materials (plus fertilizers).[41] A country is classified as an exporter for a given commodity if more than 25 percent of its commodity export share is within a particular commodity class. A country falls into the manufacturing exporter category if less than 30 percent of its exports are commodities.[42] For importers, we divide the countries into agriculture (food and beverages), energy, and manufacturing importers. A country is included in the category of importer of a given commodity if more than 15 percent of its commodity import share is within a particular commodity class. A country is classified as a manufacturing importer if less than 30 percent of its imports are commodities. The difference in the threshold for the classification of exporters and importers in each commodity group reflects the lower average share of commodities in imports and exports.[43]

and we perform robust to outliers regressions.

[40]We also run separate specifications in which we have export and import characteristics in separate regressions as in Table 7 and the results remain robust. We do not include them here to preserve space but are available upon request.

[41]We bundled precious metals into the metal category as otherwise we would have no countries in the precious metal exporters category. This happens because precious metal exports do not represent a large enough share of exports. Therefore, we can think of this group as related to mining activity and including both industrial and precious metals. In addition, we included fertilizers into the agriculture raw materials group because otherwise we were left with a very small group on its own.

[42]The following countries are agriculture (food and beverages) exporters: Argentina, Brazil, Colombia, Cote d'Ivoire, Ghana, Guatemala, Honduras, Kenya, Madagascar, Malawi, Mauritius, Senegal, Sudan, Thailand, and Uruguay. Energy exporters are Algeria, Bolivia, Cameroon, Chad, Colombia, Egypt, Equatorial Guinea, Gabon, Indonesia, Nigeria, and Sudan. The following countries are metal exporters: Bolivia, Congo, Peru, and South Africa. Manufacturing exporters are Bangladesh, Niger, Pakistan and Philippines. Finally, agriculture raw materials (plus fertilizers) exporters are Burkina Faso, Chad, Equatorial Guinea, Jordan, Malawi, and Sudan.

[43]The country split is as follows. Manufacturing importers is composed of Argentina, Bolivia, Burkina Faso, Chad, Colombia, Congo, Dominican Republic, Gabon, Ghana, Honduras, Madagascar, Malawi, Mauritius,

The impulse responses for each export group are summarized in Figures E.2, E.3, E.4 while for each import group they are included in Figures E.5, E.6, E.7. Each color denotes a sector: agriculture (food and beverages) is in green, energy in magenta, manufacturing in red, metals in blue, agriculture raw materials (plus fertilizers) in turquoise, and for comparison purposes the results for all countries are in black (with the corresponding dashed confidence bounds). The solid lines denote the mean response weighted by the country's size proxied by their GDP. The squares denote that zero is not within the 68 percent confidence band.

E.3 Agriculture: Food and Beverage Commodities

Figures E.2, E.3, E.4, show the impulse responses for agriculture exporters (in green) while Figures E.5, E.6, E.7 display the impulse responses for agriculture importers (also in green). For comparison, the impulse responses for all countries are shown in black in the same figure.

The impulse responses for agriculture exporters share the overall trends with respect to all countries but some contrasts are present. Specifically, as a response to a P^x shock, GDP, consumption and investment increase by more on impact with respect to the sample of all countries. Following a P^m shock we observe that the path for GDP follows very closely the result for all countries while the responses of consumption and investment are statistically insignificant. After a global demand shock the responses of export prices and import prices are similar to the ones for the whole sample.

Some interesting differences appear when we look at the results of agriculture importers. As a response to a 1 percent P^x shock, the trade balance improves around 0.1 percent, which is the largest change compared to all other groups. By contrast, the response on GDP is modest, only improving about 0.06 percent. A P^m shock leads to a modest decline in output while the impact on consumption, investment and the trade balance are insignificant. A global demand shock leads to an increase in both export and import prices. The impact on export prices is slightly larger than for the sample comprising all countries while the effect on import prices is moderately smaller.

Tables E.2 and E.3 show the forecast error variance decomposition of international prices and business cycle variables, respectively for each commodity group. Focusing on the effects on GDP for agriculture exporters, the export price shock explains up to 32 percent of the variance of GDP while the import price shock explains up to 12 percent at a 10-year horizon (jointly explaining 44 percent of the variance of GDP). For agriculture importers, the share of GDP variance explained by the sum of P^x and P^m shocks goes from 17 percent on impact to 40 percent at a 10-year horizon. For agriculture exporters, we observe that the global demand shock explains up to 32 percent of export prices and 32 percent of import prices. However, it only explains up to 23 percent of the variation in terms of trade. The pattern is similar for agriculture importers, where global demand shocks explain up to 30 percent of the variation in export prices, 36 percent of the variation in import prices, and only 26 percent of the variation in terms of trade.

E.4 Energy

The impulse responses for energy exporters are shown (in magenta) in Figures E.2, E.3, E.4. The ones for energy importers are displayed (in magenta) in Figures E.5, E.6, E.7.

Mexico, Niger, Nigeria, Philippines, South Africa and Sudan. The group of agriculture (food and beverages) importers includes Algeria, Bangladesh, Burkina Faso, Congo, Cote d'Ivoire, Egypt, Equatorial Guinea, Jordan, Madagascar, Mauritius, Niger, Senegal and Sudan. Energy importers are Brazil, Cote d' Ivoire, India, Indonesia, and Pakistan.

