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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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JEL Classification: F41, F44, E32

Keywords: terms of trade, commodity prices, business cycles, World Shocks

Federico DiPace - federico.dipace@bankofengland.co.uk
Bank of England

Luciana Juvenal - ljuvenal@imf.org
International Monetary Fund

Ivan Petrella - ivan.petrella@wbs.ac.uk
University of Warwick and CEPR

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Terms-of-Trade Shocks are Not all Alike*†

Federico Di Pace[1], Luciana Juvenal[2] and Ivan Petrella[3]

[1] *Bank of England*
[2] *International Monetary Fund*
[3] *Warwick Business School and CEPR*

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†Federico Di Pace, Bank of England. E-mail: `federico.dipace@bankofengland.co.uk`; Luciana Juvenal, International Monetary Fund. E-mail: `ljuvenal@imf.org` (corresponding author); and Ivan Petrella, Warwick Business School and CEPR. E-mail: `ivan.petrella@wbs.ac.uk`.

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 (ToT) 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 indicate 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 "terms of trade disconnect:" terms-of-trade shocks appear less important in the data than in theory.

We postulate that the reason behind this disconnect is that ToT measured as a ratio between export and import prices are an inaccurate proxy of how terms of trade affect the economy. As a result, they explain a small proportion of output fluctuations, which is at odds with the predictions of theoretical models. A terms-of-trade shock may result from a shift in export prices, import prices, or not perfectly offsetting movements in both. Yet, when analyzing terms-of-trade shocks, it is often implicitly assumed that the economy responds symmetrically to an increase in export prices and a decline in import prices. Instead, we highlight that export and import prices are terms-of-trade measures, broadly defined as a relative price, since they are expressed in real terms and in US dollars. Therefore, movements in export and import prices by themselves matter and, as a result, *"terms-of-trade effects"* are empirically complex and go beyond the fluctuations in ToT. In fact, we show that terms-of-trade shocks are not all alike: the effects of a positive export price shock do not mirror the effects of a negative import price shock. While the effects of a positive export price shock resemble the mechanism of transmission of a "traditional" positive terms-of-trade shock, negative import price shocks do not. For instance, positive export price shocks are associated with a positive comovement between ToT and output and a negative comovement between ToT and the real exchange rate, as in a standard model. Instead, while the positive comovement between ToT and output remains after an import price shock, the ToT and the real exchange rate move in the same direction, as in Catão and Chang (2015). We show empirically that movements in export and import prices themselves matter, and combined they explain a fraction of output variability consistent with the predictions of theoretical models.

These findings have implications for theory because our results point to the need to make structural changes to theoretical models to allow export and import price shocks to have independent effects. In a multi-sector small open economy model (SOE) like the MXN described in Mendoza (1995) and Schmitt-Grohé and Uribe (2017) only the ToT matter for equilibrium allocations while it is irrelevant if they shift due to changes in export or import prices. A key assumption behind this result is that real export prices denominated in US dollars are perfectly (negatively) correlated with real import prices denominated in US dollars. We show that once this assumption is relaxed, export and import price shocks yield heterogeneous aggregate effects. We also highlight that these effects crucially depend on assumptions about financial markets. For example, there is a distinctive role for export and import prices operating through the external position. In addition, we show that an extension of the MXN model which accounts for these factors yields independent export and import price shocks which display an heterogeneous transmission mechanism that is in line with the results of our empirical analysis.

From an empirical viewpoint, 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 economic activity shocks, which reflect unexpected changes in global output, are a common shifter of commodity export and import prices. When global economic activity 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 change in the ToT.[1] However, since the economy responds asymmetrically to movements in export and import prices, global economic activity shocks, while largely not visible in the ToT 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 economic activity shock.

In order to investigate the transmission of export and import price shocks separately, we construct a comprehensive time series of country-specific export and import price indices for a sample of emerging and developing economies (EMDEs).[2] Specifically, we calculate these indices using individual commodity and manufacturing prices combined with time-varying sectoral export and import shares. This extends earlier work that has followed a similar approach but only focused on the construction of terms-of-trade measures based on prices of raw commodities (see, Deaton and Miller, 1996; and Cashin, Céspedes, and Sahay, 2004). With regard to the methodology, we follow the recommendation of the IMF Export and Import Price Manual. By and large, our terms-of-trade measure offers an improvement with respect to the official one based on unit values derived from countries' customs data. As documented in Kravis and Lipsey (1971) and Silver (2009), the latter measure is likely to contain biases originated in, for example, changes in the mix of heterogeneous products or incorrect recording of quantities.

One conjecture in Schmitt-Grohé and Uribe (2018) is 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 fact, Fernández, Schmitt-Grohé, and Uribe (2017) argue that world shocks propagate to the domestic business cycle through commodity prices and show that fluctuations in the latter explain a sizable proportion of domestic business cycles. To illustrate this result, the scatter plot presented in Panel (a) of Figure 1 compares, for each country, the one-year ahead forecast error variance decomposition of 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 in Fernández et al., 2017).[3] Note 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.

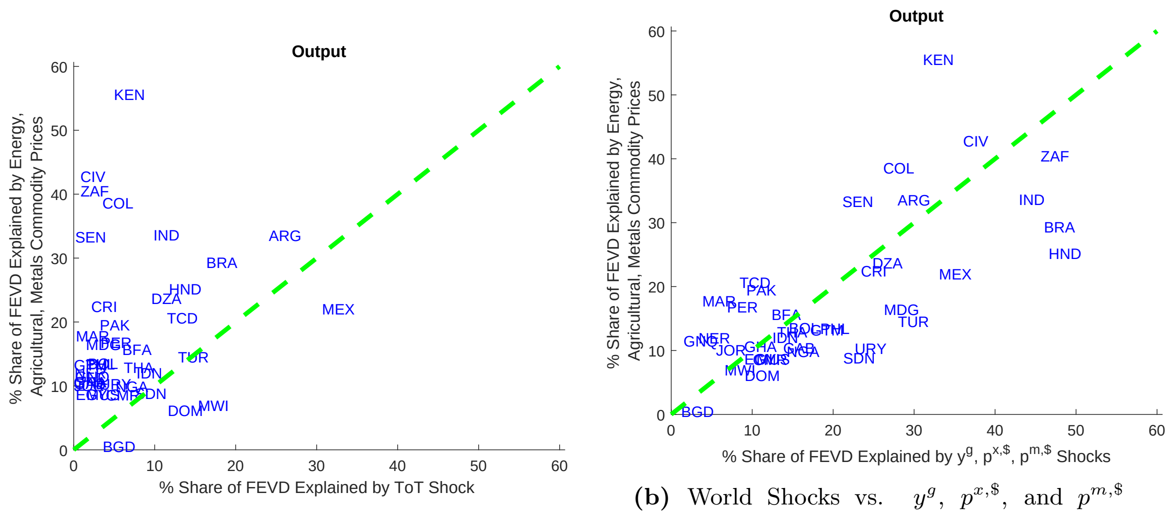
Our paper proposes an explanation for why the recent empirical evidence is at odds with the predictions of theoretical models. In doing so, we bridge the gap between the literature on the "terms of trade disconnect" and the one suggesting that shocks to world commodity prices explain a large proportion of aggregate fluctuations. In particular, we highlight that a departure from a single international 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 illustrates that the combination of export price, import price and global economic activity shocks explains a share of output variance consistent with the proportion attributed to the three commodity price indices. Therefore,

[1] Juvenal and Petrella (2015) show that global demand shocks are the main drivers of the comovement between commodity prices. See also Alquist et al. (2020) and Delle Chiaie et al. (2017).

[2] This dataset will be updated on regular time intervals and available from our websites.

[3] We calculate the variance decomposition using our own dataset and the methodology explained in Section 4. The results are in line with those of the papers cited. The three commodity prices are: energy, agriculture and metals.

Figure 1: Comparison Forecast Error Variance Decomposition



(a) *ToT* Shocks and World Shocks

(b) World Shocks vs. y^g, $p^{x,\$}$, and $p^{m,\$}$ Shocks

Notes: The first panel of this Figure compares the one-year ahead 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) comprising export price ($p^{x,\$}$), import price ($p^{m,\$}$) and global economic activity shocks (y^g) *vis-à-vis* Fernández et al. (2017) (y-axis).

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, reinforcing the focus of policy makers on ToT movements. Overall, the finding that terms-of-trade shocks are empirically important for business cycle fluctuations and the fact that the implicit assumption of symmetric responses of the economy to an export price and import price shock, common in theoretical models with ToT, is rejected by the data, invites the use of a new theoretical framework to study imports and exports price shocks separately. We provide some examples under which an independent mechanism operating for export and and import prices is theoretically plausible.

Our empirical analysis consists of identifying export price, import price and global economic activity 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. Narrative restrictions were constructed examining historical documents and newspaper articles to identify episodes of significant commodity price changes that were unrelated to important macroeconomic developments such as natural disasters, weather related shocks or major geopolitical events. From this analysis we identify a total of 23 price episodes that we use to derive narrative restrictions for export and import price shocks. In particular, we match those events to export price and import price shocks, for each country, by assessing the export and import shares of each commodity for every episode.[4]

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 up to 30 percent of output fluctuations. Moreover, we find that

[4]For example, we identify a positive coffee price shock in 1986 originated in droughts in Brazil. This episode would serve as a positive export price shock for coffee exporting countries such as Guatemala.

global economic activity shocks explain up to 24 percent of the variation in export prices and 30 percent of the variation in import prices while they account for only one-fifth 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 economic activity shocks 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. Given that aggregate results mask a great deal of heterogeneity across countries, we 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 larger for countries with a larger commodity export share. The response of output following an import price shock is more homogeneous across countries.

This 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, one of the reasons why the role of terms-of-trade shocks is less important in the data than in theory is 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).[5] 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 business cycles. One feature which distinguishes our paper from papers which construct their own measure of terms of trade (see, for example Bidarkota and Crucini, 2000; Cashin et al., 2004) is that 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. We show that not accounting for the share of manufacturing overstates the volatility of export and import prices and yields less volatile terms of trade.

The paper is organized as follows. Section 2 provides theory-guided examples which show that export and import price shocks can have their own independent effects on business cycles. Section 3 presents the data, details the methodology to calculate the country-specific export and import prices indices and includes a rich set of descriptive statistics. The empirical methodology and identification strategy are summarized in Section 4 while Section 5 discusses the asymmetric impact of export and import price shocks. Additional results are presented in Section 6 and Section 7 concludes. Appendix A includes an extension of a small open economy model which features independent export and import price shocks. Appendix B describes the macroeconomic and commodity data sources, while Appendix C presents additional descriptive statistics. The construction of narrative series of exogenous price shocks is detailed in Appendix D. The empirical evidence on global economic activity shocks is in Appendix E. Finally, Appendix F presents the cross-country and group heterogeneity results.

2 Linking Theory and Empirics

In standard SOE models ToT shocks are akin to TFP shocks and, as such, are a major determinant of business cycle fluctuations (see, e.g. Mendoza, 1995). The key contribution of this paper is to highlight that ToT are an inaccurate empirical proxy for how *"ToT effects"* operate in the economy. In order to fully capture those effects, it is important to go beyond the fluctuations in the ToT. While in standard SOE models only the ToT matter for equilibrium allocations (see, for example Mendoza, 1995; Schmitt-Grohé and Uribe, 2017, 2018), we make

[5] Ben Zeev et al. (2017) question the identification of terms-of-trade shocks using short run restrictions and instead highlight the importance of accounting for the news component in terms of trade.

the point that the two legs of the ToT, the real price of exports and the real price of imports (in terms of the US consumption price index, CPI), are themselves relative prices and as such they are both ToT measures. The latter is broadly considered the relative price at which two different goods are exchanged. Therefore, export and import prices are both distinctively relevant for allocations in the domestic economy.

In this section we provide examples guided by theory which indicate that shifts in export and import prices can have an independent and heterogeneous impact on domestic economic activity. As a first step, we show that export and import prices on their own embed a ToT component. We refer to this ToT component as *"direction of terms of trade"* (DToT). Then, we show that in a two-sector SOE model featuring importable and exportable sectors, referred to as the MX model in Schmitt-Grohé and Uribe (2017, Chapter 7) the ToT and the real exchange rate are negatively correlated after an export price shock and positively correlated in response to an import price shock. Building on this example, we also illustrate why in a multi-sector SOE model featuring exportable, importable, and nontradable sectors like the MXN described in Mendoza (1995) and in Schmitt-Grohé and Uribe (2017, Chapter 8) only the ToT matter for equilibrium allocations while it is irrelevant if their shift is due to a movement in export or import prices.[6] Finally, we highlight that when domestic debt is priced in foreign currency there is a distinctive role for export and import prices operating through the external position. More generally, the asymmetry in the transmission of export and import price shocks depends on assumptions about financial markets. Appendix A shows the heterogeneous effects of shifts in export and import prices within a standard MXN model (Mendoza, 1995; Schmitt-Grohé and Uribe, 2018) with independent export and import price shocks.

2.1 Direction of Terms of Trade

Let $p_t^{x,\$}$ and $p_t^{m,\$}$ be the price of exports and imports in terms of the foreign aggregate consumption index denominated in US dollars ($). In this section we show these relative prices embed a *"direction of terms-of-trade"* component, which we denote as DToT. To see that, it is useful to decompose the US CPI in terms of the (nominal) price of goods the US exports to the home country ($P_t^{x,*}$), the price of goods the US imports from the home country ($P_t^{m,*}$) and the price of non-tradable goods ($P_t^{n,*}$). Assuming that the CPI is a geometric price index, $P_t^* = (P_t^{x,*})^a (P_t^{m,*})^b (P_t^{n,*})^{(1-a-b)}$, we can then write $p_t^{x,\$} = P_t^{x,\$}/P_t^*$ as follows:

$$p_t^{x,\$} = \left(\frac{P_t^{x,\$}}{P_t^{x,*}}\right)^a \times \left(\frac{P_t^{x,\$}}{P_t^{m,*}}\right)^b \times \left(\frac{P_t^{x,\$}}{P_t^{n,*}}\right)^{(1-a-b)} . \tag{1}$$

For simplicity, assume that all the foreign country imports are the domestic economy exports, so that $P_t^{m,*} = P_t^{x,\$}$. Therefore,

$$p_t^{x,\$} = \left(\frac{P_t^{x,\$}}{P_t^{x,*}}\right)^a \times \left(\frac{P_t^{x,\$}}{P_t^{n,*}}\right)^{(1-a-b)} , \tag{2}$$

where $P_t^{x,\$}/P_t^{x,*}$ is the DToT of exports, which is defined as the relative price of the home country's exports ($P_t^{x,\$}$) with respect to the price of the goods the home country imports from the US. An analogous treatment of imports yields the DToT of imports defined as the relative price of the home country's imports relative to the goods the home country exports to the US, as a determinant of $p_t^{m,\$}$. Therefore, $p_t^{x,\$}$ and $p_t^{m,\$}$ are relative prices and both reflect an

[6] In the absence of nominal frictions, allocations are entirely driven by real variables. Thus, in a multi-sector model, relative prices drive the relative demand and the allocation of resources across sectors. Thus, unless there is perfect substitutability across goods, there will be real effects on the aggregate economy.

element of terms of trade. In addition, the former also reflects the relative price of exports with respect to nontradables in the foreign economy, while the latter incorporates the relative price of imports with respect to nontradables.

2.2 Independent $p_t^{x,\$}$ and $p_t^{m,\$}$ and the Real Exchange Rate

The presence of independent $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks has implications for the behavior of the real exchange rate. We can analyze such implications from the lens of an SOE model with two sectors (exportable and importable) referred to as the MX in Schmitt-Grohé and Uribe (2017, Chapter 7). In this setting, by taking the price of tradables as the numeraire, it follows that the relative price of tradables, p_t^{τ}, is a weighted average of the relative price of exports and imports (in logs):[7]

$$\widetilde{p}_t^{\tau} = 0 = (1 - \chi_m)\,\widetilde{p}_t^{x} + \chi_m \widetilde{p}_t^{m}, \tag{3}$$

where p_t^x and p_t^m denote the real price of exports and imports with respect to the aggregate home consumption price index and $\chi_m \in (0, 1)$. The law of one price (LOOP) in export and import prices requires that $p_t^x = p_t^{x,\$} q_t$ and $p_t^m = p_t^{m,\$} q_t$, where q_t is the real exchange rate (defined as the price of foreign goods in terms of domestic goods).[8,9] Therefore equation (3) together with the LOOP implies that

$$\widetilde{q}_t = -\left[(1 - \chi_m)\widetilde{p}_t^{x,\$} + \chi_m \widetilde{p}_t^{m,\$}\right]. \tag{4}$$

Equation (4) highlights an important distinction between the effects of a shift in ToT originating from shocks to export or import prices. With independent shocks to $\widetilde{p}_t^{x,\$}$ and $\widetilde{p}_t^{m,\$}$, the real exchange rate falls when either $\widetilde{p}_t^{x,\$}$ or $\widetilde{p}_t^{m,\$}$ go up. Therefore, in response to a shift in export prices, the behavior of the real exchange resembles the predictions of an increase in ToT in standard SOE models, i.e. an improvement in ToT leads to an exchange rate appreciation. By contrast, Equation (4) shows that an increase in $\widetilde{p}_t^{m,\$}$ also leads to an exchange rate appreciation, as in Catão and Chang (2015). This implies that response of the real exchange rate following a shift in import prices is at odds with the one that would result from a decline in ToT in traditional models.

Export and import price shocks do not mirror each other and the opposite movement in the real exchange rate is an important driver of their heterogeneous impact on the economy. To see that, it is instructive to consider the impact of a one percent increase in both $\widetilde{p}_t^{x,\$}$ and $\widetilde{p}_t^{m,\$}$ (which corresponds to an exogenous shift in international prices with no impact on ToT). From equation (4) it follows that the real exchange rate will fall one percent and as a result the price of imports and exports in local currency remain unchanged. Therefore, in this setting the aggregate impact of a ToT-neutral equal shift in $\widetilde{p}_t^{x,\$}$ and $\widetilde{p}_t^{m,\$}$ depends on how a shift in the real exchange rate affects the domestic business cycle.

[7] From here onward the log of a generic variable x_t, will be denoted as $\widetilde{x}_t$.

[8] We are assuming that the domestic economy features only tradable goods, so that the price of tradables is equal to the aggregate domestic price index. However, by defining a real exchange rate to be different from one, we are implicitly assuming the presence of a nontradable sector in the foreign economy. While this structure creates an asymmetry in the treatment of the domestic and foreign economies, it allows us to neatly derive the implications for the real exchange rate. In Section 2.3 we introduce nontradables in the domestic economy and show that the intuition developed in this section applies in that setting.

[9] Note that in the traditional MX model the real exchange rate does not enter in any of the structural equations of the model and foreign debt is priced in units of consumption, i.e. tradable goods (see, e.g., Schmitt-Grohé and Uribe, 2017, p. 237).

2.3 Terms of Trade in MXN Models

In a model with a nontradable goods sector, such as the MXN Schmitt-Grohé and Uribe (2017, Chapter 8), independent movements of $p_t^{x,\$}$ and $p_t^{m,\$}$ are ruled out by additional assumptions on the determinants of the real exchange rate. Specifically, the assumption that $q_t = p_t^{\tau}$. To see that, let us consider a standard setting where tradable and nontradable goods are aggregated into a composite tradable good with a function which is homogeneous of degree 1. In this case, the relative price of tradables with respect to the aggregate domestic consumption price index is a weighted average of the relative price of exports and imports, which (in logs) can be defined as $\widetilde{p}_t^{\tau} = (1-\chi_m)\,\widetilde{p}_t^{x} + \chi_m \widetilde{p}_t^{m}$. Therefore, the LOOP in export and import prices allows us to obtain the following relationship between the price of tradables, international prices and the real exchange rate:

$$\widetilde{p}_t^{\tau} = (1-\chi_m)\,\widetilde{p}_t^{x,\$} + \chi_m \widetilde{p}_t^{m,\$} + \widetilde{q}_t. \tag{5}$$

It follows that unless $\widetilde{p}_t^{x,\$} = -\chi_m \widetilde{p}_t^{m,\$}/(1-\chi_m)$ at every t, there is a wedge between the relative price of tradables and the real exchange rate. Consequently, $q_t \neq p_t^{\tau}$ unless export and import prices expressed in foreign currency are perfectly negatively correlated.[10]

Schmitt-Grohé and Uribe (2017, 2018) carefully explain that the mapping $q_t = p_t^{\tau}$ follows from a number of implicit assumptions such as the LOOP holding in the tradable goods sector as well as ToT shifts not affecting the relative price of tradables over the aggregate consumption price index in the foreign economy.[11] The latter is a strong assumption, which is automatically violated if $p_t^{x,\$}$ and $p_t^{m,\$}$ can vary independently from one another. To see that, consider the definition of the price of tradables in the foreign country in terms of aggregate consumption goods, and for simplicity assume that the consumption bundles are the same as in the domestic economy (i.e. $\chi_m = 1-\chi_m^*$):[12]

$$\begin{aligned}\widetilde{p}_t^{\tau,*} &= (1-\chi_m^*)\,\widetilde{p}_t^{x,*} + \chi_m^* \widetilde{p}_t^{m,*} \\ &= \chi_m \widetilde{p}_t^{m,\$} + (1-\chi_m)\,\widetilde{p}_t^{x,\$},\end{aligned} \tag{6}$$

where the last equation is obtained assuming that goods exported (imported) by the foreign economy are the ones imported (exported) by the domestic economy. Therefore, the assumption that $p_t^{\tau,*}$ is invariant to fluctuations in the terms of trade requires, again, that $\widetilde{p}_t^{x,\$} = -\chi_m \widetilde{p}_t^{m,\$}/(1-\chi_m)$.

The assumption of $p_t^{\tau} = q_t$ is central in delivering predictions in MXN models where real allocations are only a function of the ToT_t. In fact, under this assumption it can be shown that the real exchange rate is inversely related to ToT_t and does not depend on $p_t^{x,\$}$ and $p_t^{m,\$}$ separately. In the more realistic setting, where fluctuations in $p_t^{x,\$}$ and $p_t^{m,\$}$ are not perfectly (negatively) correlated, q_t guarantees that the LOOP holds both for export and import markets. Therefore, a shock to $p_t^{x,\$}$ ($p_t^{m,\$}$) unless fully neutralized by an equal shift in q_t, maps into a shift of p_t^{x} (p_t^{m}) and will affect the economy's relative demand and real

[10] In Section 3.5 we show that this assumption is strongly rejected in the data. In fact, the relative price of exports and imports (in units of US CPI) are strongly positively correlated for all the countries in our sample.

[11] To see this, recall the definition of the real exchange rate $q_t = \frac{\mathcal{E}_t P_t^*}{P_t} = \frac{\mathcal{E}_t P_t^*}{P_t^{\tau}}\frac{P_t^{\tau}}{P_t} = \frac{\mathcal{E}_t P_t^{\tau,*}}{P_t^{\tau}}\frac{P_t^*}{P_t^{\tau,*}}\frac{P_t^{\tau}}{P_t}$ where P_t and P_t^* (P_t^{τ} and $P_t^{\tau,*}$) denote the aggregate (tradable) price index (at home and abroad), and $\mathcal{E}_t$ is the nominal exchange rate. Assuming the LOOP in the tradable goods (hence $\mathcal{E}_t P_t^{\tau,*}/P_t^{\tau} = 1$), $q_t = p_t^{\tau}$ only if $P_t^*/P_t^{\tau,*} = 1$. Hence, ToT shocks cannot affect the relative price of tradables over the aggregate price index on the foreign economy.