Let us first focus on the results for energy exporters, which offer some interesting differences with respect to the ones for all countries. Let us recall from Section 2 that energy exporters are the group which depends most heavily on commodity exports, judged by the share of commodity exports in total exports. In addition, this group conveys the highest concentration of exports in a single commodity, which is typically crude oil, although in some countries natural gas also plays a key role.[44]

A positive P^x shock causes an expansion in GDP, which is smaller than the increase obtained for the whole sample. In particular, a 1 percent increase in P^x leads to a 0.06 percent of GDP increase on impact. Private consumption contracts on impact and then recovers but the response is statistically insignificant. The 1 percent increase in P^x leads to a 0.05 percent real exchange rate appreciation on impact which reverts very slowly. In contrast to the results for all countries, the trade balance improves around 0.1 percent on impact and then converges to its trend path. The positive effect on the trade balance, consistent with the HLM effect, could partly be related to the fact that exports are very concentrated in the energy commodities, which have a relatively low degree of substitutability. A P^m shock leads to a negative effect on GDP which follows closely the results for the whole sample of countries. In addition, the exchange rate depreciates 2 percent on impact. The effects on the trade balance, consumption and investment are insignificant.

In response of a GD shock, export prices exhibit a larger effect compared to the sample of all countries. Specifically, we observe that a one percent increase in global demand leads to a 6 percent increase in export prices on impact, which is about forty percent higher than the effect of global demand on export prices for the sample which includes all countries. The real exchange rate appreciates about five percent on impact and reverts to 2.5 percent after a year. Interestingly, the effects on GDP are very persistent and show a peak response at a 2-year horizon. This response illustrates the high exposure of energy exporters to the global business cycle. The variance decomposition in Table E.2 indicates that, taken together, P^x and P^m shocks explain up to 36 percent of GDP in the energy exporters group. In turn, global demand shocks explain up to 28 percent of export prices, 45 percent of import prices and 25 percent of the terms of trade.

We now focus on the responses for energy importers. The description from Section 2 suggests that this group of countries exhibits a high concentration of commodities in total imports. By contrast, their export structure does not have a defined pattern, as the countries are specialized in exports across the different commodity groups. By and large, the shape of the responses to a P^x shock follow the ones for the whole sample. However, we observe that the export price shock has a larger effect on consumption and GDP while. Interestingly, the import price shock leads to a decline in output and exchange rate appreciation which is comparable to the results for the whole sample. Following a global demand shock, we observe a larger impact on import prices for energy importers. In particular, a 1 percent increase in global demand leads to a 4 percent increase in P^m. The variance decomposition in Table E.2 shows that global demand shocks explain between 48 and 44 percent of the variation in import prices on impact and at a 10-year horizon, respectively; and between 40 and 36 percent of the variation in export prices in the same horizon period. By contrast, they explain 27 of the variance in terms of trade at a 10-year horizon.

[44] As an example, this is the case in Bolivia.

E.5 Manufacturing

Figures E.2, E.3, and E.4 show the impulse responses for manufacturing exporters (in red) while the impulse responses for manufacturing importers are displayed in Figures E.5, E.6, and E.7.

Let us first focus on the results for manufacturing exporters. A positive P^x shock leads to an exchange rate appreciation which is larger than the one observed for all countries. Specifically, a 1 percent increase in P^x leads to a 0.7 percent decline in the real exchange rate. We also observe an increase in output, which is smaller than the response for the whole sample, and a hump-shape response of investment. By contrast, the response of consumption is insignificant. A positive P^m shock leads to a decline in output and exchange rate depreciation which are smaller in magnitude compared to the whole sample of countries. The global demand shock has a smaller impact on export prices and GDP for manufacturing exporters. Specifically, we observe that a 1 percent increase in global demand leads to a 2 percent increase in export prices on impact. The variance decomposition in Tables E.2 and E.3 show that export and import price shocks jointly explain only 13 percent of the variation of output on impact and 39 percent of the variation of output at a 10-year horizon. Global demand shocks explain 22 percent of the variation in export prices and 37 percent of the variation of import prices at a 10-year horizon.

We now turn to the results for manufacturing importers. A P^x shock leads to an expansion of output, an increase in investment and an exchange rate appreciation. Specifically, in response to a 1 percent increase in P^x, output increases 0.2 percent while investment increases 0.6 percent. The real exchange rate appreciates 0.8 percent on impact. After a P^m shock, these groups of countries have a larger decline on GDP and the exchange rate depreciates twice as much with respect to the results for the whole sample. In particular, after a 1 percent increase in P^m, GDP contracts 0.4 percent and the exchange rate depreciates 1.5 percent. Focusing on the global demand shock, we observe that a 1 percent increase in global demand leads to a 4 percent increase in export prices and a 2 percent increase in import prices. From the variance decomposition in Tables E.2 and E.3 it follows that, taken together, P^x and P^m shocks explain 45 percent of the variation of output at a 10-year horizon. The global demand shock explains 28 percent of the variation in export prices and 34 percent of the variation in import prices at a 10-year horizon while only explaining 21 percent of the variation in terms of trade at the same forecast horizon.

E.6 Metals and Minerals

The results for metal exporters, shown in figures E.2, E.3, and E.4 in blue display contrasting results with respect to the whole sample of countries (in black). Let us first focus on real business cycle variables. A positive P^x shock causes an increase in GDP which is, on impact, slightly smaller than the magnitude for the whole sample of countries. Investment displays an initial increase on impact with a peak response after one year. Specifically, a 1 percent increase in P^x causes an increase of 0.1 percent of GDP on impact, while investment increases 0.5 percent on impact, 0.7 percent at a 1-year horizon and then declines gradually. It is interesting to observe that in response to a P^x shock the real exchange rate appreciates by about 0.6 percent on impact while the trade balance improves on impact but then deteriorates but the response is not statistically significant.

A positive P^m shock leads to a decline in GDP, and a drop in investment. In particular, a 1 percent increase in P^m leads to a 0.4 contraction in output and a 1.8 percent decline in investment at a 1-year horizon.

In response to a global demand shock, we observe an increase in GDP and investment. Specifically, a 1 percent increase in global GDP leads to a 1 percent increase in output on impact, while investment goes up by 4 percent on impact.

The variance decomposition indicates that, taken together, P^x and P^m shocks explain up to 35 percent of output fluctuations. In turn, global demand shocks explain up to 30 percent of export price and 36 percent of import price fluctuations. Moreover, global demand shocks explain 21 percent of the variation of output on impact. As it is the case for energy exporters, these groups of countries are very exposed to the global business cycle.

E.7 Agriculture Raw Materials (plus fertilizers)

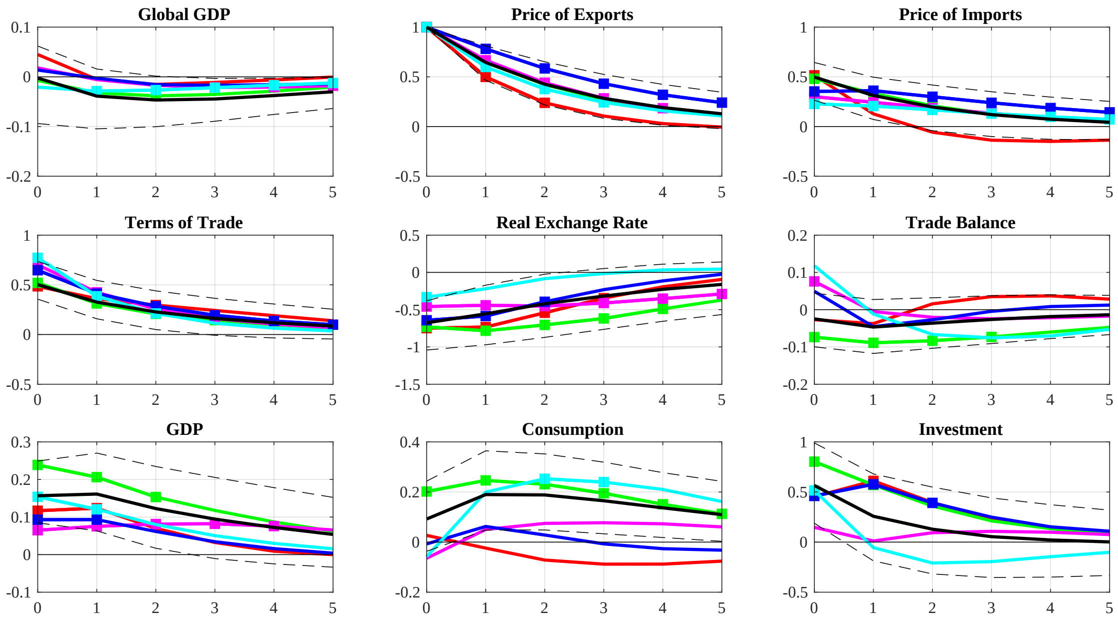
The results for agriculture raw material plus fertilizers exporters are shown in Figures E.2, E.3, and E.4 (in turquoise). A positive P^x shock leads to an increase in output, consumption and investment. The real exchange rate appreciates on impact and then quickly mean reverts while the trade balance show no significant response.

After a P^m shock, output, and investment go down, the exchange rate depreciates while consumption and the trade balance display no significant response.

In response to a one percent global demand shock export prices increase by 7 percent on impact while import prices go up by 2 percent. The real exchange rate appreciates while the effect on the trade balance is 2 percent on impact but mean reverts quickly.

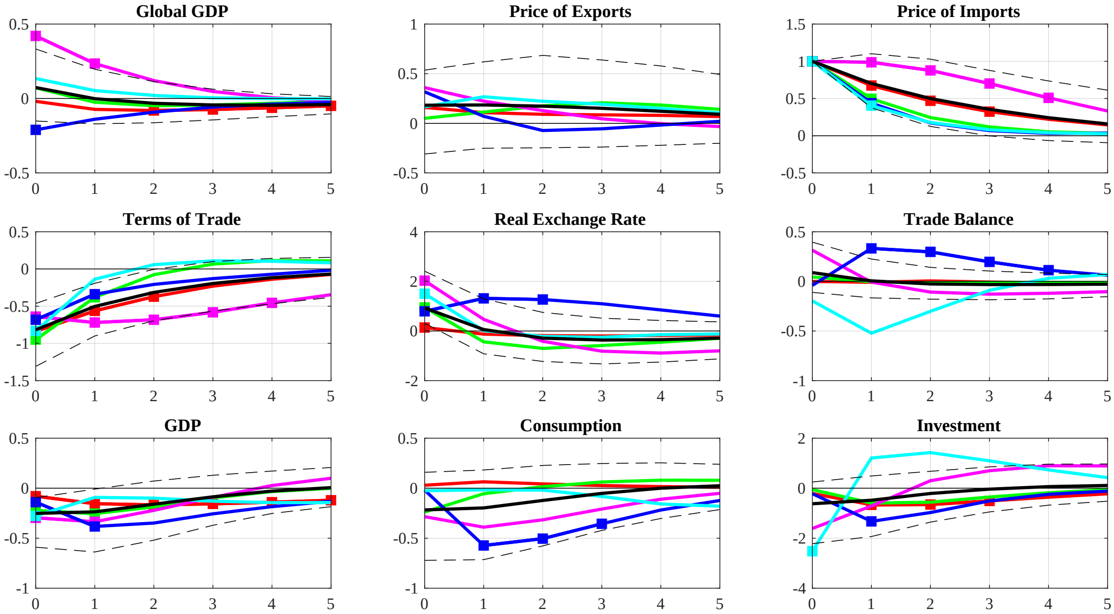
The variance decomposition shows that the combined effect of P^x and P^m shocks explain up to 32 percent of output fluctuations. The global demand shock accounts for up to 38 percent in the variation in export prices and 23 percent in the variation in import prices.