[12] Note that in the more general framework where preferences across countries are not symmetric, the LOOP in export and import goods market does not imply the LOOP holds for the tradable price index between the two countries. The empirical evidence on the LOOP points at the need to look at more disaggregated sectoral data rather than aggregate price indices. See, for example, Imbs et al. (2005) and Juvenal and Taylor (2008).

allocations so that it will generally impact the economy at the aggregate level (i.e. this shock is not a purely redistributive shock).

To the extent that the shocks to $p_t^{x,\$}$ and $p_t^{m,\$}$ are, at least partially, attenuated by an opposite movement in q_t, it follows that a positive (negative) shift in ToT_t associated with a $p_t^{x,\$}$ ($p_t^{m,\$}$) shock generates a real exchange rate appreciation (depreciation). Therefore, as discussed in Section 2.2, the opposite movement of the real exchange rate is a distinct feature of the heterogeneity in the response of the economy to different international price shocks. For instance, in a setting with nontradable goods, credit constraints and foreign debt partially leveraged on nontradable income (i.e. liability dollarization credit constraints) the opposite movement in the real exchange rate will have a reverse effect on the probability of the economy falling into a sudden stop (Mendoza, 2006).[13]

2.4 Terms of Trade and the External Position[14]

The transmission of changes in $p_t^{x,\$}$ and $p_t^{m,\$}$ to the economy crucially depends on financial markets and on the assumption about pricing of domestic debt. Let d_t be the stock of debt in the domestic country expressed in terms of foreign consumption goods. The debt accumulation equation is defined as:

$$\frac{q_t d_{t+1}}{1+r_t} = q_t d_t + p_t^m m_t - p_t^x x_t, \tag{7}$$

where x_t and m_t denote the quantity of exports and imports and r_t is the real interest rate paid on debt. To appreciate that the transmission of international price shocks goes behind the standard ToT channel, it is instructive to rewrite the debt accumulation equation (7) as a function of ToT_t:[15]

$$\frac{d_{t+1}}{p_t^{m,\$}(1+r_t)} = \frac{d_t}{p_t^{m,\$}} + m_t - ToT_t x_t, \tag{8}$$

Therefore, shifts in international prices affect the borrowing cost of the domestic economy. As a result, the same shift in the ToT will have a different impact on the external position of the domestic economy depending on whether it originates from a shift in $p_t^{x,\$}$ or a shift in $p_t^{m,\$}$. Similarly, an equal shift in $p_t^{x,\$}$ and $p_t^{m,\$}$, while leaving the ToT invariant, still impacts the economy by affecting the domestic economy external position and more generally investment and saving decisions.

This result crucially depends on the assumption that domestic debt is denominated in terms of foreign consumption goods. In fact, if foreign bonds are denominated in units of import goods, as in the traditional SOE literature (see, for example Mendoza, 1995; Greenwood, 1984), then all terms of trade shocks are alike in the sense that only ToT enters the equilibrium conditions and the impact of $p_t^{x,\$}$ and $p_t^{m,\$}$ is proportional to their impact on ToT.[16]

On top of this mechanism, Drechsel and Tenreyro (2018) highlight the interaction between country financing conditions, defined as the country spread over the international real rate, and the terms of trade. Allowing for export and import prices to have a different impact on the spread would potentially introduce additional heterogeneity in the transmission of $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks.

[13] More generally, with financial constraints, shocks to $p_t^{x,\$}$ and $p_t^{m,\$}$ can have a different impact in the economy insofar as they have a different impact on the collateral function.

[14] We thank Stephanie Schmitt-Grohé for highlighting this as a potential transmission mechanism.

[15] Alternatively equation (8) can be re-written in terms of $p_t^{x,\$}$, specifically: $\frac{d_{t+1}}{p_t^{x,\$}(1+r_t)} = \frac{d_t}{p_t^{x,\$}} + \frac{m_t}{ToT_t} - x_t$.

[16] In that case, the country's resource constraint is $\frac{p_t^m d_{t+1}}{1+r_t} = p_t^m d_t + p_t^m m_t - p_t^x x_t$, which implies that $\frac{d_{t+1}}{(1+r_t)} = d_t + m_t - ToT_t x_t$.

2.5 Independent $p_t^{x,\$}$ and $p_t^{m,\$}$ within a Calibrated MXN Model

In Appendix A we extend the MXN model along two main dimensions. First, we assume that the LOOP holds for imports and exports rather than for tradables. Second, we assume that domestic debt is priced in terms of foreign consumption goods instead of tradable consumption goods.

Within this modified setting we show that the effects of $p_t^{x,\$}$ and $p_t^{m,\$}$ are heterogeneous. The transmission mechanism of a positive $p^{x,\$}$ shock resembles the one of a positive "traditional" ToT shock in a standard SOE model. In particular, an increase in export prices leads to a substitution towards importable and nontraded goods, an income effect whereby households increase their demand for all goods, including nontradables, and an exchange rate appreciation. This generates an expansion in consumption, investment, and output. By contrast, a positive $p^{m,\$}$ shock leads to an overall contraction of output, investment, and consumption. However, the transmission of this shock does not mirror the effect of a negative ToT shock in a standard SOE model. One stark contrast between the two models is that in response to a $p^{m,\$}$ shock the real exchange rate appreciates, as in Catão and Chang (2015). This exercise conveys that there are more terms-of-trade shocks that should be taken into account when looking at the transmission of foreign shocks into the domestic economy in an SOE environment.

3 Data and Descriptive Statistics

We focus on emerging and low-income countries as in Schmitt-Grohé and Uribe (2018). The sample is annual and covers the period 1980-2019 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. This group is defined as all countries with an average GDP per capita at PPP US dollars of 2005 over the period 1980-2019 below 25,000 dollars according to the World Bank's World Development Indicators (WDI) database.[17] Appendix B details the data sources. 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. All the variables are calculated as the quadratically detrended log of the original data.[18]

3.1 Macroeconomic Data

The country-specific macroeconomic variables are real GDP per capita (y_t), real consumption expenditure per capita (c_t), real gross investment per capita (i_t), the trade balance as a percentage of GDP (tb_t), and the real exchange rate (q_t). Our empirical measure of the real exchange rate is the bilateral US dollar real exchange rate defined as $q_t = \frac{\mathcal{E}_t P_t^*}{P_t}$, where $\mathcal{E}_t$ is the official nominal exchange rate, P_t^* denotes the US CPI, and P_t is the domestic country CPI. Since the real exchange rate is defined as the price of foreign goods in terms of domestic goods, a decrease in the real exchange rate 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 Bertolotto (2016). We measure real world GDP using an aggregate obtained from Haver Analytics calculated based on data for 63 countries, expressed at 2010 prices and

[17]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.

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

exchange rates. A full description of the macro data is detailed in Appendix B.1.

3.2 Export and Import Price Indices

We construct country-specific export and import price indices denominated in US dollars ($P^{x,\$}$ and $P^{m,\$}$) using sectoral export and import shares, commodity prices, and disaggregated US PPI data as a proxy for manufacturing prices. For each country, we compute $P^{x,\$}$ and $P^{m,\$}$ following the indications of the IMF Export and Import Prices Manual.[19] 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:

$$P^{0:t} = P^{0:t-1} \sum_{j=1}^{No.Goods} w_{j,t-1} P_j^{t-1:t}, \tag{9}$$

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:

$$P^{0:t} = \prod_{\tau=1}^{t} \left[\sum_{j=1}^{No.Goods} \left(w_{j,\tau-1} \frac{P_{j,\tau}}{P_{j,\tau-1}} \right) \right]. \tag{10}$$

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 3.3, these changes can be quite significant for some countries.

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.[20] 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 B.2). For 16 manufacturing categories such as transport equipment, machinery and equipment, and textile products and apparel we proxy world prices using sectoral US PPI data sourced from the Federal Reserve Bank of St. Louis FRED. The implicit assumption for using US PPI data is that the LOOP holds for the manufacturing sector. Ideally, we would like to have the specific prices of the actual goods that are exported and imported but due to data limitations this is not possible. Table B.2 in Appendix B 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.

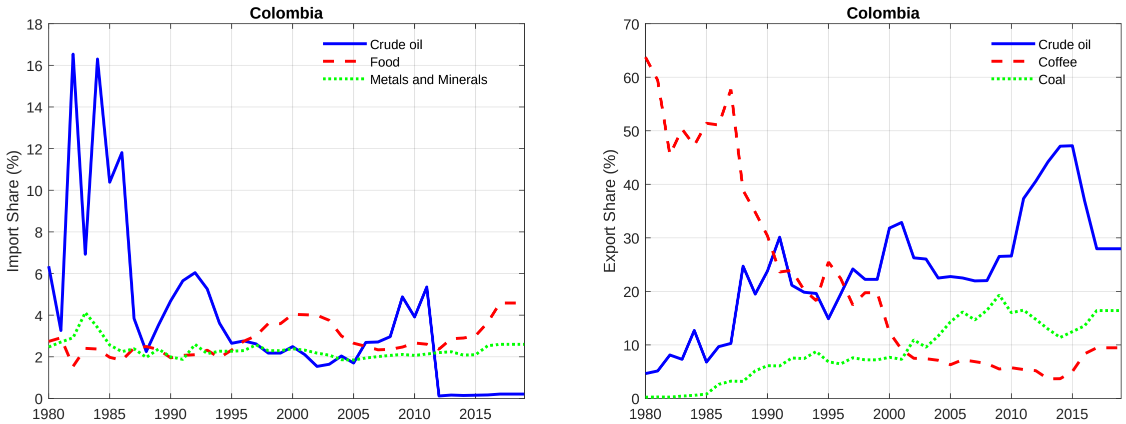
In our empirical analysis we deflate the export and import price indices by the US CPI, and therefore consider real dollar export and import prices (as in Cashin et al., 2004) defined as $p_t^{x,\$}$ and $p_t^{m,\$}$.[21] The terms of trade of a given country are defined as the relative price of

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

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

[21] Given that a large fraction of the export and import shares is composed of commodities whose prices are

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 for the period 1980-2016.

its exports in terms of its imports and can be calculated as: $ToT_t = \frac{p_t^{x,\$}}{p_t^{m,\$}}$.

3.3 Time Variation in Trade Shares

Developing countries depend heavily on commodity exports which 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.[22] This is not surprising given that developing countries' economies are less diversified and therefore tend to import a wide range of products.

Countries specialize in exports of different groups of commodities. However, many of them depend on exports of crude oil and food.[23] In fact, over the sample period analyzed, crude oil is the main export for 10 countries while food is the main export for 7 countries. There is, however, heterogeneity in the relative importance of commodity exports across countries. While total commodity exports represent 17 percent in Bangladesh, they account for 93 percent of total exports for Algeria for the period between 1980 and 2019. Given that many countries also depend on crude oil and food imports, 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, exports of a few commodities represent a large share of total exports while the importance of commodity imports is much smaller. This could be an indication that price shocks affecting exports may have different effects on the economy than price shocks affecting imports.

There is a group of countries for which we observe that the main commodities exported and imported shifted significantly across the different periods. For example, Figure 2 shows

orders of magnitude more volatile than the US CPI, deflating export and import prices makes little difference for their dynamics. Our empirical analysis is not be affected by this.

[22] See Tables C.1-C.5 in Appendix C.

[23] 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`.

that up to the early 1990s coffee was the main commodity export for Colombia, representing around 40 percent of total exports, but afterward oil became the main export with a trade share of up to 50 percent. Moreover, in the early 1980s Colombia was a net importer of crude oil, but then switched to a net exporter. These changes in the values of the trade shares have important implications for computing terms of trade. Following with this example, it is clear that in the early part of the sample the price of oil would be negatively correlated with $p_t^{m,\$}$ and ToT_t. In the second part of the sample it would instead be positively correlated with ToT_t because of its positive correlation with $p_t^{x,\$}$. It is common in the literature to construct terms of trade proxies using fixed trade shares. What would happen if we measured terms of trade using a fixed trade share? Using fixed trade shares would severely bias the results against finding an important role for the terms of trade in explaining output fluctuations whenever a country trade specialization changes substantially over time so that it shifts from being a net importer to a net exporter of a given commodity (or the other way around). In the example of Colombia, if we had used fixed trade shares anchored in the values of the 1980s, the terms of trade would be negatively correlated with the "true" terms of trade in the first half of the sample. Given that a terms of trade improvements are associated with an increase in output, the terms of trade measure with fixed shares would result in a positive correlation between terms of trade and output in the early part of the sample and an erroneous negative correlation in the second part, possibly bringing the correlation for the entire sample closer to zero.

These examples highlight the importance of using time-varying trade shares given that the shifts in trade specialization over time are present for the majority of countries. The change in the pattern of export specialization is related to the findings of Daruich, Easterly and Reshef (2019) who document that these patterns are not persistent over time. Interestingly, we find a similar result not only for export but also for import specialization.

3.4 Alternative Measures of Terms of Trade

It is instructive to compare different terms-of-trade measures, namely the official one based on unit values (ToT^o), the one we construct (ToT), and the commodity terms of trade (ToT^c). The latter is often used in the literature as a proxy of the relevant ToT for EMDEs (see Ben Zeev et al., 2017; Cashin et al., 2004). ToT^o, sourced from the WDI, is calculated as a ratio of the export unit value index to the import unit value index. Unit values are derived from countries' customs data. As it has been pointed out in earlier literature, these indices are likely to contain biases stemming from changes in the mix of heterogeneous products recorded in customs documents or poor quality of recorded data on quantities (see Kravis and Lipsey, 1971; Silver, 2009). In addition, those biases are likely to be different for each of the countries considered.

The main advantage of the proxies of export and import prices, and hence terms of trade, that we construct is that they are partly based on observable (world) commodity prices and linked to each of the countries based on their trade exposure. For manufacturing, prices data are more limited and we therefore use different categories of US PPI, which are the same for all countries in our sample.[24] ToT^c is another popular measure used in the literature (see Cashin et al., 2004; Bidarkota and Crucini, 2000). As the name suggests, it is based on commodity trade shares and associated prices only.[25] We construct ToT^c using the export and import commodity prices calculated using equations (9) and (10) but including only commodity prices and trade shares.

Table 1 compares the main summary statistics. The initial block of the table shows, for our ToT measure, ToT^o and ToT^c, the standard deviation (σ), the persistence (measured by

[24] We acknowledge that this is a limitation of the given the potential price dispersion for manufacturing and final goods but it is not possible to obtain country-specific price measures at such a granular level.

[25] Note that Cashin et al. (2004) use only nonfuel primary commodities.

Table 1: Terms of Trade: Descriptive Statistics

	Terms of Trade (our measure)			Terms of Trade (unit values)			Commodity Terms of Trade				
	$\sigma(ToT)$	$\rho_1(ToT)$	$Corr(ToT, y)$	$\sigma(ToT^o)$	$\rho_1(ToT^o)$	$Corr(ToT^o, y)$	$\sigma(ToT^c)$	$\rho_1(ToT^c)$	$Corr(ToT^c, y)$	$Corr(ToT, ToT^o)$	$Corr(ToT, ToT^c)$
Algeria	33.5	80.2	70.9	35.6	79.4	60.9	29.8	78.4	72.1	95.0	94.4
Argentina	10.5	73.9	59.1	10.5	53.5	63.5	7.4	52.0	-49.3	55.3	-37.1
Bangladesh	8.6	83.0	-3.6	10.2	70.4	-4.2	7.6	75.3	30.3	88.8	80.1
Bolivia	15.0	78.1	28.4	21.0	82.1	4.1	9.2	58.2	0.0	80.6	21.1
Brazil	5.2	67.0	64.9	10.1	51.8	41.0	10.7	68.2	-25.6	46.1	23.4
Burkina Faso	13.5	68.7	-35.3	17.4	85.0	-52.3	17.1	75.4	-54.3	76.6	65.7
Cameroon	17.8	79.3	0.1	14.2	29.2	30.2	10.6	63.6	16.5	55.1	72.6
Chad	23.3	65.2	47.0	22.7	73.4	69.3	13.6	34.8	14.3	77.9	77.5
Colombia	16.0	72.3	5.3	16.2	74.7	-13.2	12.7	51.4	-21.6	95.6	74.2
Congo, Dem. Rep.	12.1	66.1	-21.9	16.9	54.1	17.2	9.9	55.0	11.3	62.9	71.4
Cote d'Ivoire	10.5	51.9	-29.8	16.9	48.1	-28.7	15.1	52.9	32.5	45.9	60.0
Dominican Republic	7.7	43.0	29.7	9.2	48.3	51.1	11.0	45.9	5.9	5.2	71.2
Egypt, Arab Rep.	14.8	69.4	11.9	13.9	77.9	20.3	18.5	72.3	25.1	53.9	94.1
Equatorial Guinea	26.5	72.3	46.6	34.9	81.4	58.5	16.5	58.3	23.3	72.0	84.3
Gabon	29.1	76.9	-38.0	24.2	74.9	-5.4	22.2	71.7	-33.2	84.2	92.1
Ghana	11.9	68.8	26.9	13.0	52.7	20.2	10.7	47.0	-13.3	83.1	29.0
Guatemala	7.1	46.1	9.5	19.4	44.3	3.7	15.0	63.2	-33.1	58.9	67.1
Honduras	5.4	37.1	-21.4	20.1	68.4	34.1	14.7	71.0	-29.7	-5.8	58.0
India	5.5	70.0	8.9	11.0	68.6	-12.1	10.5	70.2	20.6	71.0	79.8
Indonesia	8.6	78.4	-36.9	16.0	71.5	-21.0	7.4	74.8	-43.8	85.4	66.0
Jordan	5.1	37.6	31.5	9.3	41.7	-7.2	8.8	39.8	37.3	25.1	82.9
Kenya	7.8	43.9	14.3	10.1	65.7	-18.2	17.0	65.7	43.6	26.9	54.8
Madagascar	7.2	51.4	21.4	10.8	64.5	-27.3	9.7	60.9	-21.6	17.6	31.8
Malawi	8.3	56.6	26.1	10.1	44.9	17.7	15.8	61.8	-21.5	57.4	44.3
Mauritius	14.7	54.3	47.5	9.9	67.2	-8.7	22.1	58.4	64.0	9.0	93.2
Mexico	7.4	73.3	68.3	19.9	82.2	68.0	11.2	68.2	48.4	96.4	82.8
Morocco	3.8	44.4	0.2	5.6	24.8	-11.1	6.7	49.6	-2.4	38.8	54.6
Niger	12.1	80.1	-8.9	18.9	79.5	-3.8	24.0	77.1	-23.7	37.0	93.1
Nigeria	32.5	76.8	67.7	35.0	74.8	57.7	24.5	74.3	43.7	97.4	90.4
Pakistan	9.5	80.6	9.6	11.4	72.9	-12.1	13.4	74.6	33.5	69.2	79.8
Peru	12.2	73.5	46.1	14.4	74.1	53.9	7.9	45.8	-10.5	76.8	22.2
Philippines	6.1	61.1	-6.6	10.1	52.9	-14.0	10.7	59.5	-16.3	60.5	83.3
Senegal	5.4	52.7	-41.3	13.4	79.3	-42.8	6.2	61.0	-42.6	11.8	17.2
South Africa	7.9	79.0	64.9	5.5	63.5	29.7	8.0	60.5	-45.8	74.9	9.5
Sudan	17.9	74.0	50.6	16.1	73.5	47.9	10.0	25.4	-15.0	90.4	48.8
Thailand	6.2	55.1	37.3	5.6	67.3	56.2	11.6	59.9	44.9	49.0	71.6
Turkey	4.8	72.7	-12.9	6.3	61.1	52.9	9.7	75.8	27.2	39.2	73.3
Uruguay	7.6	75.4	52.4	9.1	63.2	40.8	17.0	77.0	23.4	81.5	76.8
Median	9.0	69.7	17.9	13.6	67.9	17.5	11.1	61.4	2.9	61.7	71.5

Notes: σ denotes standard deviation, ρ_1 is the first order autocorrelation, and $Corr$ indicates correlation. ToT, ToT^o and ToT^c represent our measure of terms of trade, the official one based on unit values, and the commodity terms of trade, respectively. 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.

the first order autocorrelation, ρ_1) and the ToT-output correlations. The last block of the table includes the correlations of our ToT measure with ToT^o and ToT^c.

This table illustrates some important facts. First, focusing on the median values, ToT is positively correlated with both and ToT^o and ToT^c. The median persistence is also broadly comparable across the three measures. Therefore, at first glance it would appear as if these three measures would tell us a similar story. However, some moments of the data are dissimilar. For instance, the median volatility is substantially lower for ToT than for ToT^o and ToT^c. In addition, there are stark contrasts in the median correlation between the different ToT measures and output. It is is 17.9 percent using ToT, 17.5 percent using ToT^o and only 2.9 percent using ToT^c.

Second, there are considerable differences in the moments of the data at the country level. For most of the countries (21 out of 38) ToT and ToT^o are positively correlated and the correlation in the detrended data is higher than 50 percent.[26] However, some correlations are surprisingly low, with the notable example of Honduras, which displays a negative correlation. The correlation between ToT and ToT^c is higher and positive with the exception of Argentina. We also observe substantial cross-country differences in the variability and persistence across the three terms-of-trade measures as well as in their respective correlations with output. The correlation between the terms of trade and output, which is generally low and positive, varies considerably across countries. Looking at the values for our measure, the correlation ranges from -41 percent for Senegal to 71 percent for Algeria.

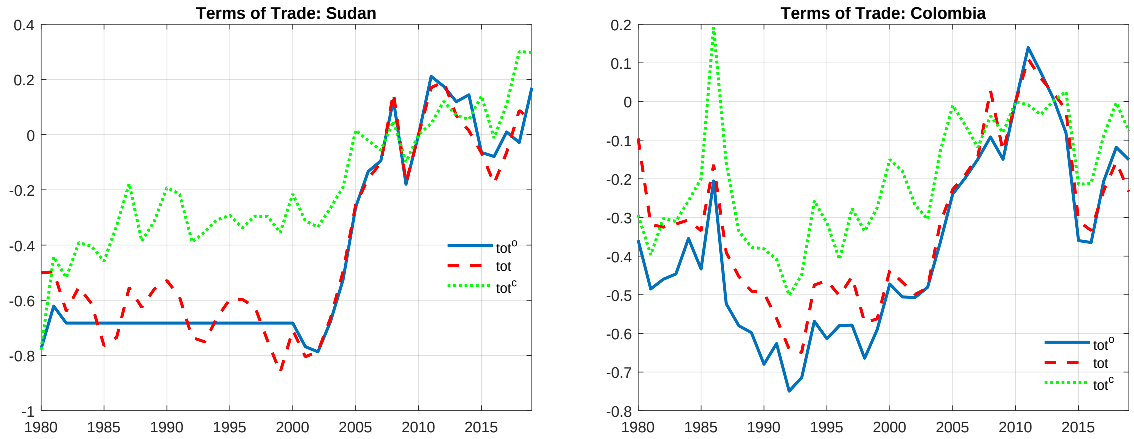
This heterogeneity is particularly relevant because theoretical models use as an input for calibration the standard deviation, the persistence, and the ToT-output correlation of the observed terms-of-trade measures. If these moments are similar across the terms-of-trade measures, the model would yield similar results for all three. However, if they are not, the model predictions can vary considerably depending on the measure used. At the country-level there is substantial heterogeneity in the variability and persistence of the different terms-of-trade measures, and some differences are also visible in median values.