Figure E.2: Impulse Responses to an Export Price Shock by Export Group



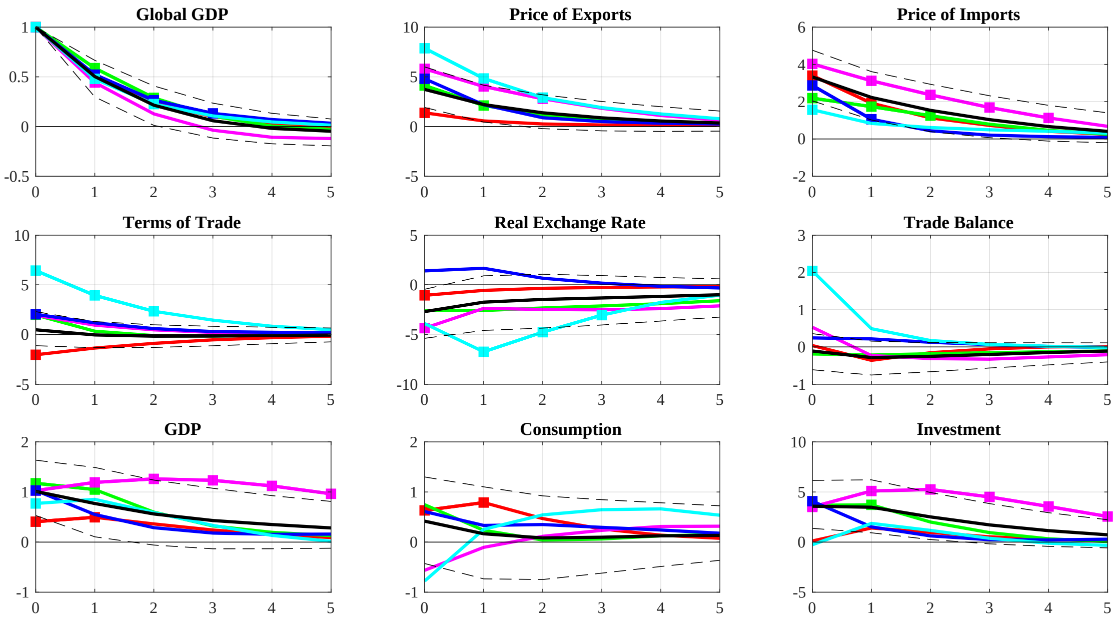
Notes: The figure shows the impulse responses to an export price shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different export group: agriculture (food and beverages) exporters are in green, energy exporters in magenta, manufacturing exporters in red, metal exporters in blue and agriculture raw material (plus fertilizers) exporters in turquoise. The lines denote the mean response weighted by each country's size proxied by their GDP (PPP). The squares denote that zero is not within the 68 percent confidence band. For comparison, the impulse responses for all countries are shown in black with the corresponding 16th and 84th percentile error bands.

Figure E.3: Impulse Responses to an Import Price Shock by Export Group



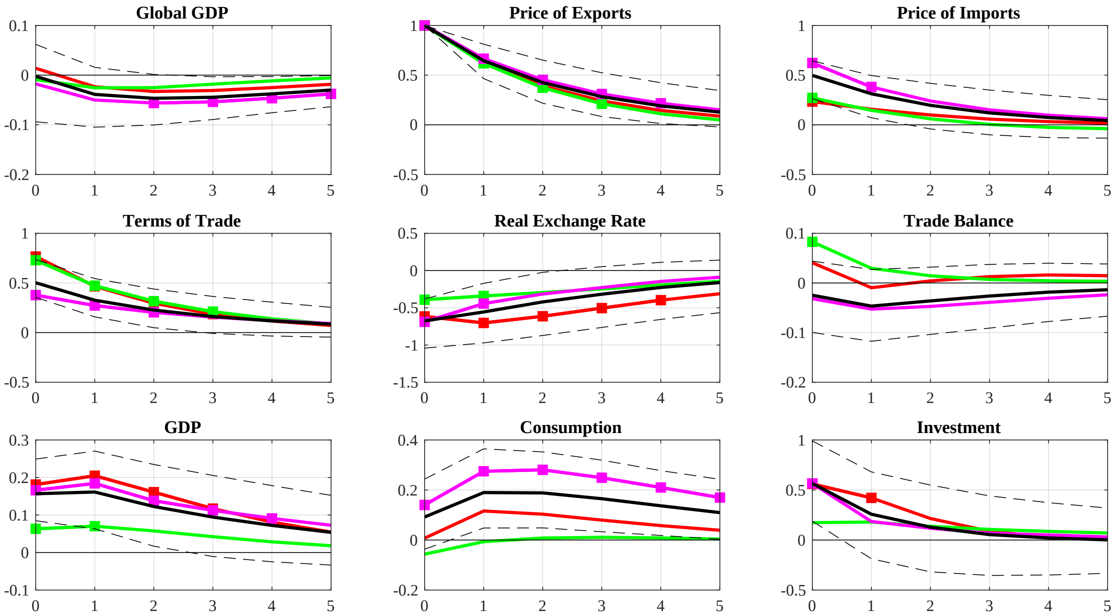
Notes: The figure shows the impulse responses to an import price shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different export group: agriculture (food and beverages) exporters are in green, energy exporters in magenta, manufacturing exporters in red, metal exporters in blue and agriculture raw material (plus fertilizers) exporters in turquoise. The lines denote the mean response weighted by each country's size proxied by their GDP (PPP). The squares denote that zero is not within the 68 percent confidence band. For comparison, the impulse responses for all countries are shown in black with the corresponding 16th and 84th percentile error bands.

Figure E.4: Impulse Responses to a Global Demand Shock by Export Group



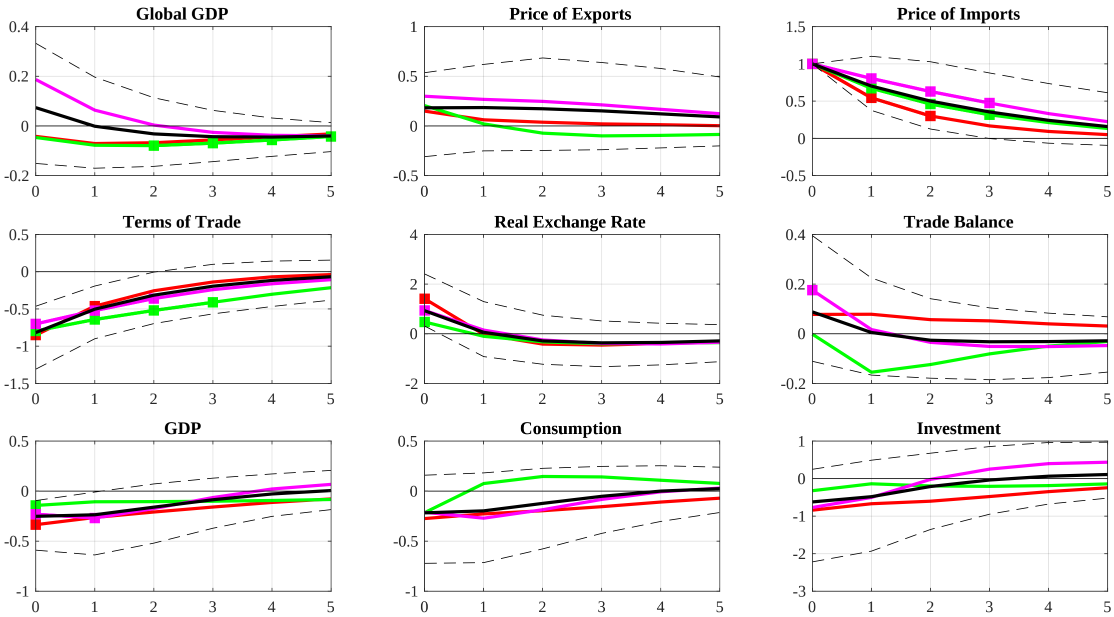
Notes: The figure shows the impulse responses to a global demand shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different export group: agriculture (food and beverages) exporters are in green, energy exporters in magenta, manufacturing exporters in red, metal exporters in blue and agriculture raw material (plus fertilizers) exporters in turquoise. The lines denote the mean response weighted by each country's size proxied by their GDP (PPP). The squares denote that zero is not within the 68 percent confidence band. For comparison, the impulse responses for all countries are shown in black with the corresponding 16th and 84th percentile error bands.

Figure E.5: Impulse Responses to an Export Price Shock by Import Group



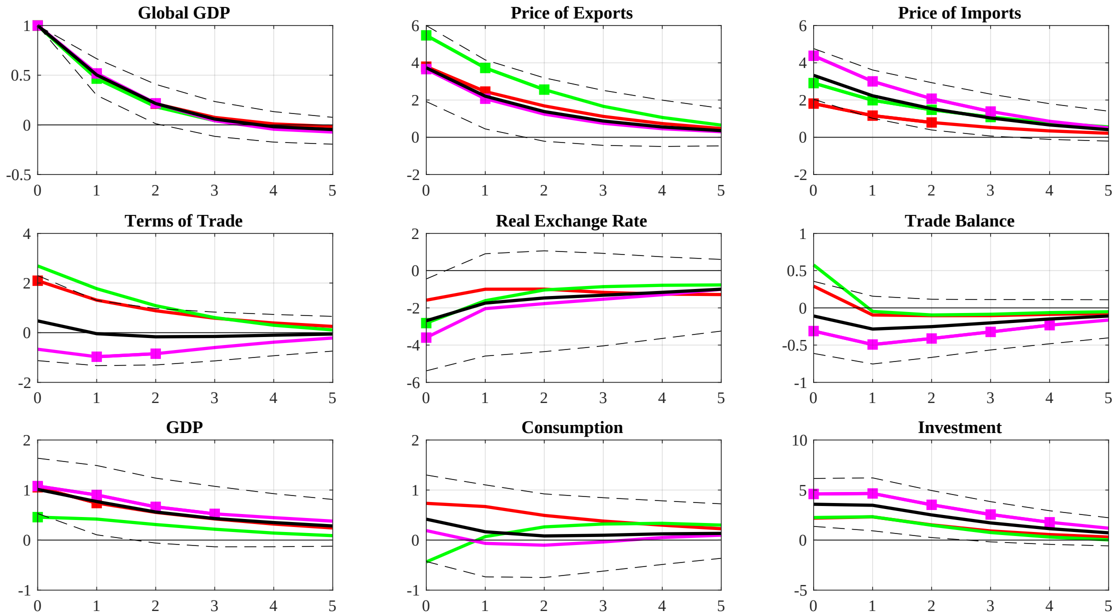
Notes: The figure shows the impulse responses to an export price shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different import group: agriculture (food and beverages) importers are in green, energy importers in magenta, and manufacturing importers in red. The lines denote the mean response weighted by each country's size proxied by their GDP (PPP). The squares denote that zero is not within the 68 percent confidence band. For comparison, the impulse responses for all countries are shown in black with the corresponding 16th and 84th percentile error bands.