ToT^o contains some patterns which are difficult to explain. As an example, Figure 3 plots the ToT, ToT^o and ToT^c for two countries in our sample, Sudan and Colombia. For Sudan, it is clear that there is a measurement issue since ToT^o is constant for about 18 years.[27] In the case of Colombia, we observe that ToT^o and ToT comove for the entire period. By contrast, when we consider ToT^c we observe a significant higher volatility. Note that not accounting for the share of manufacturing tends to overstate the volatility of export and import prices, particularly the latter, since they are more manufacturing intensive. In all countries, the commodity export and import prices, denoted as $p_c^{x,\$}$ and $p_c^{m,\$}$, respectively are more volatile than their all goods counterparts, $p^{x,\$}$ and $p^{m,\$}$. The median value of the volatility ratio of the commodity index over the all goods index is 1.47 for export prices and 2.99 for import prices. Interestingly, when we compare the ratio of the volatility between ToT^c and ToT ($\sigma(ToT^c)/\sigma(ToT)$), we find that the volatility ToT^c is instead larger than the one for ToT in only 8 countries, with a median value of 0.8. This happens because $p^{x,\$}$ and $p^{m,\$}$ are dominated by a few commodity prices and are highly correlated, which yields larger fluctuations in the numerator and denominator that tend to cancel out. Table C.6 in Appendix C summarizes these results. As a final observation, one striking feature of ToT^o is that it was subject to substantial data revisions across the two data vintages we have, which correspond to the data

[26]Given that we are linking 988 sectors into 62 categories for which we have commodity and manufacturing price data, the correlation is quite remarkable. 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.

[27]This period coincides with the Second Sudanese Civil War.

Figure 3: Terms of Trade Measures: A Comparison



Notes: This Figure shows the evolution of alternative measures of terms of trade for Sudan and Peru over the period 1980-2016. ToT^o is the (log) official measure of terms of trade sourced from WDI, ToT is the (log) measure of terms of trade that we compute using our own export and import price indices, and ToT^c denotes (log) commodity terms of trade. Each of the terms of trade measures are normalized to equal zero (i.e. one in levels) in 2010.

downloaded in 2017 and 2020.[28]

These observations have important implications. First, our measure is partly based on actual world prices and is potentially less prone to the measurement issues originated in the use of unit value measures. Second, including the price of manufacturing goods is essential to recover the volatility and persistence of export and import prices to appropriately identify export and import price shocks and their contribution to the economy. Finally, a country-by-country calibration exercise of traditional SOE models would yield very different results depending on the measure of terms of trade used given the large heterogeneity in the data moments.

3.5 Empirical Regularities: Export and Import Prices

Table 2 summarizes the main descriptive statistics for export and import prices data by country. In particular, it shows the standard deviation and the persistence of export prices and import prices; their correlation with output, 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 that we are able to explain with the first principal component of the series.

Four 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.[29] Second, export prices and

[28]There are different ways to measure how important revisions are in practice. Following Aruoba (2008), one way consists on looking at the noise-to-signal ratio which is given by the variance of the revision (between the 2020 and 2017 vintages) divided by the variance of the terms of trade obtained from the 2020 vintage. Large numbers suggest that the revisions are sizable. It turns out that some ratios are extremely large. For Honduras and Guatemala, for example, the noise-to-signal ratio is 80 percent and 71 percent, respectively. By contrast, the revisions from our ToT measure are generally much smaller and stemming from revision of the PPI data. Appendix C.1 provides further analysis.

[29]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.

Table 2: Export and Import Prices: Descriptive Statistics

	Export Prices			Import Prices			
	$\sigma(p^{x,\$})$	$\rho_1(p^{x,\$})$	$Corr(p^{x,\$}, y)$	$\sigma(p^{m,\$})$	$\rho_1(p^{m,\$})$	$Corr(p^{m,\$}, y)$	$Corr(p^{x,\$}, p^{m,\$})$
Algeria	36.2	79.1	68.7	6.5	74.7	17.9	49.9
Argentina	15.5	76.5	63.2	5.4	77.2	67.2	95.9
Bangladesh	3.3	59.2	-5.5	9.9	77.5	1.3	53.3
Bolivia	19.6	77.3	21.3	6.3	75.9	-1.3	80.3
Brazil	12.8	76.8	83.4	9.8	74.3	74.9	93.0
Burkina Faso	17.2	68.9	-20.5	7.1	68.7	17.3	67.7
Cameroon	25.0	79.3	3.2	8.8	75.1	8.7	87.3
Chad	27.6	68.9	49.4	5.0	75.3	53.2	87.8
Colombia	20.2	74.6	17.0	5.4	72.2	47.8	83.6
Congo, Dem. Rep.	17.6	70.1	-10.8	7.0	75.0	10.6	86.0
Cote d'Ivoire	17.4	74.3	-67.7	11.6	74.0	-74.8	81.3
Dominican Republic	9.9	51.2	25.3	7.2	74.6	3.2	64.1
Egypt, Arab Rep.	19.8	71.0	27.0	9.5	75.9	37.4	69.5
Equatorial Guinea	30.3	74.5	50.8	5.5	73.4	54.7	72.9
Gabon	32.1	76.8	-38.3	5.2	76.6	-23.8	63.2
Ghana	17.5	74.2	33.6	7.2	70.9	37.1	85.5
Guatemala	12.2	68.2	24.5	8.1	72.7	28.5	82.6
Honduras	7.8	55.1	42.4	8.5	80.0	52.4	78.7
India	8.4	74.7	36.3	12.6	75.7	20.1	94.1
Indonesia	17.1	77.3	-21.9	11.7	79.2	-5.0	89.0
Jordan	12.8	68.0	45.9	9.2	75.3	46.4	94.5
Kenya	13.6	71.0	-17.6	10.3	74.5	-34.2	81.9
Madagascar	11.7	64.8	24.9	6.5	71.9	21.2	83.6
Malawi	11.3	71.4	46.9	6.6	75.6	47.4	68.6
Mauritius	17.6	59.5	36.1	6.8	67.7	-9.2	58.6
Mexico	9.4	70.3	50.4	4.2	62.8	-7.0	65.6
Morocco	10.7	69.7	43.7	9.2	74.8	50.5	93.7
Niger	13.7	76.0	3.8	6.7	77.4	23.8	46.5
Nigeria	37.6	77.3	72.0	7.5	79.5	68.2	74.1
Pakistan	6.3	66.2	-5.4	12.2	74.7	-10.2	64.7
Peru	20.7	78.8	50.2	9.0	78.4	52.9	96.7
Philippines	6.0	34.6	38.8	6.3	58.6	43.3	52.2
Senegal	14.6	69.2	-16.0	10.6	72.8	-0.9	95.6
South Africa	14.4	79.8	74.9	7.1	75.3	78.4	94.7
Sudan	22.8	74.0	56.5	6.4	61.4	59.7	82.4
Thailand	8.5	60.3	28.0	9.0	73.9	0.9	75.3
Turkey	6.7	63.7	0.9	9.0	76.1	7.5	85.1
Uruguay	10.8	75.7	48.3	11.0	78.5	11.2	75.8
Median	14.5	71.2	30.8	7.4	74.9	20.6	81.6
PC#1	80.2			93.1			

Notes: σ denotes standard deviation, ρ_1 is the first order autocorrelation, and $Corr$ indicates 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.

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 economic activity 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. Finally, both the correlation between export prices and output, and import prices and output are higher than the correlation between ToT and output. Although counter-intuitive, the correlation between import prices and output is positive, which goes against what would be expected if import price shocks are thought as negative ToT shocks. However, this can be explained by the fact that import prices are not exogenous to aggregate macroeconomic conditions. If most of the variation in import prices reflects changes in global demand, then the positive comovement is a reflection of the comovement between domestic and global business cycles.

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.

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

	$\sigma(p^{x,\$})$					$\sigma(p^{m,\$})$			
Commodity Export Share	0.264***	0.207***	0.180***	0.153***	Commodity Import Share	0.284***	0.312***	0.311***	0.292***
	(0.035)	(0.044)	(0.047)	(0.037)		(0.023)	(0.029)	(0.050)	(0.021)
Agricultural Exporters		-0.032*	-0.017	-0.015	Agricultural Importers		-0.015***	-0.015***	-0.011***
		(0.017)	(0.015)	(0.012)			(0.003)	(0.003)	(0.003)
Energy Exporters		0.068***	0.064***	0.066***	Energy Importers		0.004	0.004	-0.001
		(0.021)	(0.018)	(0.017)			(0.005)	(0.007)	(0.004)
Metals Exporters		-0.010	0.008	0.017					
		(0.022)	(0.020)	(0.018)					
H Index Exports (all goods)			0.120**		H Index Imports (all goods)			-0.011	
			(0.054)					(0.228)	
H Index Exports (all commodities)				0.149***	H Index Imports (all commodities)				0.141**
				(0.042)					(0.054)
Adj. R^2	0.604	0.775	0.820	0.841	Adj. R^2	0.710	0.814	0.808	0.849

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.

This serves as a further motivation to consider export and import prices separately and also to account for the presence of global economic activity shocks.

The last row of the table shows the percentage of the variability of export prices, import prices 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 80 percent of the variation in export prices and 93 percent in the variation in import prices.[30] 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 71 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. In fact, 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.[31] This highlights that a common shock to export and import prices is important to explain the data. We will introduce such shock in the form of a global economic activity shock.

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 country across the period analyzed. 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. 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.

[30] Fernández et al. (2018) document the presence of a factor structure in the commodity price of exports. We show a similar stylized fact for a broader export price (which includes manufacturing goods) and a larger number of countries. Moreover, we show that a similar feature holds for the price of imports.

[31] The loadings on the principal components for the ToT appear with different signs, highlighting that ToT are often negatively correlated across countries. On the contrary, the loadings are typically all of the same sign both the price of exports and imports. We do not show these results to preserve space but they are available upon request.

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 may respond differently to export and import price shocks. Since the price of exports and imports are highly correlated, by looking at the effects of terms-of-trade shocks we may be missing the important role played by world shocks which move these international prices in the same direction and are therefore partially canceled out when looking at the difference between these prices, i.e. the ToT. These patterns that we observe in the data provide a motivation for our baseline analysis.

3.6 The Trade Balance and the Terms of Trade

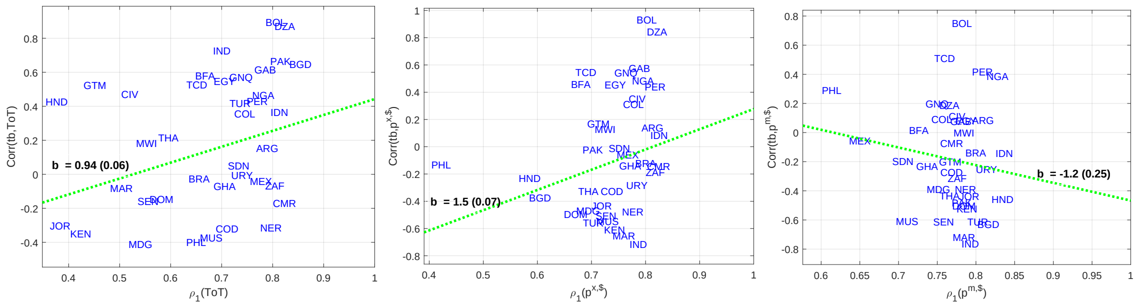
The literature has proposed two explanations for the relationship between the trade balance and the terms of trade. On the one hand, the Harberger-Laursen-Metzler (HLM) effect would predict that a rise in the terms of trade would improve the trade balance (see Harberger, 1950 and Laursen and Metzler, 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).[32]

Traditionally, researchers have analyzed the link between between ToT and the trade balance by looking at the association between the correlation of the trade balance over GDP and the terms of trade, $corr(tb, ToT)$, as a function of the persistence of ToT, $\rho_1(ToT)$ (see, for example Mendoza, 1995). In standard SOE models this relationship should be negative. By contrast, the literature has not found a systematic relationship in the data (this is the case in Mendoza, 1995 as well as in Schmitt-Grohé and Uribe, 2017, chapter 7). As shown in Figure 4, our data show a positive relation between $corr(tb, ToT)$ and $\rho_1(ToT)$, which is at odds with theory. In fact, regressing $corr(tb, ToT)$ on $\rho_1(ToT)$ yields a slope coefficient of 0.94 (with a p-value of 0.06).

We favor looking at the relation for export prices and import prices separately since we would expect that the correlation between each international price and the trade balance as a function of persistence would be different for export and import prices. The ToT would inevitably mix the persistence in export and import prices. In addition, export and import price shocks will most likely have a different impact on the trade balance, as we show from a theoretical standpoint. As we discuss in Appendix A.4, in a model with independent export and import price shocks, a positive export price shock and a negative import price shock are not symmetric. This leads to a theoretically negative relation between $corr(tb, p^{x,\$})$ and $\rho_1(p^{x,\$})$, and between $corr(tb, p^{m,\$})$ and $\rho_1(p^{m,\$})$. Theoretically, this suggests that export price shocks resemble a positive ToT shock from traditional SOE models while negative import price shocks do not. Therefore, as a next step we analyze the relation between $corr(tb, p^{x,\$})$ and $\rho_1(p^{x,\$})$ as well as between $corr(tb, p^{m,\$})$ and $\rho_1(p^{m,\$})$ using our data. In principle, it is not clear what to expect in terms of this association because the effects of an increase in export prices do not necessarily mirror the effects of a decline in import prices. If the $p^{x,\$}$ shock is thought as a positive ToT shock and a $p^{m,\$}$ shock as a negative ToT shock, we would in principle be tempted to assume that we should get a downward slopping curve for export prices and an upward slopping curve for import prices. Figure 4 shows that the data suggest the opposite. The relation between between $corr(tb, p^{x,\$})$ and $\rho_1(p^{x,\$})$ is upward slopping, and statistically significant, while the link between $corr(tb, p^{m,\$})$ and $\rho_1(p^{m,\$})$ is downward slopping, although not statistically significant.

[32] 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 to respond less and even turn negative.

Figure 4: Correlation of the Trade Balance with International Relative Prices



Note: The left panel shows the $corr(tb, ToT)$ (y-$axis$) and $\rho_1(ToT)$ (x-$axis$). The middle panel of this figure shows the $corr(tb, p^{x,\$})$ (y-$axis$) and $\rho_1(p^{x,\$})$ (x-$axis$). The right panel shows the $corr(tb, p^{m,\$})$ (y-$axis$) and $\rho_1(p^{m,\$})$ (x-$axis$).

As highlighted by Mendoza (1995) this relationship can go against the predictions of theory due to the presence of other shocks. In Section 5.1 we will look at the relationship between the trade balance and international relative prices, conditional on presence of export and import price shocks.

3.7 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 known that ToT 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 country-specific 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 measure tends to be strongly correlated with ToT^o, the two measures remain different and for some countries the difference can be quite large. 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. In addition, we use the data to test some terms of trade restrictions which point at the importance of analyzing export and import prices separately.

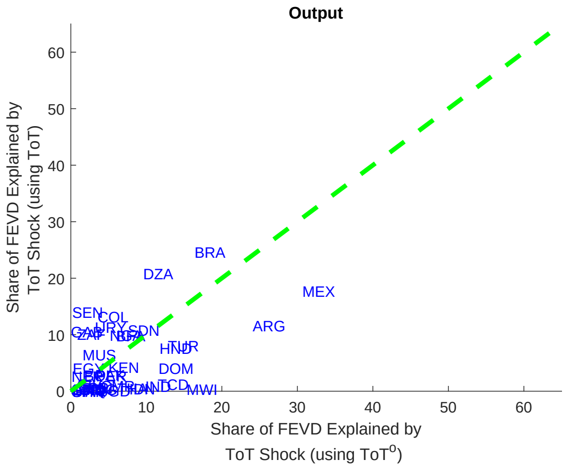
3.7.1 It's not just measurement

The scatter plot in Figure 5 compares the one-year ahead forecast error variance decomposition for output driven by terms-of-trade shocks using the official measure (x-axis) *vis-à-vis* our measure (y-axis). With the exception of a handful of countries, the contribution of ToT to the variability of output is rather limited for the countries in the our sample. In fact, in line with Schmitt-Grohé and Uribe (2018), we still find that on average, terms-of-trade shocks explain about 10 percent of the variance decomposition of output for both measures. The same result holds when we do this exercise on the other macro variables. This suggests that a single measure of world prices like the ToT provides insufficient information to uncover the channels through which global shocks are transmitted to the economy.

3.7.2 Terms of Trade Restrictions

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

Figure 5: Forecast Error Variance Decomposition: ToT and ToT^o Shocks



Notes: The Figure compares the one-year ahead 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).

imports, with an opposite sign. In other words, a simultaneous increase of the same 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. In particular, for each variable of interest in the data set, we run the following regression in a panel framework:[33]

$$x_{ik,t} = a_0 + a_1 x_{ik,t-1} + \sum_{j=0}^{1} b_j^x p_{k,t-j}^{x,\$} + \sum_{j=0}^{1} b_j^m p_{k,t-j}^{m,\$} + D_k + v_{ik,t}, \tag{11}$$

where $x_{ik,t}$ is the log of the variable of interest i (quadratically detrended) for country k in year t; $p_{k,t}^{x,\$}$ and $p_{k,t}^{m,\$}$ are the log of export and import prices (quadratically detrended) for country k at time t, respectively; and D_k is a country fixed effect. Robust standard errors are adjusted for clustering at the country-year level. Noting that $ToT_{k,t} = p_{k,t}^{x,\$} - p_{k,t}^{m,\$}$ the regression above becomes particularly convenient to test the hypothesis that a positive shift in terms of trade has the same impact on the economy whether it 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:

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

Table 4 shows 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. 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., 2017) 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.

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

Table 4: Testing Terms of Trade Restrictions

	Output (1)	Consumption (2)	Investment (3)	Trade Balance (4)	Real Exchange Rate (5)
F-test	12.5	5.18	9.87	7.65	40.3
	(0.000)***	(0.004)**	(0.006)***	(0.000)***	(0.000)***

Notes: This table reports the results of the F-test for the Hypothesis. *p-values* in parenthesis. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

4 Econometric Method

We follow the practice of the empirical literature on terms-of-trade shocks (see e.g. Schmitt-Grohé and Uribe, 2018), as well as the theoretical studies (see e.g. Mendoza, 1995), and impose a standard "small open economy" assumption which implies that there is no impact from the current or lagged country specific macroeconomic variables to the "foreign bloc" of variables. The foreign bloc pins down the channels through which world shocks are transmitted to small open economies and includes two world prices which are export prices and import prices, as well as a measure of global economic activity. Specifically, let

$$\mathbf{z}_{k,t} = \left[y_t^g, p_{k,t}^{x,\$}, p_{k,t}^{m,\$}\right]', \tag{12}$$

where y_t^g is the log-deviation of real world GDP from its trend.

The impact of the three shocks of interest, $\mathbf{u}_{k,t}$, to the "foreign bloc" of variables can be recovered from the following structural VAR, which we estimate country-by-country:[34]

$$\mathbf{z}_{k,t} = \mathbf{a}_k + \mathbf{A}_{1k}\mathbf{z}_{k,t-1} + \mathbf{A}_{0k}^{-1}\mathbf{u}_{k,t}, \tag{13}$$

where $\mathbf{A}_{0k}^{-1}$ captures the contemporaneous impulse response of the shocks to the foreign bloc and $\mathbf{u}_{k,t} \sim N(0, I)$. In the next subsection we describe the identification restrictions used to identify the structural shocks in equation (13). In order to retrieve the impact of the shocks $\mathbf{u}_{k,t}$ to the macroeconomic variables of each country we use a simple regression approach in line with Kilian (2008, 2010).

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

$$x_{ik,t} = \rho_{0k} + \rho_{1k}x_{ik,t-1} + \gamma_{0k}\mathbf{z}_{k,t} + \gamma_{1k}\mathbf{z}_{k,t-1} + \varepsilon_{ik,t}, \tag{14}$$

where the structural innovation $\varepsilon_{ik,t}$ is serially uncorrelated (see, e.g., Cooley and LeRoy, 1985). The 1×3 vector of coefficients γ_{jk} captures the impact (including the direct and indirect effects) of a shift in the "global variables" $\mathbf{z}_{k,t}$ (Pesaran and Smith, 2014). Under strict exogeneity, there is no current or lagged feedback from $x_{ik,t}$ to $\mathbf{z}_{k,t}$ and we can retrieve the impact of the shocks of interest onto the macroeconomic variables combining (13) with

[34] 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).

(14):

$$x_{ik,t} = c_{0k} + \gamma_{0k}\mathbf{A}_{0k}^{-1}\mathbf{u}_{k,t} + \sum\nolimits_{j=1}^{\infty} \rho_{1k}^{-j} \left(\gamma_{0k} + \gamma_1 \mathbf{A}_{1k}\right) \mathbf{A}_{1k}^{-j}\mathbf{A}_{0k}^{-1}\mathbf{u}_{k,t-j} + \sum\nolimits_{j=0}^{\infty} \rho_{1k}^{-j}\varepsilon_{ik,t}. \quad (15)$$

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 (13) and (14) are relatively parsimonious, they have a reduced estimation error on short samples and are also more robust to structural change. Second, given that equation (14) 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 (15) 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 5 provide a measure of the expected response of macroeconomic variables to exogenous global shocks based on historical data.[35] 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 using inverse variance weights (see, for example, Swamy, 1970; Havránek et al., 2020) which is a standard approach to report results of meta-analysis studies.

4.1 Identification

We identify export price, import price and global economic activity 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.[36]

We impose a minimum set of sign restrictions for each shock, summarized in Table 5. The sign restrictions for export and import price shocks are consistent with the model presented in Appendix A. A positive export price shock generates a substitution towards importable and nontraded goods. The increase in export prices also leads to an income effect whereby households become richer and therefore increase their demand for all goods, including nontradables. The expansion in the exportable and nontradable sectors would typically lead to an increase in GDP. By contrast, in response to an import price shock GDP contracts. We leave the response of other variables unrestricted to let the data speak.

In order to better disentangle positive shocks to import prices *vis-à-vis* negative shocks

[35] 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 economic activity, export price and import price shocks.

[36] In a related paper, De Winne and Peersman (2016) use narrative restrictions to identify global food commodity price shocks.

Table 5: Sign restrictions

Shock/Variable	Global GDP	Domestic GDP	Price of Exports	Price of Imports
$p^{x,\$}$		+	+	
$p^{m,\$}$		−		+
y^g	+	+	+	+

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 import (export) prices both on impact and at its maximum impact.

to export prices, we also include restrictions on the absolute relative response of import and export prices in response to $p^{x,\$}$ and $p^{m,\$}$ shocks (see De Santis and Zimic, 2018). Specifically, we impose that in response to $p^{x,\$}$ ($p^{m,\$}$) shocks, 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 export price shock with a positive import price shock and *vice versa*. Moreover, with these restrictions we ensure that a positive export price (import price shock) can be interpreted as a positive (negative) terms-of-trade shock. Note that shocks to import or export prices refer to shocks to these prices that are not caused by changes in global demand.

Global economic activity shocks are included to incorporate any other world shocks that do not directly originate from exogenous shifts in countries' export or import prices. A global economic activity 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 Alquist et al. (2020). 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 global economic activity shock could potentially be confounded with an export price 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 global economic activity shock. In particular, we impose that in 2009 the global economic activity shock is negative and it is the largest contributor to the innovations to global GDP.[37] 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 export and import price 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, weather shocks, or major geopolitical events. A total of 23 episodes were identified and are detailed in Appendix B. Second, we 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

[37] 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.