Figure E.6: Impulse Responses to an Import Price Shock by Import Group



Notes: The figure shows the impulse responses to an import price shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different import group: agriculture (food and beverages) importers are in green, energy importers in magenta, and manufacturing importers in red. The lines denote the mean response weighted by each country's size proxied by their GDP (PPP). The squares denote that zero is not within the 68 percent confidence band. For comparison, the impulse responses for all countries are shown in black with the corresponding 16th and 84th percentile error bands.

Figure E.7: Impulse Responses to a Global Demand Shock by Import Group



Notes: The figure shows the impulse responses to a global demand shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different import group: agriculture (food and beverages) importers are in green, energy importers in magenta, and manufacturing importers in red. The lines denote the mean response weighted by each country's size proxied by their GDP (PPP). The squares denote that zero is not within the 68 percent confidence band. For comparison, the impulse responses for all countries are shown in black with the corresponding 16th and 84th percentile error bands.

Table E.2: FEVD International Prices: Commodity Groups

	Exports Prices			Imports Prices			Terms of Trade		
	GD	P^x	P^m	GD	P^x	P^m	GD	P^x	P^m
				Agriculture (Food and Beverages) Exporters					
0	32.07	64.26	3.67	26.76	39.26	33.98	22.73	46.46	30.82
10	31.03	60.83	8.14	31.98	41.64	26.39	23.44	48.98	27.58
				Energy Exporters					
0	24.88	73.17	1.95	44.88	29.88	25.24	18.18	78.21	3.61
10	27.59	68.06	4.35	42.71	35.29	22.00	25.06	64.76	10.18
				Manufacturing Exporters					
0	19.92	66.52	13.55	40.04	13.19	46.77	33.95	20.04	46.01
10	22.17	54.91	22.91	36.70	17.03	46.27	31.79	23.82	44.40
				Metals Exporters					
0	29.56	68.25	2.19	36.25	42.77	20.98	22.10	71.84	6.06
10	25.94	69.37	4.69	27.90	58.29	13.80	23.26	67.96	8.77
				Agriculture Raw Materials (plus Fertilizers) Exporters					
0	37.62	59.05	3.33	19.44	32.72	47.83	36.77	55.74	7.49
10	38.11	54.73	7.16	22.92	47.65	29.44	40.67	51.67	7.67
				Agricultural Importers					
0	28.27	68.15	3.58	35.97	20.75	43.28	22.91	59.83	17.26
10	29.88	59.03	11.09	34.98	28.72	36.30	25.70	54.01	20.29
				Energy Importers					
0	39.97	54.40	5.62	47.81	25.54	26.65	26.11	33.59	40.30
10	35.86	52.09	12.05	44.42	27.14	28.44	27.38	34.76	37.86
				Manufacturing Importers					
0	25.41	70.94	3.65	33.35	28.81	37.84	15.99	70.19	13.82
10	28.30	65.25	6.45	33.70	36.39	29.91	20.91	64.75	14.34

Table E.3: FEVD Business Cycle: Commodity Groups

	Trade Balance			Output			Consumption			Investment		
	GD	P^x	P^m	GD	P^x	P^m	GD	P^x	P^m	GD	P^x	P^m
	Agriculture (Food and Beverages) Exporters											
0	4.76	8.27	7.66	15.54	21.23	5.18	7.03	14.73	8.19	11.13	17.52	2.82
10	14.56	24.67	10.25	21.44	32.36	11.67	14.45	30.42	11.98	19.99	24.87	10.30
	Energy Exporters											
0	11.92	10.76	9.05	12.02	9.41	4.36	5.18	8.21	5.18	12.66	4.37	4.94
10	22.73	19.75	11.22	29.31	25.40	10.15	14.19	20.23	11.21	27.61	14.89	10.84
	Manufacturing Exporters											
0	11.91	4.91	5.13	8.70	8.29	5.15	13.67	6.50	5.15	3.87	9.60	6.04
10	23.76	12.87	20.46	16.60	14.24	24.66	23.79	15.95	20.21	15.96	18.87	21.96
	Metals Exporters											
0	7.46	8.40	2.33	20.95	8.99	2.45	11.25	5.48	3.26	11.81	10.79	2.62
10	11.56	17.01	16.76	19.40	20.13	15.41	15.09	15.79	14.62	16.04	23.61	12.57
	Agriculture Raw Materials (plus Fertilizers) Exporters											
0	12.02	5.99	3.74	4.24	12.61	3.60	7.48	4.73	3.77	4.96	8.17	15.73
10	17.40	16.17	7.35	14.17	19.27	13.35	13.75	26.39	11.57	12.36	20.80	17.22
	Agricultural Importers											
0	12.40	15.27	6.53	7.15	10.78	6.48	8.40	13.20	7.10	12.09	6.75	6.05
10	17.96	20.83	14.19	15.52	23.02	16.45	21.12	24.62	17.63	19.43	19.25	14.77
	Energy Importers											
0	9.28	6.06	8.19	23.60	13.43	7.87	6.00	8.35	6.21	19.99	10.01	3.56
10	24.43	17.26	13.35	30.67	25.68	14.71	13.37	29.52	13.61	32.33	15.73	10.99
	Manufacturing Importers											
0	10.53	7.38	6.79	14.42	14.18	8.68	10.54	5.27	9.29	11.22	12.08	7.63
10	18.06	20.24	12.56	18.89	29.49	14.68	17.29	17.47	15.06	20.07	19.91	14.66