Table 6: 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
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, SDN
1997	Cereals	−	ARG, BGD, BFA, CIV, GHA, GTM, HND IND, 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
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, 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	
1983	Soybean	+	ARG, BRA	
1988	Soybean	+	ARG, BRA	
1984	Sugar	−	DOM, MWI, MUS, THA	
1993	Timber	+	BOL, CMR, CIV, GNQ, GAB, GHA	
1989	Tobacco	+	MWI	
1993	Tobacco	−	MWI	

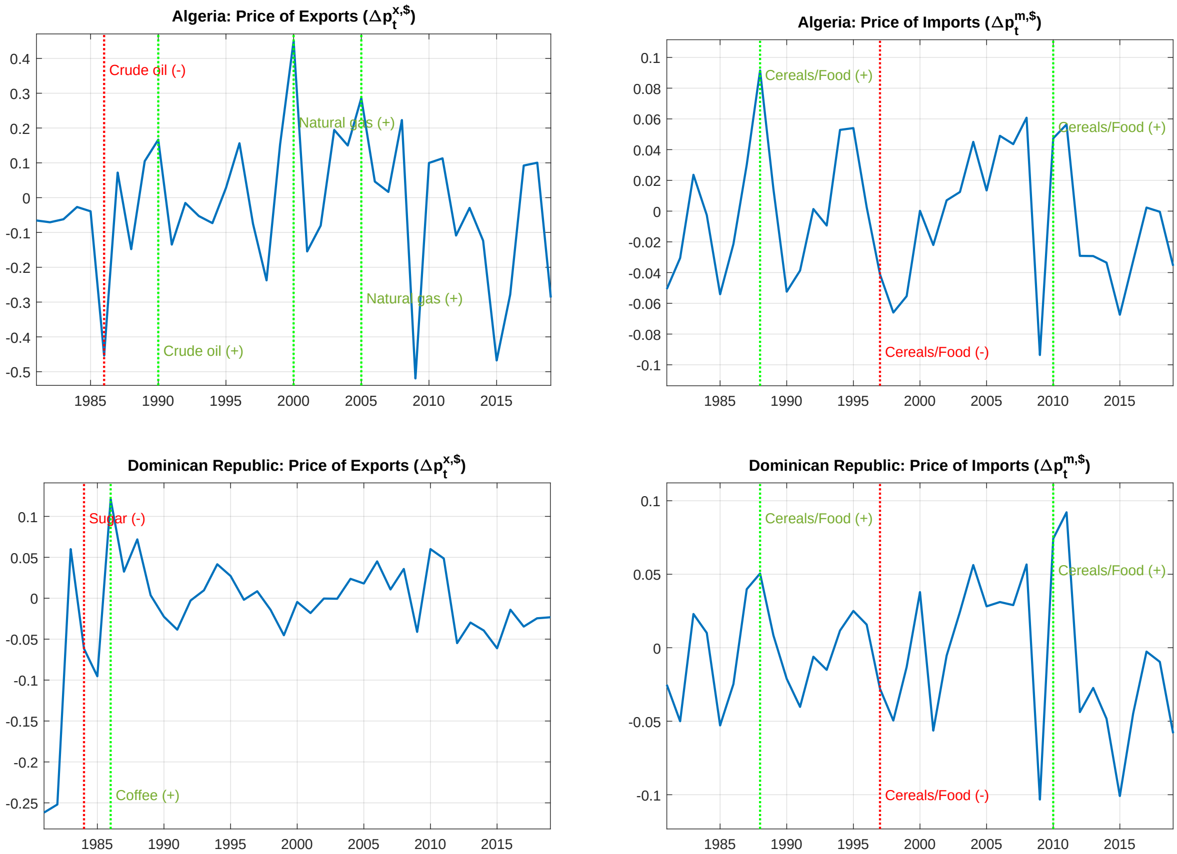
Notes: The table lists each of the episodes identified as generating large exogenous variations in commodity prices and indicates for which countries it was used as a narrative restrictions to identify export and import price shocks.

event to an export (import) price shock if the export (import) share of the particular country for the specific year and commodity (or commodity group) is larger than 7 percent.[38] When an event is due to weather conditions or political events of a specific country, we exclude such event for that country. This avoids selecting events which have the characteristic of being both an export or import price shock and a capital or productivity shock at the same time. For example, in 1986 there was a large increase (of about 30 percent) in coffee prices caused by droughts in the major producing regions in Brazil. Therefore, this shock was not used as part of the narrative restrictions for Brazil, but was used for other coffee exporters such as Colombia and Guatemala. Appendix B describes each event used in the narrative approach in detail and summarizes some country-specific assumptions. Table 6 provides a summary of the narrative restrictions imposed.

El Niño and La Niña weather events are known to generate disruptions in agricultural activities and damaging crops and we take advantage of such events for our narrative. However, what distinguishes these weather events from others is that they tend to affect the atmospheric

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

Figure 6: 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).

circulation worldwide, leading to meteorological consequences in all the regions in the world (Kiladis and Diaz, 1989). As such, this type of weather shock could be confounded with a productivity shock. This means that the only cases in which we could use the El Niño or La Niña events as part of the narrative is when the whether-induced crop damage happened only in one region of the world, for example, the Pacific, and could therefore serve as a narrative for the other side of the world, in this case, the Atlantic. We searched how each El Niño and La Niña event affected the crops across the globe and found one example of a crop affected by weather conditions only in the Pacific, which could serve as an event for countries in the Atlantic. In particular, following Brenner (2002) we found that the price increase in soybeans in 1983 was driven by droughts caused by El Niño in Australia and New Zealand, which we can therefore use in countries in the Atlantic such as Argentina and Brazil. In Section C.6 of Appendix C, we provide a detailed analysis on the narrative related to El Niño and La Niña events.

Despite the fact that the events are commodity specific, whereas $p^{x,\$}$ and $p^{m,\$}$ are a blend of multiple individual prices, the movement of the specific commodity prices around the time of the events are large enough to dominate the variation in export and import prices during that specific year. As an illustration, Figure 6 provides examples for two countries, Algeria and the Dominican Republic. The graphs show the change in export and import prices (in blue) while the vertical lines identify the commodity price episodes for each country. At the time of all the events, we find that $p^{x,\$}$ and $p^{m,\$}$ move in the expected direction, often reflecting spikes in the series. For example, this is the case for the change in $p^{x,\$}$ in the Dominican Republic in 1986 since this country was a coffee exporter although coffee only accounted for 8 percent of exports that year.[39]

We acknowledge two potential limitations in the identification. First, inventories could be playing a role in insulating a country from export and import price shocks. For example, Goldberg and Knetter (1997) suggest that demand for inventories may be driving the high variability of export volumes compared to that of prices and Alessandria et al. (2010) find that inventories play a role in driving large import adjustments in response to large devaluations while prices respond more gradually. Although due to lack of data we cannot control for the role of inventories, we would expect that to the extent that exports and imports differ in terms of storability, inventories could be playing a role in the heterogeneous transmission of export and import price shocks. Second, we focus our effort on the identification of "surprise" terms-of-trade shocks as opposed to "news" shocks. Ben Zeev et al. (2017) highlight that the contribution of terms-of-trade shocks is larger once accounting for the news component.[40]

5 Asymmetric Impact of Export and Import Price Shocks

Figure 7 shows the impulse responses to a one standard deviation positive export price shock (in blue) and a one standard deviation negative import price shock (in red). If the transmission mechanism of these two shocks was symmetric, the blue and red impulse responses would overlap. As it is clear from the Figure, this is not the case.

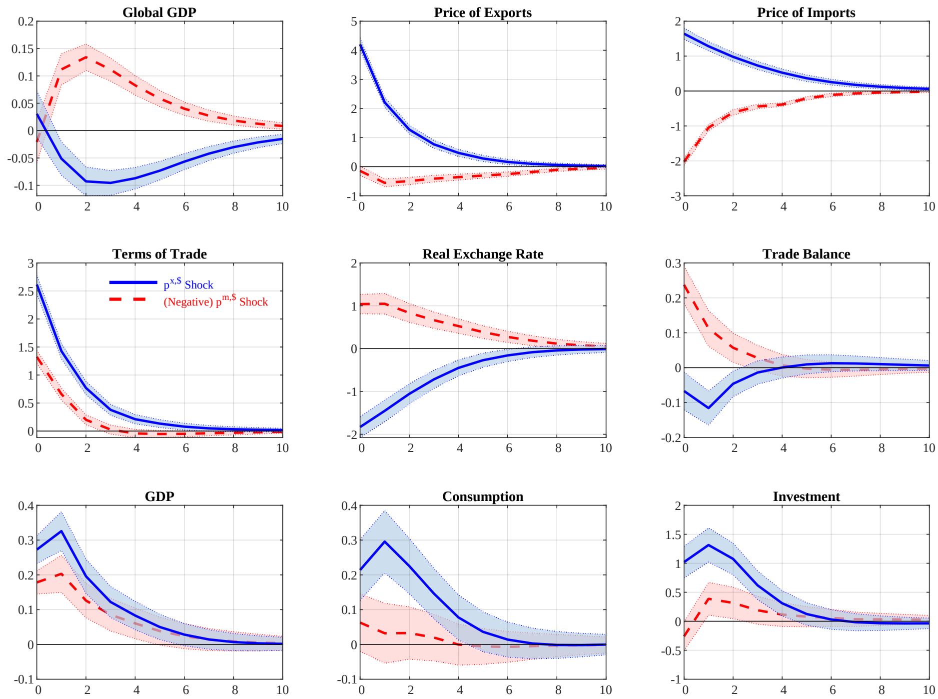
We observe that an improvement in export prices leads to an increase in domestic GDP, private consumption and investment. In particular, a one standard deviation shock to export prices causes an increase of 0.3 percent in domestic GDP on impact while private consumption increases 0.2 percent. Investment shows a larger expansion (1 percent). The ToT improve by about 2.5 percent on impact while the real exchange rate appreciates around 2 percent. The effects on global GDP are negative and small. The effect on the trade balance is negative and short lived. From the Figure it follows that a one standard deviation negative shock to import prices leads to an increase in domestic GDP of about 0.18 percent, the effects on consumption are not significant while the impact on investment is very small. In addition, after an import price shock, the terms of trade and the real exchange rate display a positive comovement, as in Catão and Chang (2015). The broad comovement of the main macroeconomic aggregates (domestic GDP, consumption and investment) is consistent with a variety of models which emphasize how ToT movements are a key source of fluctuation for small open economies (e.g., Mendoza, 1995). Another contrast between the effects of export and import price shocks relates to the impact on global GDP. A fall in import prices is beneficial for global economic activity, whereas an increase in export prices contracts economic activity. The impact on the trade balance can in part be attributed to this since an increase in foreign demand would tend to have an expansionary effect on domestic exports.

The impulse responses reveal that negative import price shocks are not the mirror image of positive export price shocks. We observe empirically that while the effects of export price shocks tend to be consistent with the effects of a "traditional" terms-of-trade shock, the transmission of a negative import price shock shock does not follow what is a textbook effect of a ToT shock. There are a number of reasons which can be generating this result. In particular,

[39] The charts also highlight that changes in $p^{x,\$}$ and $p^{m,\$}$ tend to be similar for those countries with similar trade specialization. This is the case for the import prices of the two countries in the example given that their import base is dominated by agricultural commodities.

[40] In principle, we could augment the foreign bloc (in eq. 13) with additional foreign variables and impose that the combination of y^g, $p^{x,\$}$ and $p^{m,\$}$ shocks maximizes the forecast error variance of the price of exports and imports at a given horizon, in line with the approach of Ben Zeev et al. (2017). Since we are working with annual data and a relatively short sample we do not pursue this route.

Figure 7: Impulse Responses to an Export and Import Price Shock: All Countries



Notes: The figure shows the impulse responses to a positive one standard deviation export price shock (blue) and negative one standard deviation import price shock (red) for all countries using a VAR with sign and narrative restrictions. The solid lines denote the mean response weighted using inverse variance weights and the dashed lines represent the 16$^{\text{th}}$ and 84$^{\text{th}}$ percentile error bands.

in a standard model we would expect the real exchange rate to appreciate in response to an improvement in ToT, regardless of whether it is driven by an increase in export prices or a decline in import prices. The negative comovement between ToT and the real exchange rate is observed after an export price shock. Instead, in line with our theoretical results, in response to a positive import price shock the real exchange rate appreciates, leading to a positive comovement between ToT and the real exchange rate. This is consistent with what we would expect from theory when export and import price shocks are not perfectly correlated, as we discussed in Section 2. In practice, it might reflect a high pass-through of import prices into the domestic CPI. More generally, the asymmetric response of the economy to export and import price shocks can also be driven by the fact that 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 export price shocks affect the economy differently from import price shocks.

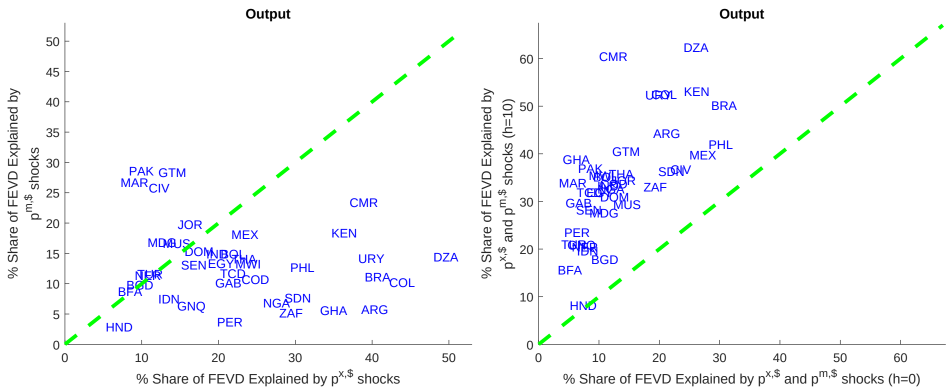
One way to assess the importance of a particular shock in driving business cycles is to compute the variance decomposition. Table 7 shows the share of the variance of all the variables in the VAR explained by $p^{x,\$}$ and $p^{m,\$}$ shocks. As highlighted above, when thinking about terms-of-trade shocks it is important to distinguish their origin, as they are, in general, a combination of export and import price shocks. Therefore, in order to assess the share of variance explained by terms-of-trade shocks, we look at the joint effect of export and import price shocks. Figure 8 presents the variance decomposition of output by country. The left panel shows the long run (10-year horizon) variance decomposition of output associated with export and import price shocks while the right panel compares the variance decomposition of output in the long run and short run.

Table 7: Forecast Error Variance Decomposition

	Export Prices		Import Prices		Terms of Trade		Real Exchange Rate	
	$p^{x,\$}$	$p^{m,\$}$	$p^{x,\$}$	$p^{m,\$}$	$p^{x,\$}$	$p^{m,\$}$	$p^{x,\$}$	$p^{m,\$}$
0	68.72	7.53	24.84	45.58	65.54	19.16	9.29	7.00
1	69.05	9.14	28.55	42.55	64.46	18.62	12.62	10.31
4	63.94	13.18	32.51	38.96	58.18	21.44	17.04	14.22
10	61.80	14.60	33.56	37.82	56.32	22.69	19.18	15.32
	Trade Balance		**Output**		**Consumption**		**Investment**	
	$p^{x,\$}$	$p^{m,\$}$	$p^{x,\$}$	$p^{m,\$}$	$p^{x,\$}$	$p^{m,\$}$	$p^{x,\$}$	$p^{m,\$}$
0	7.62	7.00	5.20	3.07	8.29	5.44	6.92	4.67
1	11.57	10.31	9.72	6.19	11.94	8.74	10.70	7.89
4	14.77	14.22	16.03	10.91	16.16	12.36	15.35	11.28
10	16.04	15.32	18.46	12.93	17.86	13.63	17.07	12.47

Notes: The table shows the forecast error variance decomposition of all the variables in the VAR for export price and import price shocks on impact, at a 1-year, 4-year and 10-year horizons. Reported are mean responses weighted using inverse variance weights. $p^{x,\$}$ and $p^{m,\$}$ denote export and import price shocks, respectively.

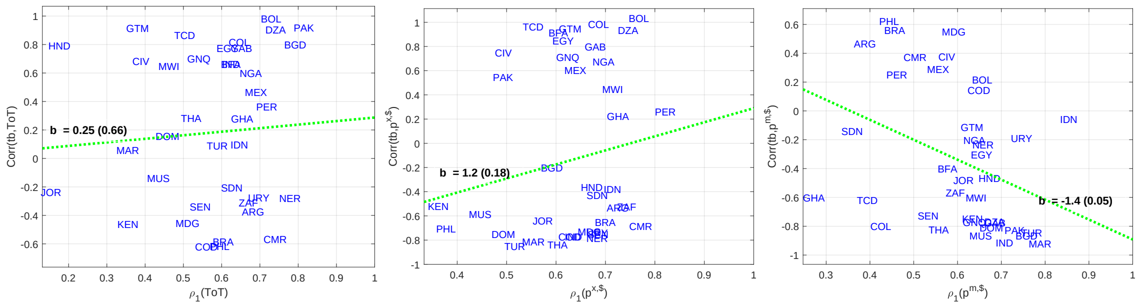
Figure 8: Forecast Error Variance Decomposition by Country



Notes: The first panel of this Figure compares the 10-year ahead forecast error variance decomposition of output, for each country, for export price (x-axis) and import price (y-axis) shocks. The second panel shows a comparison of the forecast error variance decomposition of output in response to terms-of-trade shocks, for each country, on impact (short run, x-axis) and at a 10-year horizon (long run, y-axis).

Some interesting results stand out. 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 7 to 31 percent of domestic GDP on impact and at a 10-year horizon, respectively. A similar result is obtained for consumption, where both shocks explain from 14 to 31 percent of its variation on impact and at a 10-year horizon. In addition, export and import price shocks explain up to 30 percent of investment. Second, the effects of $p^{x,\$}$ shocks tend to be larger than those of $p^{m,\$}$ shocks. For example, the importance of export price shocks in explaining the volatility of domestic GDP is over two-thirds higher than the one of import price shocks. As it is clear from Figure 8 (left panel), this also visible at the country level, as reflected by the fact that most of the observations are below the 45-degree line. This suggests that for the majority of countries export price shocks play a more important role than import price shocks in explaining the volatility of domestic output. As illustrated in Figure 8 (right panel), ToT shocks build up over time. At the country-specific level they are also more important to explain output fluctuations in the long run than in the short run. More generally, these figures highlight that there is a marked heterogeneity in the impact of ToT shocks on output. For instance, ToT shocks explain around 60 percent of output volatility in the long run for Algeria while for Bangladesh, which

Figure 9: Conditional Correlation of the Trade Balance with International Relative Prices



Notes: The left panel shows the $corr(tb, ToT)$ (*y-axis*) and $\rho_1(ToT)$ (*x-axis*), conditional on both $p^{x,\$}$ and $p^{m,\$}$ shocks. The middle panel of this figure shows the $corr(tb, p^{x,\$})$ (*y-axis*) and $\rho_1(p^{x,\$})$ (*x-axis*), conditional on $p^{x,\$}$ shocks only. The right panel shows the $corr(tb, p^{m,\$})$ (*y-axis*) and $\rho_1(p^{m,\$})$ (*x-axis*), conditional on $p^{m,\$}$ shocks only.

has a relatively small commodity export share, they explain less than 20 percent.[41] Further analysis on the cross-country heterogeneity is presented in the next Section.

Third, export and import price shocks explain up to 35 percent of the volatility of the exchange rate. This result is related to the findings in Ayres et al. (2020), who show that a large share of real exchange rate volatility is explained by fluctuations in commodity prices. The fact that $p^{x,\$}$ shocks are 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. Forth, export price shocks have a larger impact on import prices than the reverse since export prices are more commodity intensive and therefore their shocks would spillover to downstream sectors, many of which produce importable goods. These changes in global economic activity subsequently lead to an increase in import prices. Finally, while $p^{x,\$}$ shocks explain over 50 percent of the volatility of the terms of trade, $p^{m,\$}$ shocks only account for up to 23 percent of its variability.

5.1 The Trade Balance and International Relative Prices

In Section 3.6 we emphasized that when analyzing the association between the tb-ToT correlation and the persistence in the ToT it was important to control for the presence of other shocks. In this Section we therefore repeat that exercise accounting for that. The left panel of Figure 9 shows the relationship between $corr(tb, ToT)$ and $\rho_1(ToT)$ conditional on both $p^{x,\$}$ and $p^{m,\$}$ shocks. The middle panel displays the association between $corr(tb, p^{x,\$})$ and $\rho_1(p^{x,\$})$, conditional on $p^{x,\$}$ shocks and the right panel shows $corr(tb, p^{m,\$})$ and $\rho_1(p^{m,\$})$, conditional on $p^{m,\$}$ shocks.[42]

Conditional on both shocks the relationship between $corr(tb, ToT)$ and $\rho_1(ToT)$ is insignificant. However, we need to be careful in interpreting this correlation as the impact of the terms of trade on the trade balance can be very different depending on whether the movement of ToT originates in export or import price shocks, as we showed in Figure 7. In fact, in Appendix A we show that the logic of the HLM effect is reversed if we focus on import price shocks. We should get a stronger correlation between tb-ToT with more persistent ToT if the latter is driven by more persistent import prices, whereas the reverse is true if it is driven by the persistency in export prices. Therefore, we should look at the predictions of the HLM effect conditional on one shock at the time. Theoretically, we would expect a downward sloping

[41] For Algeria more than 45 percent of output variability is accounted for by export price shocks. This reflects the potential vulnerability of Algeria to fluctuations in the price of energy commodities, which account for almost 90 percent of the export share.

[42] The conditional correlations are calculated following Den Haan (2000).

association between the correlation of the trade balance and both export and import prices against their persistence. Those are plotted in the middle and right panel of Figure 9. It is clear that the predictions of the model are verified for import price shocks but the relationship is insignificant for export price shocks.[43]

6 Additional Results

In this section we summarize some additional analysis. We first describe the effects of a global economic activity shock. Next, we compare how our results relate to those captured by main commodity price indices. We also present evidence on cross-country heterogeneity as well as an extension where we show the results by grouping the countries into main commodity export and import groups.

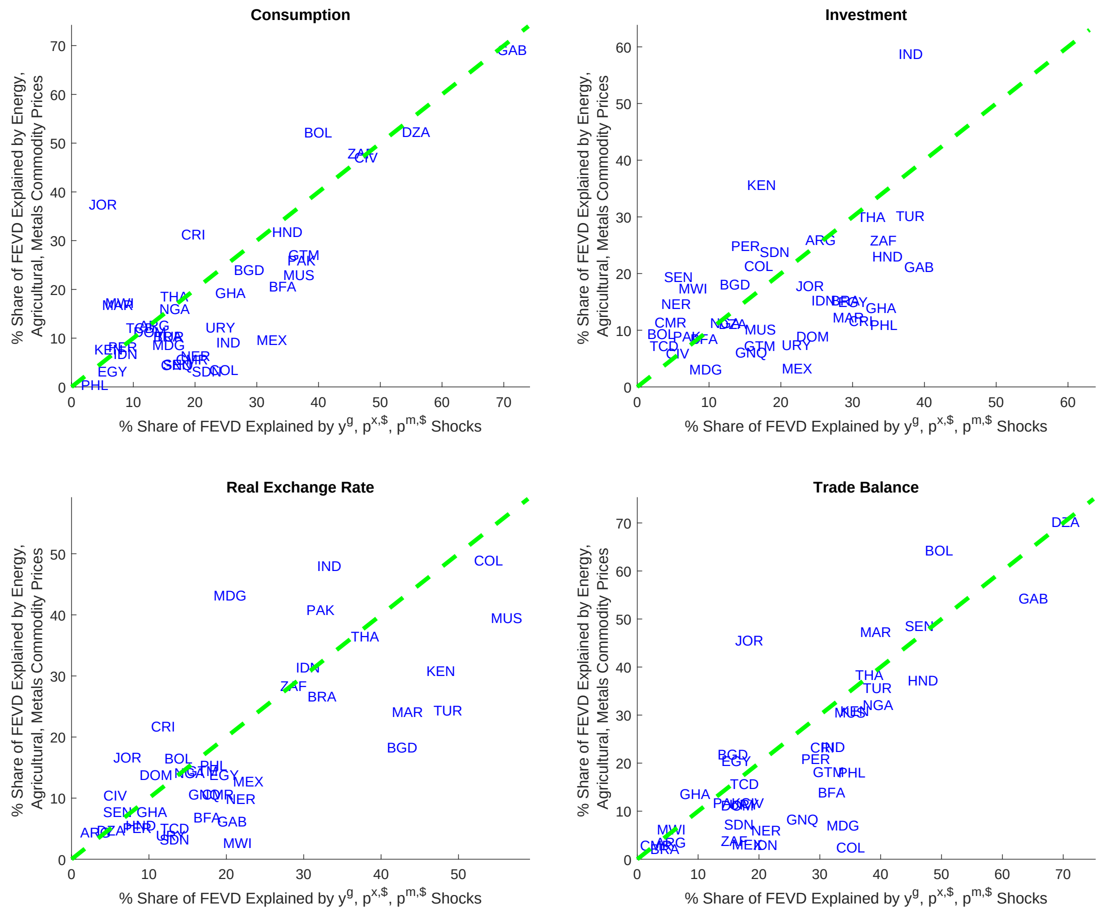
Global Economic Activity Shocks. A positive global economic activity shock is associated with high-demand pressures which lead to an increase in both export and import prices. This happens because global economic activity shocks reflect an increase in demand for all industrial commodities triggered by 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 economic activity shocks (see also Alquist et al., 2019). Given that positive global economic activity shocks lead to an increase in both export and import prices, it is not surprising that the impact on the ToT is small and actually insignificant after a one-year horizon. These findings highlight our point that world disturbances like a global economic activity shock would tend to yield a small effect on the ToT because of the simultaneous increase in export and import prices. However, the effects on the economy could be significant: a global economic activity shock is associated with a robust increase in GDP, consumption, investment and a fall in the real exchange rate. Therefore, our results are also consistent with the presence of other shocks (e.g. financial) 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). Appendix E contains the empirical evidence on global economic activity shocks.

Commodity Price Shocks as World Shocks. Fernández et al. (2017) show that world shocks, summarized by three commodity 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 10, 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* the combined contribution to shocks to three major commodity indices as in 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 commodities that are part of the export and import prices. In addition, commodity prices, and metal prices in particular, are often considered an indicator of global economic activity (see, for example, Caldara, Cavallo, and Iacoviello, 2019).

The plots highlight that for some countries, world shocks are by far the most dominant source of business cycle fluctuations. The advantage of our methodology is that it allows us to characterize the main channels of transmission of world disturbances. We find that terms-of-trade shocks, defined as a combination of export and import price shocks are key to understanding the dynamics of developing countries business cycles. In particular, export price shocks seems to be, on average, more important, especially at longer horizons (i.e. export

[43] As in Figure 4, the association between $corr(tb, p^{x,\$})$ and $\rho_1(p^{x,\$})$ is still upward slopping but in contrast to Figure 4, the relationship is statistically insignificant.

Figure 10: Comparison Forecast Error Variance Decomposition: Our Model 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 4.

price shocks have a more persistent effect to the economy).

Cross-Country Heterogeneity. The aggregate results summarized in the previous section mask a great deal of heterogeneity across countries. First, the effects of export price shocks on output tend to be larger than those stemming from import price shocks. Second, the impact of import price shocks appears to be more homogeneous across countries. Third, with only a few exceptions, the top 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 effects of export and import price shocks are not only an aggregate phenomena but also present at the country-level.[44]

We also investigate what explains the heterogeneity across countries. We find that the variable that is systematically statistically significant 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 an export price shock. We find that the response of the terms of trade after an export price shock is larger, on average, for energy exporters as well as for countries that exhibit a higher concentration. In

[44]Figure F.2 in Appendix F attends to the heterogeneous effects of global economic activity shocks on export prices, import prices, and output.

addition, countries with a higher GDP per capita tend to display a larger response of output and the trade balance in response to an export price shock. By contrast, the cross-country heterogeneity in the impact of import price shocks has proven more challenging and in general we only found that higher commodity import share is associated with a higher impact on the response of the terms of trade.

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. This finding is related to Kohn et al. (2020) who show that countries with a higher share of commodity exports in GDP exhibit a higher volatility of real GDP. Further results can be found in Appendix F.

Analysis by Export and Import Group. In Appendix F, we also analyze the effects of export price, import price and global economic activity shocks by grouping the countries according to whether they are exporters or importers of main commodity groups. Details about the sample split as well as the impulse responses by group are presented in Appendix F.3. 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 export and import price shocks do not mirror each other. This reinforces the idea that terms-of-trade shocks are not all 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 energy and metal exporters while the smallest share of the variance of output pertains to the manufacturing exporters group. Interestingly, the effects of import price shocks on output are more homogeneous across importer groups.

7 Conclusion

Using a 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 economic activity shocks in explaining business cycle fluctuations in EMDEs. The shocks are identified combining sign restrictions and a narrative approach.

By breaking down terms-of-trade shocks into export price and import price shocks to study their transmission mechanism, we show that the former is not a mirror image of the latter. 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. Taken together, export and import price shocks explain up to 30 percent of output fluctuations and its components 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 international relative price measure (like the terms of trade).

Our results emphasize that terms of trade measured as a ratio of export and import prices are an inaccurate empirical proxy to assess how terms of trade affect the economy. This inaccuracy makes these measures explain a small proportion of output fluctuations. We argue that a reason behind the terms of "terms of trade disconnect" is that terms-of-trade effects are empirically complex and go beyond the fluctuations of a univariate measure of the terms of trade. However, in standard SOE models (see, for example, Mendoza, 1995; Schmitt-Grohé and Uribe, 2017) only the ratio of export and import prices plays a role for determining real allocations. Therefore, our empirical evidence invites to the use of a new theoretical framework to allow for an independent role for export and import price shocks. From the modeling side, we provide examples demonstrating that export and import price fluctuations can have their own output effects.

Our empirical framework shows that terms-of-trade shocks are important and that their swings can have substantial effects on the economy. A number of 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. Finally, disentangling the different channels of transmission of shocks to the price of exports and imports is an important avenue for future theoretical work.

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Online Appendix for "Terms-of-Trade Shocks are Not all Alike"

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Abstract

This is an online Appendix for "Terms of Trade Shocks are Not all Alike" by Di Pace, Juvenal, and Petrella. Appendix A includes an extension of a small open economy model which features independent export and import price shocks. Appendix B describes the macroeconomic and commodity data sources, while Appendix C presents additional descriptive statistics. The construction of narrative series of exogenous price shocks is detailed in Appendix D. The empirical evidence on global economic activity shocks is presented in Appendix E. Finally, Appendix F includes the cross-country and group heterogeneity results.
JEL Classification: F41, F44
Keywords: Terms of Trade, Commodity Prices, Business Cycles, World Shocks.

Contents

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Appendix A The price of exports, price of imports and ToT in the MXN model

The role of the terms-of-trade shocks for the business cycle of small open economies is traditionally studied within the MXN model (see Mendoza, 1995; and Schmitt-Grohé and Uribe, 2018). The MXN model features three types of goods (importable, exportable and nontradable), produced by three distinct sectors. In both exportable and importable sectors, production may not be equal to absorption, giving rise to imports and exports in equilibrium. The model allows for both domestic savings, through the accumulation of physical capital, and foreign savings, through the decumulation of foreign assets (debt).[1]

In this section we extend the MXN model along three dimensions. First, we allow for the presence of independent export and import price shocks, $p_t^{m,\$}$ and $p_t^{x,\$}$. To do so, we assume that the LOOP holds for imports and exports rather than for tradables.[2] This modification introduces a wedge between the relative price of tradables (p_t^{τ}) and the real exchange rate (q_t). Second, we assume that debt is priced in terms of foreign consumption goods instead of tradable consumption goods. This gives rise to a "borrowing cost" channel as we show in Section 2. Third, we relax the assumption of labor market segmentation by introducing an Armington-type labor aggregator. The first and second modifications are central for analyzing import and export price shocks separately (see Section A.1.2). The third one is introduced for analytical convenience to pin down the steady state in closed form.

To keep the model tractable, we assume that the country spread is time invariant (and does not depend on export and import price shocks).[3] In addition, we assume that $p_t^{x,\$}$and $p_t^{m,\$}$ shocks follow (independent) autoregressive processes.[4] This allows us to: (i) understand the transmission mechanisms of each shock separately, and (ii) show that a sensible calibration of the structural parameters that can generate heterogeneous effects in response to the shocks.

The remainder of Appendix A is organized as follows. We discuss the changes made to the MXN model in Section A.1. Section A.2 is dedicated to the calibration of the model. Impulse response analysis is reported in Section A.3. Section A.4 discusses the relationship between export and import price shocks and the trade balance. For completeness, a summary of the model equations is provided in Section A.5. Finally, Section A.6 shows the derivation of the steady state of the model.

A.1 The Model

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

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

[1]As pointed out by Mendoza (1995), the absence of investment and production decisions yields dynamics for net exports and real exchange rates that are at odds with the data.

[2]As we have shown in Section 2, assuming the LOOP for exports and imports implies that the LOOP holds also for tradable goods, whereas the reverse (i.e. assuming the LOOP for tradables) does not guarantee the LOOP in the two different types of goods separately.

[3]Drechsel and Tenreyro (2018) highlight the interaction between country spreads and the terms of trade. To the extent that export and import prices have a different impact on the spread, this modification would introduce additional heterogeneity in the transmission of $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks.

[4]In Section 3 of the paper we document that $p_t^{x,\$}$and $p_t^{m,\$}$ are correlated, this is an extension we leave for the future work.

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

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

Here c_t is aggregate consumption, h_t is the aggregate supply of labor, σ denotes the inverse of the inter-temporal elasticity of substitution, φ is a disutility parameter, and ω is the inverse of the Frisch elasticity of labor supply. We follow Greenwood, Hercowitz, and Huffman (1988) in specifying household's preferences. This simplification allows us to focus entirely on the interaction of foreign assets and domestic capital at the cost of eliminating the wealth effect on labor supply.

In line with Horvath (2000), we specify a labor aggregator of the form:

$$h_t = \left[(\gamma_m)^{-\frac{1}{\kappa}} (h_t^m)^{\frac{1+\kappa}{\kappa}} + (\gamma_x)^{-\frac{1}{\kappa}} (h_t^x)^{\frac{1+\kappa}{\kappa}} + (\gamma_n)^{-\frac{1}{\kappa}} (h_t^n)^{\frac{1+\kappa}{\kappa}}\right]^{\frac{\kappa}{1+\kappa}}, \tag{A.1}$$

where γ_m, γ_x and γ_n are the shares of labor supplied in the importable, exportable sectors and nontradable sectors, respectively ($\gamma_m + \gamma_m + \gamma_m = 1$), κ is a parameter controlling the degree of substitution/mobility between sectoral labor (h_t^j for $j = \{m, x, n\}$). When $\kappa = 0$, labor is prevented from moving across sectors. Whereas $\kappa \to \infty$, workers devote all their 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. 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 differentials.[5]

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

$$c_t + q_t d_t + \sum_{j\in(m,x,n)} i_t^j = q_t \frac{d_{t+1}}{1+r_t} + \sum_{j\in(m,x,n)} w_t^j h_t^j + \sum_{j\in(m,x,n)} u_t^j k_t^j - \frac{\phi_j}{2} \sum_{j\in(m,x,n)} \left(k_{t+1}^j - k_t^j\right)^2, \tag{A.2}$$

where d_t denotes the stock of debt (expressed in terms of foreign consumption goods), r_t is the interest rate on debt held from period t to $t+1$, and w_t^j is the real wage in sector $j = \{m, x, n\}$ (denominated in terms of home consumption goods). Sectoral investment and the capital stock are denoted by i_t^j and k_t^j, respectively, u_t^j is the associated rental rate of sectoral capital, and $\frac{\phi_j}{2}\left(k_{t+1}^j - k_t^j\right)^2$ is the sector-specific capital adjustment cost. The interest rate paid on debt can be written as:

$$r_t = r^* + s + \psi\left(e^{d_{t+1}-d} - 1\right), \tag{A.3}$$

where $\psi\left(e^{d_{t+1}-d} - 1\right)$ is a debt elastic premium, which helps ensure stationarity in the stock of debt as in Schmitt-Grohé and Uribe (2003), and s is the steady state value of the country spread.[6] The assumption of financial market incompleteness here limits the household's ability to insure away country-specific shocks, and strengthens the wealth effects of shocks.

An important deviation from the MXN model is that debt is priced in terms of foreign consumption goods instead of tradable consumption goods. As explained in Section 2.2, this is

[5] Labor market frictions are neutralized in the steady state, and the inefficiency associated with sectoral wage discrepancies is only temporary. The complementarity across labor types is important for generating comovement of macro aggregates after export and import price shocks.

[6] Throughout this section the value of a steady state variable is denoted without a time subscript.

a key assumption to allow for terms-of-trade shocks not to be all alike. We argue that this assumption is realistic given that external debt in EMDEs is largely denominated in foreign currency, particularly in U.S. dollars, rather than in domestic currency.

Sector-specific capital stock accumulates according to the following law of motion

$$k_{t+1}^{j} = i_t^{j} + (1-\delta)\, k_t^{j} \quad \text{for} \quad j = \{m, x, n\}\,, \tag{A.4}$$

where δ is the depreciation rate of physical capital.

The first order conditions are:

$$\begin{aligned}
\lambda_t &= \left(c_t - \varphi \frac{h_t^{1+\omega}}{1+\omega}\right)^{-\sigma}, && \text{(A.5)}\\
w_t^j &= \varphi h_t^{\omega} \left(\frac{h_t^j}{\gamma_j h_t}\right)^{\frac{1}{\kappa}}, && \text{(A.6)}\\
\lambda_t \left[1 + \phi_j \left(k_{t+1}^j - k_t^j\right)\right] &= \beta \mathbb{E}_t \lambda_{t+1} \left[(1-\delta) + \phi_j \left(k_{t+2}^j - k_{t+1}^j\right) + u_{t+1}^j\right], && \text{(A.7)}\\
\lambda_t q_t &= \beta\,(1+r_t)\, \mathbb{E}_t \lambda_{t+1} q_{t+1}. && \text{(A.8)}
\end{aligned}$$

where $j = \{m, x, n\}$, and λ_t is a Lagrange multiplier. Labor supply decisions, equation (A.6), together with the Euler equation with respect to debt, equation (A.8), are different from the standard MXN.

As for the supply side of the model we follow closely the specification in Schmitt-Grohé and Uribe (2017, ch. 8). Therefore, the firms' problems remain unchanged (i.e. the problems of firms producing tradable and nontradable final goods and those of firms producing importable, exportable and nontradable intermediate goods). As foreign debt is expressed in terms of foreign consumption goods, the only market clearing condition that differs from the standard MXN model is the evolution of the current account:

$$\frac{q_t d_{t+1}}{1+r_t} - q_t d_t = p_t^m m_t - p_t^x x_t,$$

where p_t^m and p_t^x denote the real domestic import and export prices (expressed in terms of the price of home consumption) and m_t and x_t imports and exports quantities (defined in Section A.5 below).

A.1.1 The Law of One Price and the Terms of Trade

In order to close the model, we assume full pass-through from world prices to the price of domestic export and import prices. Therefore, we assume that LOOP holds separately for export and imports prices,

$$p_t^{x,\$} = \frac{p_t^x}{q_t} \tag{A.9}$$

and

$$p_t^{m,\$} = \frac{p_t^m}{q_t}. \tag{A.10}$$

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

$$ToT_t = \frac{p_t^{x,\$}}{p_t^{m,\$}}. \tag{A.11}$$

As argued in Section 2.5 of the main text, $p_t^{m,\$}$ and $p_t^{m,\$}$ are themselves terms-of-trade measures. We assume that $p_t^{x,\$}$ and $p_t^{m,\$}$ follow AR(1) processes

$$\ln\left(\frac{p_t^{x,\$}}{p^{x,\$}}\right) = \rho^x \ln\left(\frac{p_{t-1}^{x,\$}}{p^{x,\$}}\right) + \varsigma^x \varepsilon_t^x, \tag{A.12}$$

$$\ln\left(\frac{p_t^{m,\$}}{p^{m,\$}}\right) = \rho^m \ln\left(\frac{p_{t-1}^{m,\$}}{p^{m,\$}}\right) + \varsigma^m \varepsilon_t^m, \tag{A.13}$$

where ρ^x and ρ^m denote the persistence of the two shock processes and ς^x and ς^m their respective dispersion.

A.1.2 The Relative Price of Tradables and the Real Exchange Rate

In this section we show that the relationship between the relative price of nontradable goods and the exchange rate is not necessarily negative when we allow for full pass through in the exportable and importable markets. Recall that the real exchange rate is defined as

$$q_t = \mathcal{E}_t \frac{P_t^*}{P_t}, \tag{A.14}$$

where $\mathcal{E}_t$ denotes the nominal exchange rate, P_t^* and P_t are the aggregate consumption price indices abroad and at home, respectively. In addition, the relative price of tradables is

$$p_t^\tau = \Big((1-\chi_m)\,(p_t^x)^{1-\mu_{mx}} + \chi_m\,(p_t^m)^{1-\mu_{mx}}\Big)^{\frac{1}{1-\mu_{mx}}}. \tag{A.15}$$

Dividing through by q_t, we get

$$\left(\frac{p_t^\tau}{q_t}\right)^{1-\mu_{mx}} = \left((1-\chi_m)\left(p_t^{x,\$}\right)^{1-\mu_{mx}} + \chi_m\left(p_t^{m,\$}\right)^{1-\mu_{mx}}\right). \tag{A.16}$$

This expression states that $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks create a wedge between p_t^τ and q_t and that, all else equal, there is an negative relationship between export and import price shocks and the real exchange rate. This argument is related to Catão and Chang (2015), who argue that, by allowing for shocks to the world relative price of food, the terms of trade and the real exchange rate can move in the same direction.[7]

Since full pass through from export and import prices to their domestic counterparts is assumed in the extended MXN model, the degree of complementarity between tradable and nontradable absorption becomes a key parameter that determines the response of the real exchange rate. First, note that the relative price of tradable goods is inversely related to the relative price of nontradable goods,

$$p_t^\tau = \left[\frac{1-(1-\chi_\tau)\,(p_t^n)^{1-\mu_{\tau n}}}{\chi_\tau}\right]^{\frac{1}{1-\mu_{\tau n}}}, \tag{A.17}$$

where $\mu_{\tau n}$ denotes the elasticity of substitution between tradable and nontradable absorption and χ_τ the share of tradable goods in aggregate absorption. Second, substituting for the

[7] Due to the assumption of full pass-through, their world relative price of food is like a $p_t^{m,\$}$ shock in our framework. With respect to Catão and Chang (2015), our framework differs along two main dimensions: (i) we consider nontradable goods, and (ii) we also work under the assumption of full pass-through from world export prices to domestic export prices.

relative price of tradable goods and rearranging, we get the following expression

$$(1-\chi_\tau)\left(p_t^n\right)^{1-\mu_{\tau n}} = 1-\chi_\tau\left[(1-\chi_m)\left(p_t^{x,\$}\right)^{1-\mu_{mx}}+\chi_m\left(p_t^{m,\$}\right)^{1-\mu_{mx}}\right]^{\frac{1-\mu_{\tau n}}{1-\mu_{mx}}} q_t^{1-\mu_{\tau n}}. \quad \text{(A.18)}$$

In the absence of international price shocks, this expression indeed states that the relative price of nontradable and the real exchange rate are negatively related. This is not necessarily the case once the economy is hit by $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks; i.e. the relative price of nontradable and the exchange rate can potentially move in the same direction. Note that the shares of importable, exportable and nontradable absorption together with the elasticities of substitution play an important role when it comes to the quantitative response of the real exchange rate.

A.2 Calibration

In this section, we discuss the model calibration and argue that the parametrization is central for generating heterogeneity in the impulse responses to export and import price shocks. We target a set of moments in the data and conduct a set of normalizations so that we can pin down the steady state analytically (see Section A.6). Table A.1 summarizes the calibration. One period in the model corresponds to one year in the data.

We target the export share (s_x), the shares of exportable output and nontradable output in aggregate output (s_{y_x} and s_{y_n}), and the trade balance-to-output ratio (s_{tb}). We set the interest rate paid by the home economy to be equal to $r + s$. We choose the share of importable absorption in tradable absorption (χ_{mx}), the share of tradable absorption in aggregate absorption (χ_τ), the levels of productivity in import and export sectors ($z_m = z_x$), the disutility of labor (φ), and the discount factor (β) to match these targets. Since the investment-to-output ratio in the MXN is considerably lower than the median/average country in our sample (s_i), we choose the capital share in the nontradable sector (α_n) that ensures this target. To do this, we set the relative capital shares $\alpha_m/\alpha_n = \alpha_x/\alpha_n$.

In what follows we list 14 calibration restrictions. (1) We set $\sigma = 2$, which is a common value in business-cycle analysis for emerging countries (see Mendoza, 1991 and Aguiar and Gopinath, 2007, amongst others). (2) $\varphi = 0.455$. This value implies a sectoral Frisch elasticity of labor supply of 2.2, which is the value assumed in the one-sector model studied in Mendoza (1991). (3) The depreciation rate of physical capital, $\delta = 0.1$, follows from Mendoza (1991, 1995) and Schmitt-Grohé and Uribe (2018). (4) $r^* + s = 0.0842$ in line with Aguiar and Gopinath (2007). (5) $\beta = 1/(1 + r^* + s)$. This condition ensures that the steady-state level of debt coincides with the parameter d. (6) The exports-to-GDP ratio in our sample of emerging and developing countries is 17%. (7) The shares of nontradable in aggregate output are set to match the average country, 0.49.[8] (8) The trade balance-to-GDP ratio is 1.41%, or $s_{tb} = 0.0141$, is in line with Schmitt-Grohé and Uribe (2018). (9) The average investment-to-GDP ratio in our sample is 23.15%. (10) 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 therefore set the ratio between the capital share in the import/export sectors and the capital share in the nontradable sector to 1.1. Following Mendoza (1995) and Schmitt-Grohé and Uribe (2018), (11) tradable and nontradable absorptions are assumed to be complements, $\mu_{\tau n} = 0.5$, whereas (12) the tradable absorption aggregator is assumed to be Cobb-Douglas ($\mu_{\tau n} = 1$). (13) The elasticity of substitution between labor types is set to $\kappa = 1$ as in Horvath (2000). (14) A key parameter is the share of importable absorption in total

[8] Using data from the World Bank's World Development Indicators (WDI) , we calculate the nontradable shares for each of the 38 countries considered in the empirical analysis by taking the ratio between the value added in the services sector and the aggregate value added.

tradable absorption, $\chi_m = 1/\left[1 + (s_{y_x} - s_x)/(s_{y_m} + s_x - s_{tb})\right]$. The greater the importance of exports and the exportable sector in output, the stronger the response of export price shocks on aggregate output. For the exportable sector to be large in size, it must be that the trade balance is positive and the demand for exportable goods from home and abroad high. For the proposed calibration, the size of the exportable sector is 36% and that of the importable sector, 15%. The countries we examine have a large exportable sector.[9]

The debt elastic premium (ψ) is set to the median value estimated by Schmitt-Grohé and Uribe (2018). However, the capital adjustment cost parameters (ϕ_m, ϕ_x and ϕ_n) are set to zero so that export and import price shocks have the potential to explain a high share of the output fluctuations (see Section A.3.1 for an explanation). Hence, we make the assumption that, whilst accumulating domestic capital is costless across all three sectors, shifting capital across borders is not.