Appendix F Model Details

F.1 Steady State

We denote the steady-state value of a variable by dropping the time subscript. To compute the steady state, we remove all the time subscripts in all the numbered equations above. Using equation (14), gives the following relationship

$$\beta = \frac{1}{1 + r^* + s}. \tag{F.1}$$

where $\bar{s}$ the steady state level of the country risk premium. From equation (32), we get

$$r = r^* + s. \tag{F.2}$$

We normalise all three shocks to 1,

$$GD = P^m = P^x = 1. \tag{F.3}$$

From the first order conditions with respect to capital, equations (12) and (13), it follows that the sectoral rental rates of capital are given by

$$r^n = r^x = \frac{1}{\beta} - (1 - \delta). \tag{F.4}$$

First we set $q = 1$. This means that combining equations (17) and (36), we also get that $p^n = 1$. We fix the share of intermediate imports in the export sector, μ_x. Therefore, the ratio of gross output in the export sector to net output is given by

$$s_{xy} = \frac{s_x}{1 - \mu_x}. \tag{F.5}$$

Replacing equations (21) and (25) into value added, equation (30), we get

$$y = \left(1 - \frac{\epsilon - 1}{\epsilon}\mu_n\right) y^n + (1 - \mu_x) y^x. \tag{F.6}$$

Fixing μ_n, we get the share of gross output in the nontradable sector to net output

$$s_{ny} = \frac{1 - s_{xy}(1 - \mu_x)}{1 - \frac{(\epsilon-1)}{\epsilon}\mu_n}. \tag{F.7}$$

Combining equation (28) with equations (7), (8), (20) and (24), and fixing the ratio between the capital shares $\frac{\gamma_x}{\gamma_n}$ following Schmitt-Grohé and Uribe (2018), we can find the value of the capital share that matches the share of investment, s_i,

$$\gamma_n = \frac{s_i}{\delta\left(\frac{\gamma_x}{\gamma_n}\frac{1}{r^x}s_{xy} + \frac{(\epsilon-1)}{\epsilon}\frac{1}{r^n}s_{ny}\right)}.$$

It then follows that

$$\gamma_x = \frac{\gamma_x}{\gamma_n}\gamma_n.$$

The labor shares are then given by

$$\alpha_n = 1 - \gamma_n - \mu_n$$

and

$$\alpha_x = 1 - \gamma_x - \mu_x.$$

We then substitute the FOCs of firms in n sector, equations (19)-(21), into the production function, equation (18), to get an expression for the wage w

$$1 = z_n \frac{\epsilon - 1}{\epsilon} p^n \left(\frac{1}{w^n}\right)^{\alpha_n} \left(\frac{1}{r^n}\right)^{\gamma_n} \left(\frac{1}{(P^m)\, q}\right)^{\mu_n} \Rightarrow w^n = \left[z_n \frac{\epsilon - 1}{\epsilon} \left(\frac{1}{r^n}\right)^{\gamma_n}\right]^{\frac{1}{\alpha_n}}. \tag{F.8}$$

Further, we make the assumption that in the steady state real wages across sectors are equal, $w_n = w_x = w$. This in turn implies that

$$\phi_n = \frac{1}{1 + \frac{h^n}{h^x}}.$$

We then set the z_x in order to target $q = 1$ and recover h^x by substituting equations (24) and (25) into equation (22)

$$w^x = \alpha_x^{1-\alpha_x} \left(\frac{1}{r^x}\right)^{\gamma_x} (h^x)^{\alpha_x - 1} \Rightarrow z_x = (y^x)^{-(\gamma_x + \mu_x)} \Rightarrow h^x = \alpha_x \left((r^x)^{\gamma_x} w^x\right)^{\frac{1}{\alpha_x - 1}}. \tag{F.9}$$

From the labor demand in the export sector, equation (23), we can recover the values of sectoral outputs

$$y^x = \frac{w h^x}{\alpha_x}. \tag{F.10}$$

Aggregate output and output in the tradable sector are given by

$$y = \frac{y_x}{s_{xy}}$$

and

$$y_n = s_{ny} y.$$

$$h^n = \frac{\epsilon - 1}{\epsilon} \alpha_n \frac{y^n}{w}.$$

Using equation (8), and under the assumption that $w_n = w_x = w$, it follows that

$$h = h^n + h^x. \tag{F.11}$$

Combining equations (26-30), we can recover aggregate consumption cs

$$c = y\,(1 - s_{tb}) - \left(\delta \gamma_x \frac{1}{r^x} y^x + \delta \frac{\epsilon - 1}{\epsilon} \gamma_n \frac{1}{r^n} y^n\right). \tag{F.12}$$

s Once we have the value of c, we can get absorption a from equation (27),

$$a = c + \delta \gamma_x \frac{1}{r^x} y^x + \delta \frac{\epsilon - 1}{\epsilon} \gamma_n \frac{1}{r^n} y^n. \tag{F.13}$$