The persistence parameters, ρ^x and ρ^m, are set equal to a value of 0.62, remaining close to the estimates of the data. By setting them equal across shocks, we can investigate whether equally sized shocks can have heterogenous effects on the economy.

Table A.1: Model Calibration

Calibrated Structural Parameters								
σ	δ	$r^* + s$	ω	β	$\frac{\alpha_m}{\alpha_n} = \frac{\alpha_x}{\alpha_n}$	κ	$\mu_{\tau n}$	μ_{mx}
2	0.1	0.0842	0.455	$\frac{1}{1+r^*+\bar{s}}$	1.1	1	0.5	1
Adjustment Costs & and Shock Parameters								
ψ	ϕ_m	ϕ_x	ϕ_n	ρ^x	ρ^m	σ^x	σ^m	
0.5	0	0	0	0.62	0.62	1	1	
Moment Restrictions								
s_x	s_{tb}	s_{y_n}	s_{y_x}	s_i				
0.17	0.0141	0.49	0.36	0.23				
Implied Parameters								
χ_τ	χ_m	$\alpha_m = \alpha_x$	α_n	d	φ	γ_m	γ_x	$z_m = z_x$
0.50	0.62	0.45	0.40	0.45	0.87	0.14	0.35	0.94

Notes: $s_i \equiv i/y$, $s_x \equiv x/y$ and $s_{tb} \equiv (x - m)/y$, where $y \equiv y_n + y_x + y_n$.

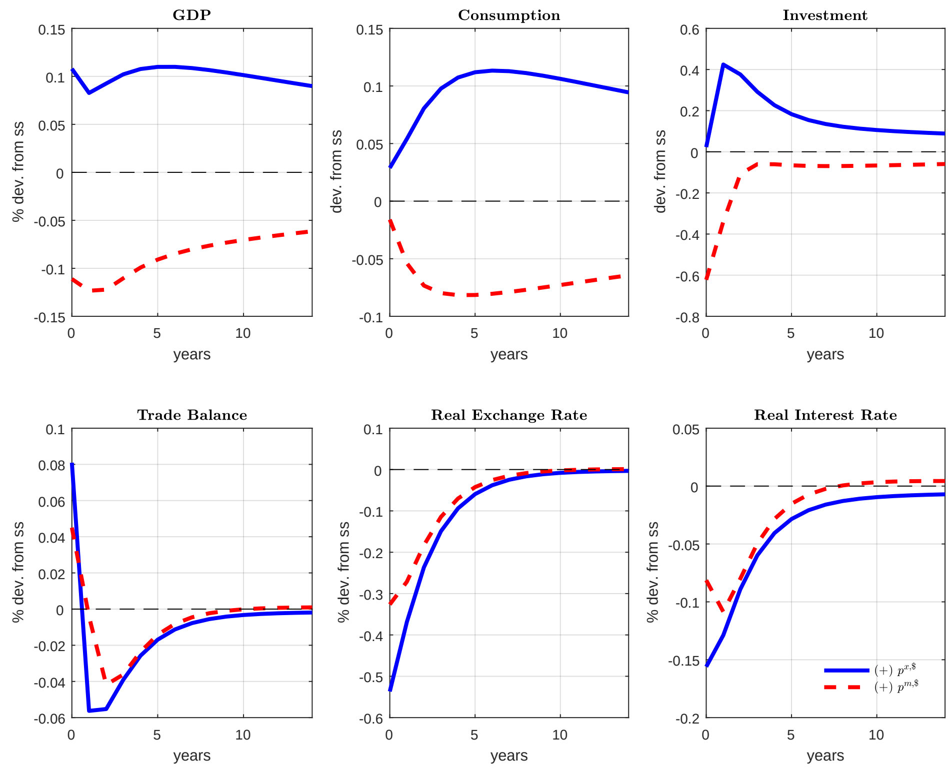
A.3 Impulse Response to Export and Import Price Shocks

In this section we study the responses of model variables to export and import price shocks. We show that they can have different compositional, sectoral and aggregate implications. Let us start first start by discussing how the economy responds to an export price shock. Figure A.1 shows in solid blue the responses of the main macroeconomic aggregates to a one percent innovation in export prices while Figure A.2 displays more disaggregated responses. A positive export price shock leads to an increase in consumption, investment, output and an appreciation of real exchange rate. This results from the interaction between wealth and substitution effects. The positive wealth effect boosts domestic demand for all types of goods. In turn, the increase in export prices leads to a substitution from exportable goods towards

[9] This is where our calibration differs from Schmitt-Grohé and Uribe (2018) (who set the shares equal across importable and exportable value added).

importable and nontradable absorption (second row Figure A.2). The rise in export prices generates an increase of exports and imports and a small improvement in the trade balance on impact. Imports go up because, as these goods become cheaper relative to exportable goods, consumers increase demand and domestic producers cut back supply. GDP expands as a result of increased activity in the export and the nontradable sectors, which is only partially offset by a contraction in the importable sector (top row of Figure A.2). Note that the wealth effect is strengthened via the presence of the nontradable sector (and in particular in light of the complementarity between tradable and nontradable expenditure). The shock boosts the demands for labor (and investment) necessary to produce final output in the expanding sectors (and reduces factor demands in the importable producing sector).[10]

Figure A.1: Impulse Responses of Macro Aggregates



Notes: This figure shows the impulse responses of the main macroeconomic aggregates to (a one percent standard deviation) export/import price shock in the extended MXN model. Solid blue lines denote the responses to $p_t^{x,\$}$ shocks and dashed red lines to $p_t^{m,\$}$ shocks. The main macroeconomic aggregates plotted are observationally equivalent counterparts (expressed in constant prices). All responses are expressed in percentage deviations from steady state values, apart from interest rate paid on debt and trade balance over GDP, which are shown in percentage points.

Since pass-through from foreign to domestic export prices is full, a positive export price shock generates an appreciation in the real exchange rate (i.e., the domestic economy becomes more expensive *vis-à-vis* the rest of the world). We find that after a $p_t^{x,\$}$ shock, as in standard models, the relative price of nontradable goods (the inverse of the relative price of tradable goods) and the real exchange rate move in the opposite direction. A rise in $p_t^{x,\$}$ makes the domestic relative price of exports, p_t^x, more costly. At the same time, the appreciation of the real

[10]Investment expands in the exportable and nontradable sectors because the persistence of the shock induces an expected rise in the *marginal* profitability of these sectors.

exchange rate renders importable goods relatively cheaper to consume. The higher demand for nontradable goods pushes up nontradable prices (and puts downward pressure on the relative price of tradable goods), resulting in a boost in consumer prices and an appreciation in the real exchange rate. Overall, the transmission meachanism of a $p_t^{x,\$}$ shock is broadly consistent with the effects of a ToT shock in the standard MXN model.

The dashed red lines in Figure A.1 and Figure A.2 shows the responses of the main macroeconomic aggregates to a one percent innovation in import prices. It is clear that the responses of import and export price shocks do not mirror each other. A positive import price shock leads do a decline in consumption, investment and output. This is the combination of an interplay between wealth and substitution effects. On the one hand, the deterioration of the terms of trade triggers a negative wealth effect, inducing a decline of demand for all types of goods. At an aggregate level, firms would want to produce less output and demand less physical capital (investment). This is reflected in a lower return on capital and, thus, in lower saving. This effect reinforces the negative impact on investment arising from the drop in wealth. This explains the sharp negative response of investment after a $p_t^{m,\$}$ shock. On the other hand, the import price shock makes importable goods relatively more expensive, and there is therefore a substitution towards the consumption (absorption) of exportable goods (second row, Figure A.2). Responding to the shock, firms increase (reduce) the demand for factors so as to expand (contract) importable (exportable) output (first row, figure A.2). In addition, the lower demand for nontradable goods prompts firms to cut down production and their demands for capital and labor. The expansion in importable output, together with the drop in demand for importable absorption, generates a drop in import quantities. At the same time, the contraction of exportable output, alongside the expansion in exportable absorption, reduces export quantities. As a result, imports drop by more than exports and the trade balance improves on impact. The fall in GDP is the result of the fall in activity in the importable and the nontradable sectors, which is only partially offset by the expansion of activity in the exportable sector.

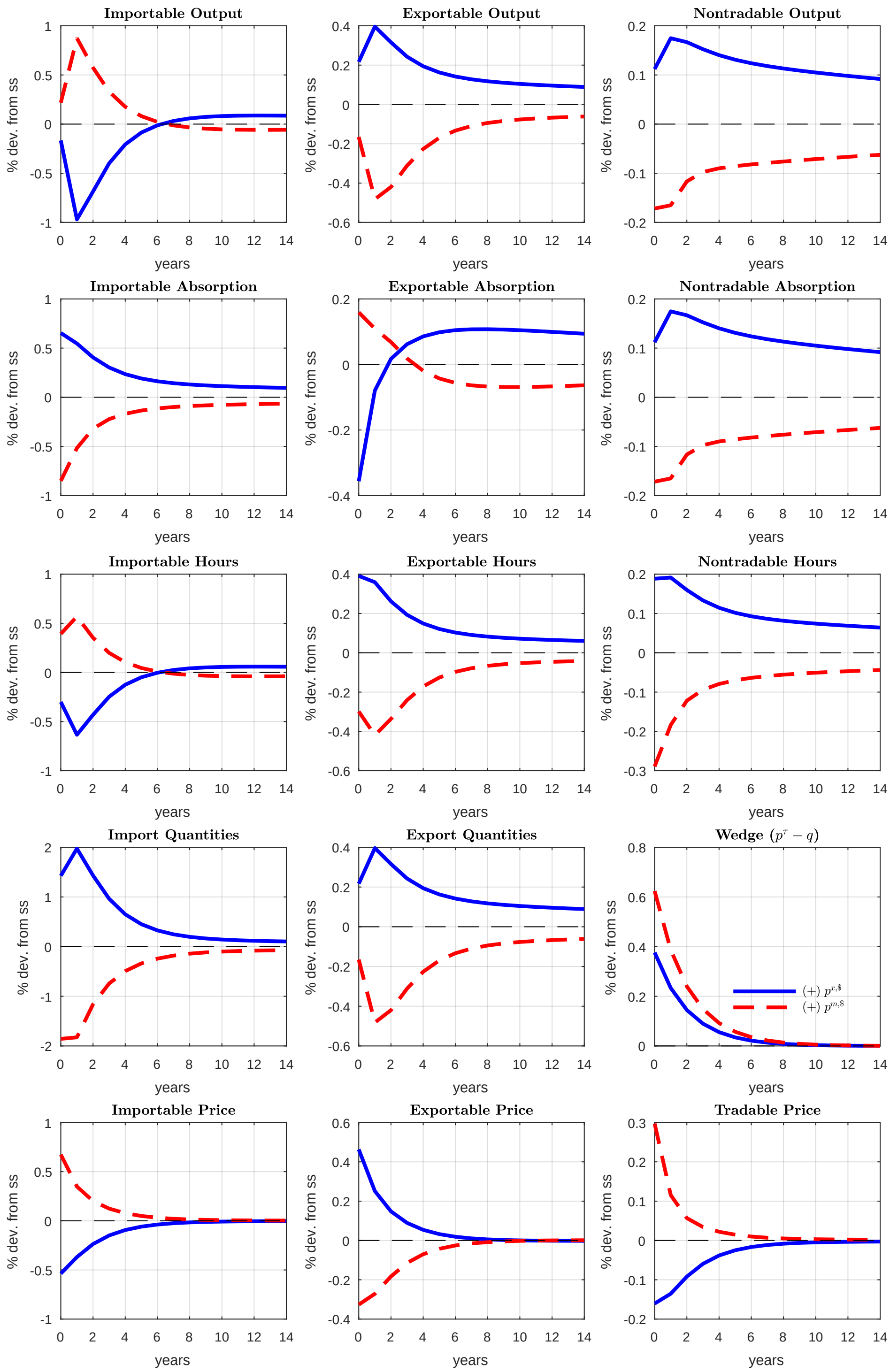
In line with Catão and Chang (2013, 2015), we observe an appreciation of the real exchange rate, which is the result of full pass-through from world to domestic import prices. The reduction in nontradable demand pushes down the relative price of nontradable goods (and pushes up the relative price of tradable goods). The shock opens up the gap between the relative price of tradable goods and the real exchange rate; i.e. the conditional correlation between real exchange rate and the relative price of nontradable goods becomes positive. An unexpected rise in $p_t^{m,\$}$ increases the relative price of imports, p_t^m, and reduces the relative price of exports.[11] To sum up, the transmission mechanism of a positive $p_t^{m,\$}$ shock does not resemble the one of a negative ToT shock in the standard MXN model.

An independent import price shock has different implications for allocations relative to an export price shock. In particular, the fact that the responses of consumption, investment and output are more persistent after an export price shock, and die out more quickly after an import price shock, are indicative that the wealth effect is relative stronger in response to a $p_t^{x,\$}$ shock.[12] As argued in the previous section, the calibration of the model plays a crucial role for

[11]Since consumption, investment and output contract after an import price shock, it could be argued that a $p_t^{m,\$}$ shock acts more like a spread shock in the standard MXN. Yet, tradable prices and the real exchange rate move in opposite directions after a $p_t^{m,\$}$ shock, further widening the gap between these two prices. By contrast, the spread shock generates a real exchange rate depreciation rather than an appreciation. As argued earlier a spread shock would not alter the negative relationship between the real exchange rate and the relative price of nontradable goods. Thus, we conclude that the two shocks are distinct from one another.

[12]This differences do not depend on the persistence of the shocks. See the next section for a more detailed analysis on the impact of the persistence of the shocks on the trade balance.

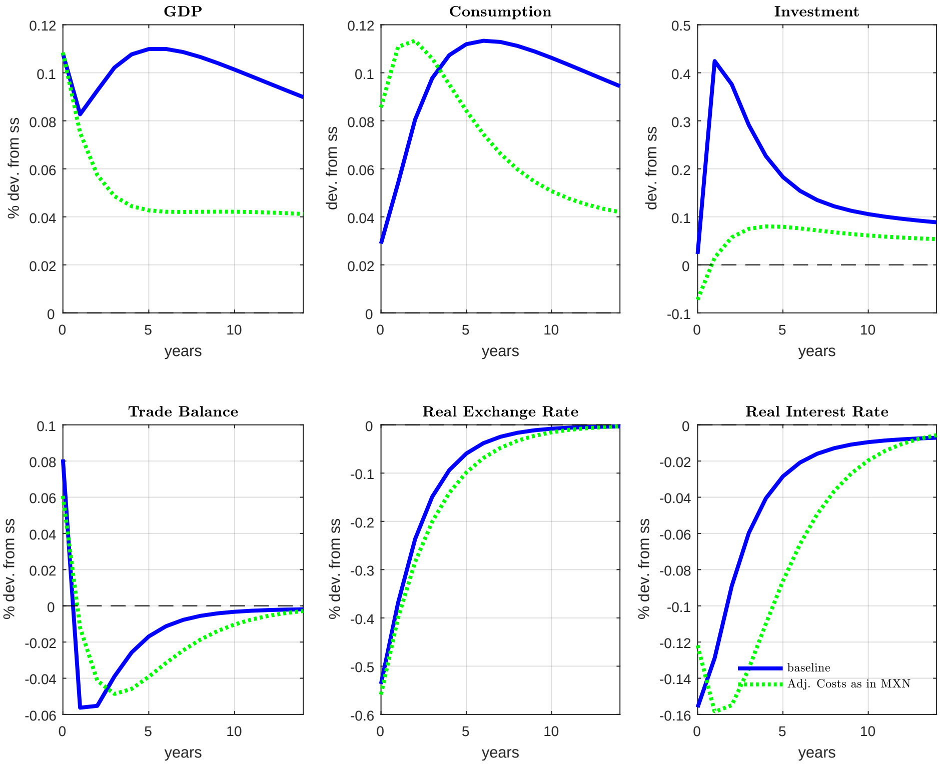
Figure A.2: Impulse Responses of Model Variables



Notes: This figure shows the impulse responses of the model variables to (one standard deviation) Terms-of-Trade shocks in the extended MXN model under the baseline calibration. Solid blue lines denote the responses to $p_t^{x,\$}$ shocks and dashed red lines to $p_t^{m,\$}$. Responses are expressed in percentage deviations from steady state values.

assessing the quantitative impact of the two shocks. There are 3 main assumptions driving the differences: (i) the share of exportable output in aggregate output is greater than the share

Figure A.3: The Role of Capital Adjustment Costs



Notes: This figure shows the impulse responses of the model variables to (a one percent) export price shock in the extended MXN model with alternative calibrations for sectoral adjustment costs. Solid blue lines denote the responses to $p_t^{x,\$}$ shocks with low sectoral adjustment costs and dashed green lines the case with high adjustment costs. Responses are expressed in percentage deviations from steady state values.

of the importable sector and (ii) the trade balance is positive in the steady state and (iii) tradable and nontradable absorption are complements. Differences arise because the income and substitution effects *are not alike between the two shocks*. First, the wealth effect turns out to be stronger after a $p_t^{x,\$}$ shock because in the steady state we have that $y_x/y > y_m/y$ and $x > m$. The $p_t^{m,\$}$ shock hits positively the *marginal* profitability of a smaller sector and negatively that of the exportable sector. Second, the weight of importable absorption (62%) on tradable absorption is higher than that of exportable goods. This explains the fact that there is less substitution away from importable goods (see for example the response of exportable absorption for a $p_t^{x,\$}$ and a $p_t^{m,\$}$ shock). As the model features three sectors of production, the behaviour of the nontradable sector turns out to be important for assessing the effects at the aggregate level. Figure A.2 illustrates that there are differences in the responses of the exportable and nontradable absorption (and output) and the prices of exportable and nontradable goods. The import price shock has a relatively weaker effect on the demand of nontradable goods, the largest sector.

While positive $p_t^{x,\$}$ shocks are expansionary and positive $p_t^{m,\$}$ shocks recessionary, there are significant differences in the way international price shocks transmit to the economy. In particular, both positive export and import price shocks imply similar responses in the real exchange rate and the trade balance. However, this means that the real exchange rate and trade balance will react differently to a ToT shock depending on whether the shift in ToT reflects a shock to $p_t^{x,\$}$ or $p_t^{m,\$}$. Quantitatively, the economic impact can differ substantially across shocks. The exact differences will depend on the model calibration. We leave the exercise of matching the different country responses to the two shocks for future research.

A.3.1 The Role of Adjustment Costs

The choice of the debt elastic premium vis-á-vis sectoral capital adjustment cost has important implications for aggregate dynamics. Whilst a high debt elastic premium tends to limit borrowing (and lending) across borders, high capital adjustment costs restrict capital accumulation and place a constraint on the productive capacity of the economy. High values of these parameters limit the ability of households to smooth out shocks over time. If decumulating debt is more costly than accumulating capital, then the representative household would prefer to accumulate (or decumulate) assets domestically. So long as sectoral capital in one of the three sectors is free to adjust relative to holding debt, agents would always prefer to use the cheapest consumption smoothing vehicle over, say, moving capital internationally. In addition, sectoral outputs will respond more in the sectors with lower adjustment costs, potentially generating greater heterogeneity in the responses.

We assess the impact of the capital adjustment costs on the transmission mechanism of the export price shock. Figure A.3 illustrates how the model dynamics changes when we align the capital adjustment cost parameters with those estimated by Schmitt-Grohé and Uribe (2018). Therefore, we set the values of these parameters to $\phi_m = 31.46$, $\phi_x = 11.54$ and $\phi_n = 12.51$. The picture is clear: the higher adjustment costs, the more costly it is to adjust capital and the lower the response of sectoral capital and output. Unsurprisingly, given that Schmitt-Grohé and Uribe (2018) estimate the adjustment cost parameters to match a ToT shock that has (on average) a limited impact on economic activity, we find that high levels of capital adjustment costs limit the ability of ToT shocks to explain a large share of the business cycle fluctuations in EMDEs. In sum, the exercise suggests that the extended MXN model has the flexibility to explain both a large and a small share of output fluctuations. Exploring this dimension of the model will ultimately depend on the exact model calibration. We leave the country-by-country estimation via impulse responses matching to future work.

A.4 ToT shocks and Trade Balance

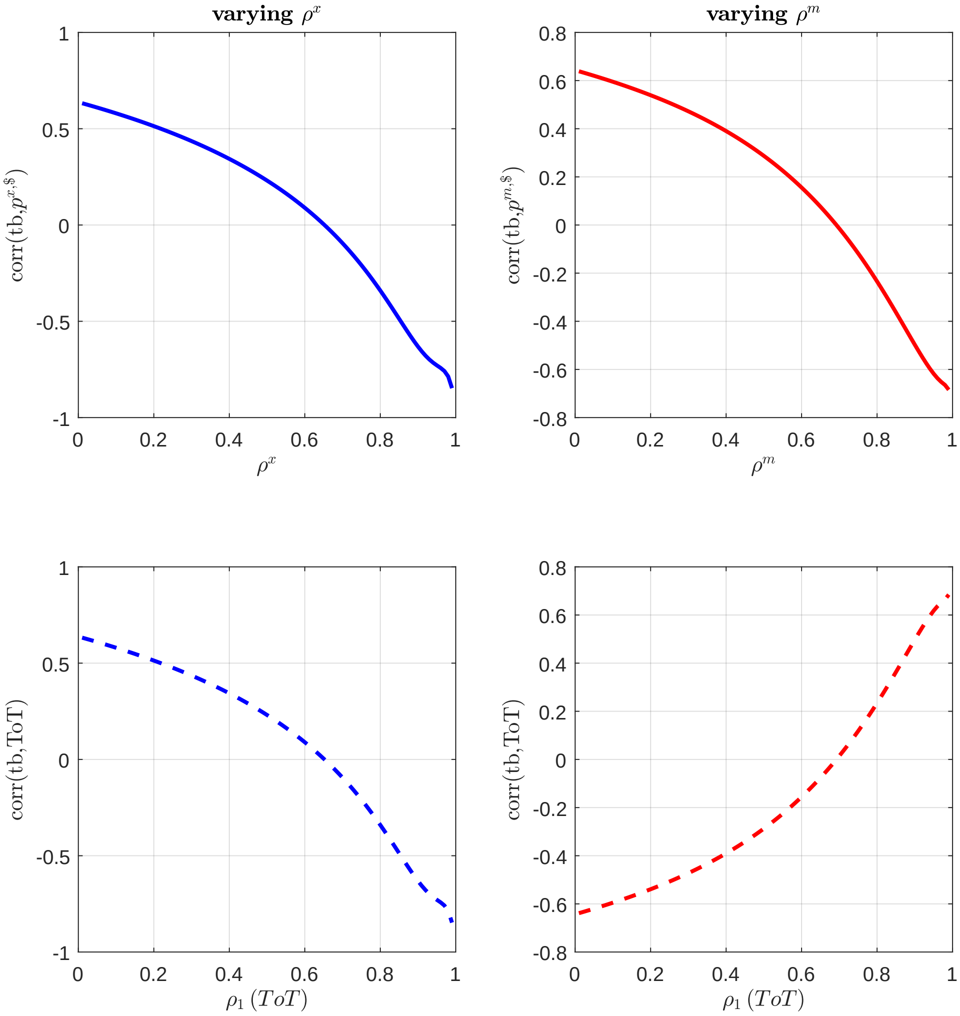
In response to an increase in ToT the trade balance could improve or worsen (see Harberger, 1950; Laursen and Metzler, 1950; Obstfeld, 1982; and Svensson and Razin, 1983). According to the Harberger-Laursen-Metzler (HLM) effect, which provides a static view of the impact of the terms of trade on the trade balance, holding the quantities of goods imported and exported constant, an increase in the relative price of exports should improve the trade balance.[13]

Using a dynamic optimizing model of the current account, Obstfeld (1982) and Svensson and Razin (1983) show that the effects of the terms of trade on the trade balance depend on the persistence of the terms-of-trade shock. If the increase in ToT is perceived to be persistent, aggregate demand may experience a strong expansion, leading to further deterioration in the trade balance. When the increase is perceived to be temporary, households may have an incentive to save, leading to an improvement in the trade balance. If the appreciation in the terms of trade triggers a sharp rise in investment, then the trade balance could also deteriorate. Traditionally, the strength of the rise in investment will also depend on the persistence of the terms-of-trade shock. This is known in the literature as the ORS effect.

When looking at the behavior of the trade balance (tb), our analysis suggests that ToT shocks are not all alike. Figure A.1 shows that under the chosen calibration, the tb improves in

[13] This effect is reinforced if demand and production of importable goods are held fixed.

Figure A.4: Correlations Between the Trade Balance and $p^{x,\$}$ and $p^{m,\$}$ shocks



Notes: The top left panel shows in solid blue the contemporaneous correlations between $p^{x,\$}$ and the trade balance (over GDP) for different values of ρ^x. The right panel illustrates in solid red the contemporaneous correlations between $p^{m,\$}$ and the trade balance (over GDP) as a function of ρ^m. The correlations are plotted against the persistence of the underlying shock process. The bottom panels show the correlations between the traditional terms-of-trade metric and the trade balance plotted against the implied persistence of ToT, $\rho_1(ToT)$. The left bottom panel illustrates (in dashed blue) the correlations between ToT and tb by increasing the value of ρ^x and the left bottom panel (in dashed red) the equivalent correlations that result from increasing the value of ρ^m.

the short run (and deteriorates thereafter) when ToT improvements are caused by upward shifts in $p_t^{x,\$}$, whereas it falls on impact (and recovers in subsequent periods) when ToT improvements are only driven by downward shifts in $p_t^{m,\$}$. Therefore, we observe a positive (short-run) correlation between tb and ToT when shifts in ToT are caused by $p_t^{x,\$}$ shocks, and a negative correlation when those shifts are driven by $p_t^{m,\$}$ shocks.[14] Therefore, in our setting it is possible to observe uncorrelated or weak correlations (of either sign) between tb and ToT

[14]The overall correlation between the tb and ToT in our baseline calibration is close to zero under both cases. This is because the response of tb switches signs and that of ToT monotonically reverts to zero.

simply because the latter reflects a combination of $p_t^{m,\$}$ and $p_t^{x,\$}$ shocks.

In this section we explore the extent to which these conclusions depend on the relative persistence of $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks in line with the traditional predictions of ORS. We therefore calculate the correlation between the price of exports (and imports) and the trade balance (over GDP) as a function of the value of the persistence of the shock processes. We start by looking at the case where the model is hit by either one of the two shocks in isolation. In this setting $\ln(ToT)$ is equal either to $\ln p_t^{x,\$}$ (when $p_t^{m,\$}$ is fixed) or to $-\ln p_t^{m,\$}$ (when $p_t^{x,\$}$ is fixed). The top two panels of Figure A.4 indicate that, when export and import price shocks are short-lived, the model economy exhibits an improvement in the trade balance. The correlations between export/import prices and the trade balance, switch from positive to negative, indicating that shocks that are more long-lived tend to deteriorate the trade balance. Noticeably the modified MXN reports opposite correlations depending on whether shifts in ToT originate from $p_t^{x,\$}$ or $p_t^{m,\$}$ shocks. This has to do with the fact that positive price shocks will always lead to an exchange rate appreciation and an improvement in the trade balance, with inter-temporal considerations becoming increasingly important when shocks are persistent.

The relationship between the correlations and persistence of the two shock processes becomes increasingly negative for higher values of the persistence parameter. A common feature between the two shocks is that they display a sign reversal in the correlation (from positive to negative) and it is zero when ρ^x and ρ^m are set close to the chosen calibrated values. Quantitatively, the export price shock has a relatively more negative effect on the trade balance as the persistence of the shock increases. This is consistent with the fact that the wealth effect becomes stronger (in absolute terms) when the economy is hit by a export price shock.[15]

The bottom panel of the figure reports the same exercise just described but instead focuses on the relationship between $corr(tb, ToT)$ as a function of the implied persistence of ToT, $\rho_1(ToT)$. Note that in this simple exercise (i.e. the case that conditions the analysis to one of the two shocks) we have that $\ln(ToT) = \ln(p_t^{x,\$})$ or $\ln(ToT) = -\ln(p_t^{m,\$})$, depending on which of the shocks we are feeding into the model. Unsurprisingly, we observe a negative relationship when assessing changes to the persistence of $p_t^{x,\$}$. This confirms that the transmission of $p_t^{x,\$}$ shocks is broadly in line with the transmission of the ToT shocks highlighted in the traditional SOE literature. By contrast, we observe the opposite relationship (positive) when varying the persistence of $p_t^{m,\$}$ shocks.

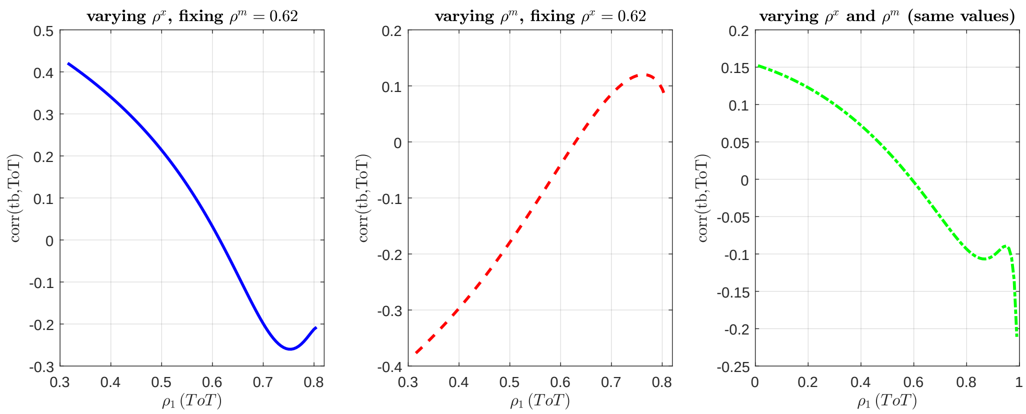
As it is possible to get either an upward or downward sloping relationships, depending on whether $p_t^{x,\$}$ or $p_t^{m,\$}$ dominates, further analysis of the link between corr(tb,ToT) and the implied persistence of ToT is needed. When both shocks are considered simultaneously, it is important to understand *what* drives the persistence of ToT; i.e. whether the higher persistence in ToT comes from higher persistence in $p_t^{x,\$}$ or in $p_t^{m,\$}$ (even when the volatility across shocks is assumed to be the same). We hit the model with both $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks and set the volatility of their innovations to $\sigma_{\varepsilon^\iota} = \sqrt{(1-\rho^\iota)}\,\varsigma \quad \text{for} \quad \iota = \{m, x\}$, where ς is common across shocks. We show three exercises in which we first vary the persistence of $p_t^{x,\$}$, then the persistence of $p_t^{m,\$}$ and finally the persistence of both shocks.[16]

Figure A.5 shows the correlations, $corr(tb, ToT)$, as functions of the (implied) persistence of the terms of trade when both shocks are considered jointly for different values of the

[15] Recall that a $p_t^{x,\$}$ shock increases the production of exports but lowers their demand, whilst it increases the demand of importable goods and reduces their production. A $p_t^{m,\$}$ shock does the opposite.

[16] We note that the persistence of ToT under the first two cases is a nonlinear function of the persistence of $p_t^{x,\$}$ and $p_t^{m,\$}$ (and therefore increasing the values from 0 to 1 maps into variations in the implied persistence of ToT that are more limited).

Figure A.5: Correlations Between the Trade Balance and the (implied) ToT Metric



Notes: The left panel shows in solid blue the contemporaneous correlations between ToT and the trade balance (over GDP) against the values of persistence of $p^{x,\$}$ (ranging from 0.01 to 0.99), whilst maintaining the persistence of the $p^{x,\$}$ fixed at the calibrated value. The middle panel illustrates in dashed red the contemporaneous correlations between ToT and the trade balance (over GDP) obtained by varying the value of persistence of the $p^{m,\$}$ increases, whilst maintaining the value of the persistence of $p^{x,\$}$ at the calibrated value. The right panel indicates in dashed green the contemporaneous correlations between ToT and the trade balance (over GDP) when ρ^x and ρ^m are set to the same value and increased simultaneously. All correlations are plotted against the implied persistence in the (traditional) ToT measure.

persistence of international prices. This exercise is useful because a more realistic calibration will feature different values of ρ^x and ρ^m (as in our empirical analysis). This may lead to more heterogeneous effects on the trade balance (and also on other variables).

By increasing the persistence of $p_t^{x,\$}$, we get a downward sloping relationship between the corr(tb,ToT) and the implied persistence of ToT. In fact, when the persistence of $p_t^{x,\$}$ is small, all the persistence in ToT is due to $p_t^{m,\$}$. Therefore, we end up by combining the effect of low persistent $p_t^{x,\$}$ shocks which are associated with high $corr(tb, ToT)$ (see left panel of Figure A.5). As a result, the overall correlation is positive but less than what would have been in absence of $p_t^{m,\$}$ shocks (as the presence of the latter attenuates the overall positive correlation coming from $p_t^{x,\$}$ shocks). As the persistence of $p_t^{x,\$}$ exceeds its calibrated value (0.62), we assess the impact of very persistent $p_t^{x,\$}$ shocks (associated with a negative correlation between tb and ToT) and mildly persistent $p_t^{m,\$}$ shocks (which are associated with close to zero correlation). The result is a negatively correlated tb with ToT. The opposite reasoning holds true if we increase the persistence of $p_t^{m,\$}$ and hold fixed the persistence of $p_t^{x,\$}$ (see middle panel of Figure A.5). In the final exercise we increase the persistence of $p_t^{x,\$}$ and $p_t^{m,\$}$ simultaneously. At low persistence levels, we have shocks whose volatility is low and equal. Since the two shocks give opposite $corr(tb, ToT)$ individually, we obtain a much smaller overall correlation. The correlation remains positive because, under our calibration, $p_t^{x,\$}$ shocks have a larger impact on tb than $p_t^{m,\$}$ shocks. The correlation eventually becomes negative because the positive wealth effect dominates when we increase the persistence of $p_t^{m,\$}$ and $p_t^{x,\$}$ simultaneously.

Mendoza (1995) highlights that, when looking at how the unconditional correlation between the trade balance and the terms of trade varies with the persistence of ToT, the presence of multiple shocks can confound the pattern implied by the ORS effect. This is the reason why Schmitt-Grohé and Uribe (2017, pp. 344-347) present the relationship between the $corr(tb, ToT)$ and the persistence of ToT by conditioning only on ToT shocks. In this section we highlighted that it is important to analyse carefully the source of variation in ToT (whether it arises from $p_t^{x,\$}$ or $p_t^{m,\$}$ shocks or a combination of both). Since $p_t^{x,\$}$ and $p_t^{m,\$}$ imply opposite patterns of correlations/persistence, the overall ORS effect is blurred and turns out to be a function of the relative importance of the two shocks and their persistence. In order to investigate the ORS effect, we have also looked at the same correlation conditioning on $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks in isolation. We report the data counterpart of this exercise in Section 3.6 of the main text. When examining this relationship in the data, it is key to proceed with caution. The association is further obscured by the fact that, as explained in the main text, there is inter-dependence between $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks. This finding is partly a reflection that there is partial pass-through of any international price shock to all prices through the intermediate input channel (see, e.g, Haung and Liu, 2007; and Auer, Levchenko and Sauré, 2019).[17]

A.5 Summary of Equations

The full system of equations in the extended MXN model is given by:

Households optimality conditions and constraints

$$\lambda_t = \left(c_t - \varphi \frac{h_t^{1+\omega}}{1+\omega}\right)^{-\sigma}, \tag{A.19}$$

$$w_t^m = \varphi h_t^\omega \left(\frac{h_t^m}{\gamma_m h_t}\right)^{\frac{1}{\kappa}}, \tag{A.20}$$

$$w_t^n = \varphi h_t^\omega \left(\frac{h_t^x}{\gamma_x h_t}\right)^{\frac{1}{\kappa}}, \tag{A.21}$$

$$w_t^n = \varphi h_t^\omega \left(\frac{h_t^n}{(1-\gamma_m-\gamma_x)\, h_t}\right)^{\frac{1}{\kappa}}, \tag{A.22}$$

$$h_t = \left[\gamma_m^{-\frac{1}{\kappa}} \left(h_t^m\right)^{\frac{1+\kappa}{\kappa}} + \gamma_x^{-\frac{1}{\kappa}} \left(h_t^x\right)^{\frac{1+\kappa}{\kappa}} + (1-\gamma_m-\gamma_x)^{-\frac{1}{\kappa}} \left(h_t^n\right)^{\frac{1+\kappa}{\kappa}}\right]^{\frac{\kappa}{1+\kappa}}, \tag{A.23}$$

$$\lambda_t q_t = \beta\,(1+r_t)\,\mathbb{E}_t \lambda_{t+1} q_{t+1}, \tag{A.24}$$

$$r_t = r^* + s + \psi\left(e^{d_{t+1}-d} - 1\right), \tag{A.25}$$

$$\lambda_t \left[1 + \phi_m \left(k_{t+1}^m - k_t^m\right)\right] = \beta \mathbb{E}_t \lambda_{t+1} \left[1 - \delta + u_{t+1}^m + \phi_m \left(k_{t+2}^m - k_{t+1}^m\right)\right], \tag{A.26}$$

$$\lambda_t \left[1 + \phi_x \left(k_{t+1}^x - k_t^x\right)\right] = \beta \mathbb{E}_t \lambda_{t+1} \left[1 - \delta + u_{t+1}^x + \phi_x \left(k_{t+2}^x - k_{t+1}^x\right)\right], \tag{A.27}$$

$$\lambda_t \left[1 + \phi_n \left(k_{t+1}^n - k_t^n\right)\right] = \beta \mathbb{E}_t \lambda_{t+1} \left[1 - \delta + u_{t+1}^n + \phi_n \left(k_{t+2}^n - k_{t+1}^n\right)\right], \tag{A.28}$$

Laws of motion of physical capital

$$i_t^m = k_{t+1}^m - (1-\delta)\, k_t^m, \tag{A.29}$$

$$i_t^x = k_{t+1}^x - (1-\delta)\, k_t^x, \tag{A.30}$$

$$i_{nt} = k_{t+1}^x - (1-\delta)\, k_t^n, \tag{A.31}$$

[17] In principle, it is possible to incorporate such (more realistic) shock process within the extended MXN model in order to study the transmission of $p_t^{x,\$}$ and $p_t^{m,\$}$ shocks. We leave this for future research.

Absorption aggregators and optimality condition of final goods firms

$$a_t = \left(\chi_\tau^{\frac{1}{\mu_{\tau n}}} \left(a_t^\tau\right)^{1-\frac{1}{\mu_{\tau n}}} + \left(1-\chi_\tau\right)^{\frac{1}{\mu_{\tau n}}} \left(a_t^n\right)^{1-\frac{1}{\mu_{\tau n}}}\right)^{\frac{1}{1-\frac{1}{\mu_{\tau n}}}}, \tag{A.32}$$

$$p_t^\tau = \chi_\tau^{\frac{1}{\mu_{\tau n}}} \left(\frac{a_t^\tau}{a_t}\right)^{-\frac{1}{\mu_{\tau n}}}, \tag{A.33}$$

$$p_t^n = \left(1-\chi_\tau\right)^{\frac{1}{\mu_{\tau n}}} \left(\frac{a_t^n}{a_t}\right)^{-\frac{1}{\mu_{\tau n}}}, \tag{A.34}$$

$$a_t^\tau = \left(\chi_m^{\frac{1}{\mu_{mx}}} \left(a_t^m\right)^{1-\frac{1}{\mu_{mx}}} + \left(1-\chi_m\right)^{\frac{1}{\mu_{mx}}} \left(a_t^x\right)^{1-\frac{1}{\mu_{mx}}}\right)^{\frac{1}{1-\frac{1}{\mu_{mx}}}}, \tag{A.35}$$

$$\frac{p_t^m}{p_t^\tau} = \chi_m^{\frac{1}{\mu_{mx}}} \left(\frac{a_t^m}{a_t^\tau}\right)^{-\frac{1}{\mu_{mx}}}, \tag{A.36}$$

$$\frac{p_t^x}{p_t^\tau} = \left(1-\chi_m\right)^{\frac{1}{\mu_{mx}}} \left(\frac{a_t^x}{a_t^\tau}\right)^{-\frac{1}{\mu_{mx}}}, \tag{A.37}$$

Production functions and optimality condition of intermediate firms

$$y_t^m = z_m \left(k_t^m\right)^{\alpha_m} \left(h_t^m\right)^{1-\alpha_m}, \tag{A.38}$$

$$y_t^x = z_x \left(k_t^x\right)^{\alpha_x} \left(h_t^x\right)^{1-\alpha_x}, \tag{A.39}$$

$$y_t^n = z_n \left(k_t^n\right)^{\alpha_n} \left(h_t^n\right)^{1-\alpha_n}, \tag{A.40}$$

$$u_t^m = p_t^m \alpha_m z_m \left(k_t^m\right)^{\alpha_m-1} \left(h_t^m\right)^{1-\alpha_m}, \tag{A.41}$$

$$u_t^x = p_t^x \alpha_x z_x \left(k_t^x\right)^{\alpha_x-1} \left(h_t^x\right)^{1-\alpha_x}, \tag{A.42}$$

$$u_t^n = p_t^n \alpha_n z_n \left(k_t^n\right)^{\alpha_n-1} \left(h_t^n\right)^{1-\alpha_n}, \tag{A.43}$$

$$w_t^m = p_t^m \left(1-\alpha_m\right) z_m \left(k_t^m\right)^{\alpha_m} \left(h_t^m\right)^{(-\alpha_m)}, \tag{A.44}$$

$$w_t^x = p_t^x \left(1-\alpha_x\right) z_x \left(k_t^x\right)^{\alpha_x} \left(h_t^x\right)^{(-\alpha_x)}, \tag{A.45}$$

$$w_t^n = p_t^n \left(1-\alpha_n\right) z_n \left(k_t^n\right)^{\alpha_n} \left(h_t^n\right)^{(-\alpha_n)}, \tag{A.46}$$

Market clearing conditions

$$a_t = i_t + c_t + \frac{\phi_m}{2}\left(k_{t+1}^m - k_t^m\right)^2 + \frac{\phi_x}{2}\left(k_{t+1}^x - k_t^x\right)^2 + \frac{\phi_n}{2}\left(k_{t+1}^n - k_t^n\right)^2, \tag{A.47}$$

$$m_t = \left(a_t^m - y_t^m\right), \tag{A.48}$$

$$y_t^n = a_t^n, \tag{A.49}$$

$$x_t = \left(y_t^x - a_t^x\right), \tag{A.50}$$

$$\frac{q_t d_{t+1}}{1+r_t} - q_t d_t = p_t^m m_t - p_t^x x_t, \tag{A.51}$$

$$y_t = p_t^m y_t^m + p_t^x y_t^x + p_t^n y_t^n, \tag{A.52}$$

$$i_t = i_t^m + i_t^x + i_t^n, \tag{A.53}$$

LOOP and ToT

$$p_t^{m,\$} = \frac{p_t^m}{q_t}, \tag{A.54}$$

$$p_t^{x,\$} = \frac{p_t^x}{q_t}, \tag{A.55}$$

$$ToT_t = \frac{p_t^{x,\$}}{p_t^{m,\$}}, \tag{A.56}$$

Observation equations

$$y_t^o = p^m y_t^m + p^x y_t^x + p^n y_t^n, \tag{A.57}$$

$$c_t^o = \frac{c_t}{y_t} y_t^o, \tag{A.58}$$

$$i_t^o = \frac{i_t}{y_t} y_t^o, \tag{A.59}$$

$$tb_t = \frac{\left(\frac{p_t^x x_t}{y_t} - \frac{p_t^m m_t}{y_t}\right) y_t^o}{y}, \tag{A.60}$$

Shocks

$$\ln\left(\frac{p_t^{x,\$}}{p^{x,\$}}\right) = \rho^x \ln\left(\frac{p_{t-1}^{x,\$}}{p^{x,\$}}\right) + \varsigma^x \varepsilon_t^x, \tag{A.61}$$

$$\ln\left(\frac{p_t^{m,\$}}{p^{m,\$}}\right) = \rho^m \ln\left(\frac{p_{t-1}^{m,\$}}{p^{m,\$}}\right) + \varsigma^m \varepsilon_t^m. \tag{A.62}$$

A.6 Steady State

We pin down the steady state analytically. We normalize $p^{x,\$} = 1$, $p^{m,\$} = 1$ and, thus, $ToT = 1$. Under LOOP, this implies that $p^\tau = q = 1$. We assume that the level of productivity is the same across import and export sectors ($z_x = z_m$) such that $p^\tau = 1$. It follows from equation (A.24) that

$$\beta = \frac{1}{1+r}, \tag{A.63}$$

where

$$r = r^* + s. \tag{A.64}$$

From the definition of output, equation (A.52), we get the share of tradable output in aggregate output

$$s_{y_\tau} = 1 - s_{y_n}. \tag{A.65}$$

We make the simplifying assumption that exportable output consumed at home is $s_{a_x} = 0.1866$, which means that output in the exportable sector is given by

$$s_{y_x} = s_x + s_{a_x}.$$

Thus,

$$s_{y_m} = s_{y_\tau} - s_{y_x}.$$

Using the trade balance and dividing by output, we can retrieve the share of imports,

$$s_m = s_x - s_{tb}. \tag{A.66}$$

From equations (A.26), (A.27) and (A.28), we can recover sectoral rental rates of physical capital

$$u^m = u^x = u^n = \frac{1}{\beta} - 1 + \delta. \tag{A.67}$$

Using the definition of aggregate investment, equation (A.53), and fixing the value of $\frac{\alpha_x}{\alpha_n}$ and $\frac{\alpha_x}{\alpha_n}$, we can recover the capital share in the nontradable sector that targets the investment-to-GDP ratio (s_i),

$$\frac{s_i}{\delta\left(\frac{\alpha_m}{\alpha_n}\frac{s_{ym}}{u^m}+\frac{\alpha_x}{\alpha_n}\frac{s_{yx}}{u^x}+\frac{s_{yn}}{u^n}\right)}=\alpha_n. \tag{A.68}$$