Then we recover the value of ν that targets s_{tb} combining equations (15) and (26),

$$\nu = \left(1 - \frac{y^n}{a}\right). \tag{F.14}$$

Note that the value of ν is not restricted to be between 0 and 1 and given s_{tb} will depend on the value of $\mu_x$and μ_n (as well as the values of aggregate labor supply n and degree of imperfect competition, ϵ). Given that $p_n = q = 1$, from equations (15) and (17), it follows that

$$a^m = \nu a, \tag{F.15}$$

$$a^n = (1-\nu)\, a. \tag{F.16}$$

Using equations (20), (21), (24) and (25), we get the demand for factors

$$k^n = \frac{(\epsilon - 1)}{\epsilon}\gamma_n \frac{y^n}{r^n}, \tag{F.17}$$

$$k^x = \gamma_x \frac{y^x}{r^x}, \tag{F.18}$$

$$m^n = \frac{(\epsilon - 1)}{\epsilon}\mu_n y^n, \tag{F.19}$$

$$m^x = \mu_x y^x. \tag{F.20}$$

From equations (7), (8) and (28), we then recover sectoral and aggregate investments,

$$i^n = \delta k^n, \tag{F.21}$$

$$i^x = \delta k^x, \tag{F.22}$$

$$i = i^n + i^x. \tag{F.23}$$

Aggregate imports are equal to

$$m = m^n + m^x + a^m.$$

From equation (31), we get the net foreign position

$$d = \frac{1+r}{r}\left(y_x - m\right). \tag{F.24}$$

We recover the marginal utility of consumption, λ, and the value of χ. Note that the value of χ to target $s_x$and not n in the steady state. The remaining auxiliary variables can be easily recovered. Finally,

$$\lambda = \left[c\left(1 - h^{\varphi}\right)\right]^{-\sigma} \tag{F.25}$$

and

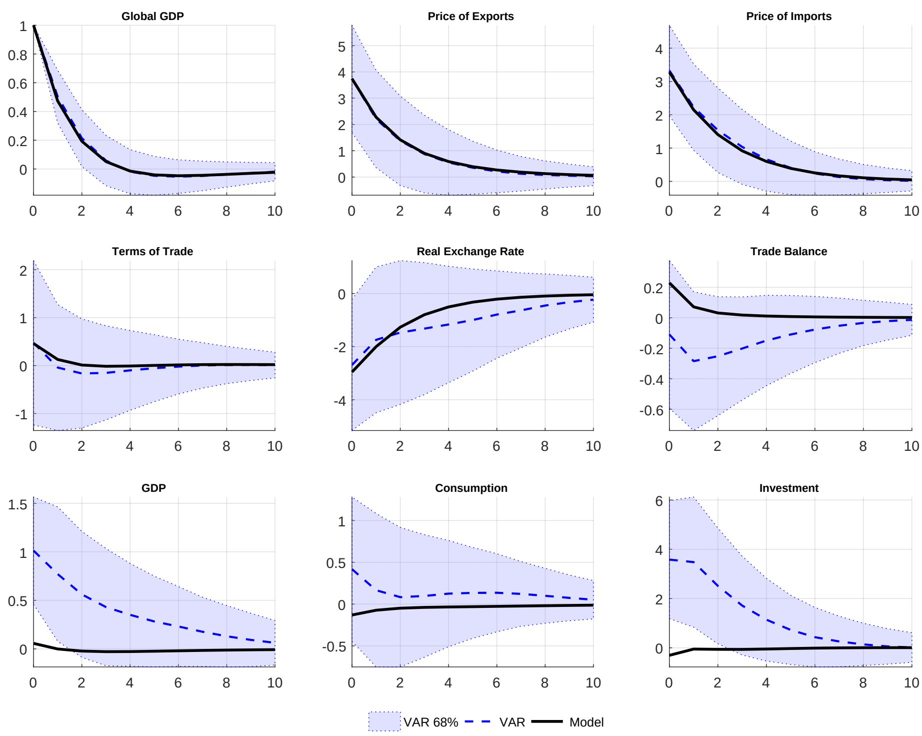
$$w \;\;=\;\; \chi\varphi h^{\varphi-1}. \tag{F.26}$$

Appendix G Model Responses to a Global Demand Shock

Figure G.1 shows that, after a positive global demand shock, the model generates responses for the real exchange rate and the trade balance that are in line with the empirical evidence. The response of the trade balance and the exchange rate are a result of the asymmetric response of export and import prices on the economy.

The model falls short of matching quantities for the median hypothetical country for consumption, investment and GDP. One reason for this is that the global demand shock does not enter directly into the model but rather via export and import prices. The empirical evidence suggests that export and import prices tend to cancel one another in response to a global demand shock. It is precisely for this that, since global demand shock does not enter directly in the model, it is reasonable to expect that the effect on quantities in the model is negligible.

Figure G.1: Impulse Responses to a Positive Global Demand Shock: Model vs All Countries



Notes: The figure shows the normalized impulse responses to a positive (one standard deviation) *GD* shock for all countries in the VAR (in blue) and in the model using mode estimates (in black). The solid lines denote the mean response weighted by each country's size proxied by their GDP (PPP) and the dashed lines represent the 16th and 84th percentile error bands.