Then, we can easily recover capital shares in the exportable and importable sectors

$$\alpha_m=\alpha_n\frac{\alpha_m}{\alpha_n}, \tag{A.69}$$

$$\alpha_x=\alpha_n\frac{\alpha_x}{\alpha_n}. \tag{A.70}$$

Replacing the capital and labor demands of the tradable sector, equations (A.46) and (A.43), into the production function of the nontradable sector, equation (A.40), we can recover the wage rate by normalizing the level of productivity in the nontradable sector, z_n, to 1,

$$1=\left(\frac{\alpha_n}{u^n}\right)^{\alpha_n}\left(\frac{1-\alpha_n}{w}\right)^{1-\alpha_n}\Rightarrow(1-\alpha_n)\left(\frac{\alpha_n}{u^n}\right)^{\frac{\alpha_n}{1-\alpha_n}}=w. \tag{A.71}$$

Given that the sectors and the capital shares are assumed to be the same in the exportable and importable sectors, it follows that $h^m=h^x$ (so long as $\frac{\alpha_x}{\alpha_n}=\frac{\alpha_x}{\alpha_n}$). Alternatively, $h^m\neq h^x$. Substituting the demand for capital, equation (A.42), into the production function in the exportable sector, equation (A.39), we can recover the level of productivity and hours worked in the exportable sector,

$$(y^x)^{1-\alpha_x}=z_x\left(\frac{\alpha_x}{u^x}\right)^{\alpha_x}(h^x)^{1-\alpha_x}\Rightarrow z_x=(y^x)^{1-\alpha_x}\Rightarrow h^x=\left(\frac{u^x}{\alpha_x}\right)^{\frac{\alpha_x}{1-\alpha_x}}. \tag{A.72}$$

Using equation (A.45), we can recover exportable output,

$$y^x=\frac{wh^x}{1-\alpha_x}. \tag{A.73}$$

Once we get the value of output in the exportable sector, aggregate output is simply

$$y=\frac{y_x}{s_{y_x}}, \tag{A.74}$$

nontradable output

$$y^n=s_{y_x}y, \tag{A.75}$$

and importable output

$$y^m=s_{y_m}y. \tag{A.76}$$

From equation (A.44), we can obtain hours worked in the importable sector

$$h^m=\frac{(1-\alpha_m)y_m}{w}.$$

Using equation (A.41), we get the capital stock in the importable sector,

$$k^m=\alpha_m\frac{y^m}{u^m}. \tag{A.77}$$

From equation (A.46), it follows that

$$h^n = \frac{(1-\alpha_n)\, y^n}{w}. \tag{A.78}$$

Taking the ratio between equations (A.20) and (A.21), we get the following expression

$$\frac{\gamma_m}{\gamma_x} h^x = h^m. \tag{A.79}$$

By dividing equations (A.21) and (A.22), we obtain

$$\gamma_x = (1-\gamma_m)\, \frac{h^x}{(h^n + h^x)}. \tag{A.80}$$

By combining the expressions above, we can recover the value of γ_m that guarantees that $w_m = w_x = w_n = w$.

$$\gamma_m \left(1 + \frac{h^m}{(h^n + h^x)}\right) = \frac{h^m}{(h^n + h^x)} \Rightarrow \gamma_m = \frac{\frac{h^m}{(h^n+h^x)}}{1 + \frac{h^m}{(h^n+h^x)}} \Rightarrow \gamma_m = \frac{1}{\frac{h^n+h^x}{h^m} + 1}. \tag{A.81}$$

Since $wh = w^m h^m + w^x n^x + w^n h^n$, it follows that, in the steady state, labor is perfectly mobile,

$$h = h^m + h^x + h^m. \tag{A.82}$$

Using equations (A.42) and (A.43), yields

$$k^x = \alpha_x \frac{y^x}{u^x}, \tag{A.83}$$

$$k^n = \alpha_n \frac{y^n}{u^n}. \tag{A.84}$$

Dividing equation (A.32) by output y,

$$\frac{a}{y} = \left(\chi_\tau^{\frac{1}{\mu_{\tau n}}} \left(\frac{a^\tau}{y}\right)^{1-\frac{1}{\mu_{\tau n}}} + (1-\chi_\tau)^{\frac{1}{\mu_{\tau n}}} \left(\frac{y^n}{y}\right)^{1-\frac{1}{\mu_{\tau n}}}\right)^{\frac{1}{1-\frac{1}{\mu_{\tau n}}}},$$

and replacing equation (A.36) into (A.35), we get the share of importable absorption in tradable absorption,

$$\chi_m = \frac{1}{1 + \left(\frac{s_{y_x} - s_x}{s_{y_m} + s_x - s_{tb}}\right)}. \tag{A.85}$$

The values of χ_m is chosen to match s_{tb}. First, use χ_m to retrieve the value of $\frac{a^\tau}{y}$. Then, use $\frac{a^\tau}{y} = \chi_\tau \frac{a}{y}$ that follows from equation (A.33) and replace into equation (A.32),

$$\chi_\tau = \frac{1}{\left(1 + \frac{s_{y_n}}{\frac{a^\tau}{y}}\right)}. \tag{A.86}$$

The value of χ_τ is such that s_{y_n} is attained. From equations (A.33), (A.34), (A.36) and (A.37), we obtain the following absorption demands

$$a^n = (1-\chi_\tau)\, a, \tag{A.87}$$

$$a^{\tau} = \chi_{\tau} a, \tag{A.88}$$

$$a^{m} = \chi_{m} a^{\tau}, \tag{A.89}$$

$$a^{x} = (1 - \chi_{m})\, a^{\tau}. \tag{A.90}$$

Exports and imports can be retrieved as

$$x = s_x y, \tag{A.91}$$

$$m = x - s_{tb} y. \tag{A.92}$$

From equation (A.51), we get

$$d = \frac{(x - m)(1 + r)}{r}. \tag{A.93}$$

From the sectoral law of motions of sectoral investment, equations (A.29), (A.30) and (A.31), it follows

$$i_m = \delta k_m, \tag{A.94}$$

$$i_x = \delta k_x, \tag{A.95}$$

$$i_n = \delta k_n. \tag{A.96}$$

Aggregate investment is simply,

$$i = s_i y. \tag{A.97}$$

Aggregate consumption can be retrieved from equation (A.47),

$$c = a - i. \tag{A.98}$$

From labor supply relationships, we can obtain the value of φ that targets s_x,

$$\varphi = \frac{w}{h^{\omega}}.$$

We obtain the value of λ from equation (A.36),

$$\lambda = \left(c_t - \varphi \frac{h^{1+\omega}}{1 + \omega} \right)^{(-\sigma)}. \tag{A.99}$$

Finally, the macroeconomic aggregates in constant prices are easily recovered:

$$c^{o} = c, \tag{A.100}$$

$$y^{o} = y, \tag{A.101}$$

$$i^{o} = i, \tag{A.102}$$

$$tb = s_{tb}. \tag{A.103}$$

Appendix B Data Sources

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.

B.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. Households and NPISHs final consumption expenditure as % of GDP. Indicator code: NE.CON.PRVT.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
9. GDP per capita, PPP (constant 2017 international $). Indicator code: NY.GDP.PCAP.PP.KD
10. Net barter terms of trade index (2000 = 100). Indicator code: TT.PRI.MRCH.XD.WD

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

The criteria for a country to be included follows Schmitt-Grohé and Uribe (2018). A country needs to have at least 30 consecutive annual observations and to belong to the group of poor and emerging countries. The latter is defined as all countries with average GDP per capita at PPP U.S. dollars of 2017 over the period 1980-2019 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. It is uncertain whether the same applies to 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 B.1 reports the data coverage for each country.

World data:

1. Global Economic Activity: Real World GDP at 2020 prices and 2010 exchange rates is sourced from Haver Analytics (Indicator Code: A001GDPD@IMFWEO).

Table B.1: Macro Data Coverage

Country	Data
Algeria	1980-2019
Argentina	1987-2019
Bangladesh	1986-2019
Bolivia	1980-2019
Brazil	1980-2019
Burkina Faso	1980-2019
Cameroon	1980-2019
Chad	1983-2019
Colombia	1980-2019
Congo, Dem. Rep.	1980-2016
Cote d'Ivoire	1980-2019
Dominican Republic	1980-2019
Egypt, Arab Rep.	1980-2018
Equatorial Guinea	1985-2019
Gabon	1980-2019
Ghana	1983-2019
Guatemala	1980-2019
Honduras	1980-2019
India	1980-2019
Indonesia	1980-2019
Jordan	1980-2018
Kenya	1980-2018
Madagascar	1980-2019
Malawi	1980-2019
Mauritius	1980-2019
Mexico	1980-2019
Morocco	1980-2019
Niger	1980-2019
Nigeria	1981-2018
Pakistan	1980-2019
Peru	1980-2019
Philippines	1980-2019
Senegal	1980-2019
South Africa	1980-2019
Sudan	1980-2018
Thailand	1980-2019
Turkey	1980-2019
Uruguay	1980-2019

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

B.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.[18] 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,

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

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.[19] The sources of price data are detailed in Tables B.2 and B.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.

Table B.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, feed, No. 2, spot	World Bank Commodity Price Data
Maize	US, no. 2, yellow, f.o.b. US Gulf ports	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, 99.5% fine	World Bank Commodity Price Data
Platinum	UK, , 99.9% refined	World Bank Commodity Price Data
Silver	UK, , 99.9% refined	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.

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

Table B.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	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.

Appendix C Additional Descriptive Statistics

This section includes additional details about the data. Specifically, Tables C.1-C.5 provide additional information about country specific export and import specialization for the entire sample as well as for four different subsamples of our data while Table C.6 provides additional descriptive statistics for the commodity terms of trade.

Table C.1: Commodity Imports and Exports (1980-2019)

	Comm. Imp. (%)	Comm. Exp. (%)	Main Comm. Imports			Main Exports		
Algeria	30.8	92.8	Food	Wheat	Met. & Min.	Crude oil	Natural gas	Fertilizers
Argentina	18.7	71.5	Natural gas	Met. & Min.	Crude oil	Soybean meal	Food	Crude oil
Bangladesh	36.8	16.5	Crude oil	Wheat	Cotton	Food	Other Raw Mat.	Tea
Bolivia	20.4	93.1	Met. & Min.	Crude oil	Wheat	Natural gas	Tin	Gold
Brazil	33.7	55.8	Crude oil	Fertilizers	Food	Iron ore	Coffee	Crude oil
Burkina Faso	29.4	92.2	Food	Crude oil	Met. & Min.	Cotton	Gold	Oils & Meals
Cameroon	32.6	94.6	Crude oil	Food	Met. & Min.	Crude oil	Timber	Cocoa
Chad	21.1	95.0	Food	Met. & Min.	Wheat	Cotton	Crude oil	Other Raw Mat.
Colombia	20.9	74.2	Crude oil	Food	Met. & Min.	Crude oil	Coffee	Coal
Congo, Dem. Rep.	29.4	68.4	Food	Crude oil	Met. & Min.	Copper	Met. & Min.	Crude oil
Cote d'Ivoire	40.6	89.9	Crude oil	Food	Rice	Cocoa	Coffee	Timber
Dominican Republic	29.4	38.0	Crude oil	Food	Met. & Min.	Sugar	Tobacco	Gold
Egypt, Arab Rep.	39.1	67.5	Wheat	Food	Met. & Min.	Crude oil	Food	Cotton
Equatorial Guinea	30.4	95.3	Met. & Min.	Beverages	Food	Crude oil	Timber	Cocoa
Gabon	23.3	95.7	Met. & Min.	Food	Crude oil	Crude oil	Timber	Met. & Min.
Ghana	27.9	88.6	Crude oil	Food	Met. & Min.	Cocoa	Aluminum	Gold
Guatemala	29.9	62.9	Crude oil	Food	Met. & Min.	Coffee	Food	Sugar
Honduras	28.2	59.8	Crude oil	Food	Met. & Min.	Coffee	Banana	Food
India	41.9	33.4	Crude oil	Gold	Fertilizers	Food	Crude oil	Met. & Min.
Indonesia	34.4	63.4	Crude oil	Met. & Min.	Food	Crude oil	Natural gas	Food
Jordan	37.1	57.9	Crude oil	Food	Met. & Min.	Fertilizers	Food	Met. & Min.
Kenya	29.7	77.0	Crude oil	Palm oil	Met. & Min.	Tea	Coffee	Food
Madagascar	26.6	69.4	Rice	Met. & Min.	Food	Food	Coffee	Met. & Min.
Malawi	23.3	90.3	Fertilizers	Met. & Min.	Food	Tobacco	Tea	Sugar
Malaysia	29.5	41.5	Food	Crude oil	Met. & Min.	Sugar	Food	Precious
Mauritius	19.8	34.1	Met. & Min.	Crude oil	Food	Crude oil	Food	Met. & Min.
Mexico	36.1	48.7	Crude oil	Wheat	Fertilizers	Food	Fertilizers	Orange
Morocco	29.1	34.5	Food	Met. & Min.	Tobacco	Crude oil	Met. & Min.	Food
Niger	24.4	96.6	Food	Met. & Min.	Crude oil	Crude oil	Natural gas	Cocoa
Nigeria	42.9	25.5	Crude oil	Palm oil	Fertilizers	Rice	Cotton	Food
Pakistan	30.2	84.1	Crude oil	Food	Met. & Min.	Copper	Gold	Zinc
Panama	28.2	28.1	Crude oil	Food	Met. & Min.	Food	Coconut oil	Copper
Peru	42.4	77.5	Crude oil	Food	Rice	Food	Oils & Meals	Fertilizers
Philippines	20.7	58.8	Crude oil	Met. & Min.	Food	Gold	Platinum	Coal
Senegal	27.0	96.9	Wheat	Food	Met. & Min.	Crude oil	Cotton	Grains
South Africa	30.8	38.0	Crude oil	Met. & Min.	Food	Food	Rice	Rubber
Sudan	31.3	33.7	Crude oil	Iron ore	Other Raw Mat.	Food	Met. & Min.	Crude oil
Thailand	31.6	61.3	Crude oil	Food	Met. & Min.	Beef	Food	Rice
Tunisia	28.6	35.8	Crude oil	Met. & Min.	Wheat	Crude oil	Food	Fertilizers
Turkey	31.9	34.2	Crude oil	Iron ore	Other Raw Mat.	Food	Met. & Min.	Crude oil
Uruguay	31.7	60.5	Crude oil	Food	Fertilizers	Beef	Food	Rice
Median	29.7	63.4						

Table C.2: Commodity Imports and Exports (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 C.3: Commodity Imports and Exports (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 C.4: Commodity Imports and Exports (2000 - 2009)

	Comm. Imp.	Comm. Exp.	Main Imports						Main Exports					
Algeria	29.8	96.1	Food	6.9	Wheat	6.5	Met. & Min.	3.2	Crude oil	67.0	Natural gas	28.0	Fertilizers	0.3
Argentina	15.9	70.9	Met. & Min.	2.6	Crude oil	2.2	Fertilizers	1.8	Crude oil	12.7	Soybean meal	10.8	Food	9.9
Bangladesh	37.5	7.8	Crude oil	7.8	Cotton	4.7	Food	3.8	Food	5.2	Other Raw Mat.	1.0	Fertilizers	0.6
Bolivia	25.4	89.3	Crude oil	7.4	Food	3.6	Met. & Min.	3.4	Natural gas	29.8	Soybean meal	11.7	Crude oil	7.2
Brazil	31.4	51.2	Crude oil	13.1	Fertilizers	3.4	Food	2.1	Iron ore	8.5	Crude oil	5.4	Soybeans	4.8
Burkina Faso	31.7	89.8	Crude oil	7.0	Food	6.0	Met. & Min.	3.1	Cotton	66.2	Grains	6.5	Sugar	4.1
Cameroon	35.5	96.1	Crude oil	13.1	Food	4.5	Met. & Min.	3.4	Crude oil	47.2	Timber	18.9	Banana	8.0
Chad	19.2	96.2	Met. & Min.	4.5	Wheat	4.1	Food	3.6	Crude oil	49.1	Cotton	39.0	Other Raw Mat.	7.4
Colombia	20.5	65.8	Food	3.1	Crude oil	2.5	Met. & Min.	2.1	Crude oil	25.5	Coal	12.8	Coffee	7.6
Congo, Dem. Rep.	36.3	49.8	Food	7.6	Wheat	5.3	Crude oil	4.6	Met. & Min.	22.8	Crude oil	12.5	Copper	6.3
Cote d'Ivoire	46.2	93.2	Crude oil	19.5	Rice	8.2	Food	6.8	Cocoa	45.6	Crude oil	14.2	Food	7.6
Dominican Republic	30.7	22.8	Crude oil	10.0	Food	4.6	Met. & Min.	2.7	Tobacco	5.2	Precious	4.0	Food	2.7
Egypt, Arab Rep.	43.5	58.6	Wheat	6.3	Crude oil	5.5	Food	3.9	Crude oil	28.2	Natural gas	8.1	Food	6.3
Equatorial Guinea	20.8	95.9	Met. & Min.	7.2	Beverages	4.0	Food	2.7	Crude oil	87.2	Timber	4.4	Natural gas	3.0
Gabon	27.1	96.1	Food	5.6	Met. & Min.	4.7	Crude oil	3.1	Crude oil	73.6	Timber	14.1	Met. & Min.	7.4
Ghana	33.4	87.5	Crude oil	12.9	Food	4.3	Met. & Min.	3.5	Cocoa	45.3	Food	11.4	Timber	7.5
Guatemala	32.8	49.4	Crude oil	13.1	Food	4.8	Met. & Min.	2.8	Food	11.3	Coffee	10.2	Banana	6.4
Honduras	34.2	29.9	Crude oil	13.4	Food	6.2	Met. & Min.	2.6	Food	9.3	Coffee	6.8	Banana	4.0
India	42.7	31.1	Crude oil	13.0	Gold	8.8	Coal	2.8	Crude oil	5.8	Food	3.8	Met. & Min.	3.6
Indonesia	44.6	48.4	Crude oil	23.7	Food	2.6	Other Raw Mat.	2.6	Crude oil	10.7	Natural gas	7.7	Coal	4.4
Jordan	35.4	45.3	Crude oil	10.7	Food	4.6	Wheat	2.2	Fertilizers	27.8	Food	6.2	Met. & Min.	2.6
Kenya	36.4	74.3	Crude oil	17.4	Palm oil	2.8	Met. & Min.	2.3	Tea	18.8	Food	18.1	Other Raw Mat.	15.3
Madagascar	22.3	50.4	Food	4.8	Met. & Min.	3.7	Crude oil	2.3	Food	39.1	Other Raw Mat.	2.3	Met. & Min.	1.9
Malawi	29.7	87.8	Crude oil	5.4	Fertilizers	4.2	Tobacco	4.2	Tobacco	61.0	Tea	8.7	Sugar	8.2
Malaysia	32.0	33.9	Crude oil	8.5	Food	8.0	Met. & Min.	2.8	Sugar	17.6	Food	9.2	Precious	2.8
Mauritius	18.4	22.5	Met. & Min.	4.4	Crude oil	3.1	Food	1.9	Crude oil	12.6	Food	3.1	Met. & Min.	2.6
Mexico	34.8	40.5	Crude oil	11.2	Wheat	3.4	Natural gas	2.7	Food	17.4	Fertilizers	9.8	Crude oil	3.6
Morocco	31.6	36.3	Food	6.8	Tobacco	4.8	Palm oil	3.8	Crude oil	29.0	Natural gas	1.8	Food	1.2
Niger	26.6	98.4	Food	5.9	Crude oil	4.2	Wheat	3.7	Crude oil	90.7	Natural gas	5.2	Cocoa	1.1
Nigeria	44.6	18.0	Crude oil	20.0	Palm oil	4.1	Cotton	2.3	Rice	5.5	Food	3.0	Crude oil	2.4
Pakistan	35.6	81.3	Crude oil	15.1	Food	2.7	Met. & Min.	2.6	Copper	19.5	Gold	12.1	Food	9.8
Panama	24.9	12.2	Crude oil	11.3	Food	2.5	Wheat	1.1	Food	2.7	Banana	1.5	Copper	1.2
Peru	48.2	72.4	Crude oil	17.2	Rice	6.9	Food	6.7	Food	37.6	Crude oil	9.5	Oils & Meals	7.5
Philippines	27.0	52.2	Crude oil	15.1	Met. & Min.	2.1	Food	1.3	Platinum	11.1	Gold	7.6	Coal	6.5
Senegal	19.2	98.3	Wheat	4.0	Food	3.9	Met. & Min.	3.9	Crude oil	77.5	Grains	5.7	Sheep	4.3
South Africa	31.4	25.0	Crude oil	14.1	Met. & Min.	3.5	Food	2.4	Food	7.9	Crude oil	3.1	Rubber	3.0
Sudan	30.2	20.5	Crude oil	10.2	Iron ore	2.8	Gold	2.5	Food	6.1	Met. & Min.	3.9	Crude oil	2.7
Thailand	37.3	59.5	Crude oil	18.5	Food	3.9	Fertilizers	2.4	Beef	15.3	Food	13.1	Rice	5.7
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
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
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	31.6	52.2		10.0		4.1		2.7		18.8		7.7		4.4

Table C.5: Commodity Imports and Exports (2010 - 2019)

	Comm. Imp.	Comm. Exp.	Main Imports						Main Exports					
Algeria	26.8	91.8	Food	5.4	Met. & Min.	4.3	Wheat	4.3	Crude oil	48.3	Natural gas	41.6	Fertilizers	1.0
Argentina	15.7	69.1	Natural gas	4.4	Met. & Min.	2.4	Fertilizers	1.5	Soybean meal	15.6	Food	10.0	Soybean oil	6.1
Bangladesh	35.1	6.5	Palm oil	5.4	Cotton	5.2	Fertilizers	4.4	Food	3.2	Other Raw Mat.	1.4	Met. & Min.	0.4
Bolivia	16.3	95.7	Met. & Min.	3.4	Food	3.3	Crude oil	2.8	Natural gas	44.1	Gold	12.6	Zinc	8.6
Brazil	26.4	63.5	Crude oil	6.4	Fertilizers	4.2	Food	2.9	Iron ore	11.5	Soybeans	8.9	Crude oil	7.4
Burkina Faso	27.9	92.8	Food	4.0	Fertilizers	3.5	Met. & Min.	3.3	Gold	55.9	Cotton	21.1	Grains	9.1
Cameroon	43.5	88.9	Crude oil	15.2	Food	7.4	Rice	4.9	Crude oil	39.4	Cocoa	18.8	Timber	12.3
Chad	17.9	95.0	Met. & Min.	6.0	Food	3.3	Wheat	2.5	Crude oil	89.2	Other Raw Mat.	2.7	Met. & Min.	1.7
Colombia	18.0	75.6	Food	3.4	Met. & Min.	2.3	Maize	2.0	Crude oil	36.4	Coal	14.7	Coffee	6.5
Congo, Dem. Rep.	34.1	89.0	Met. & Min.	6.5	Food	6.2	Crude oil	5.7	Copper	43.2	Met. & Min.	28.9	Crude oil	12.3
Cote d'Ivoire	50.2	82.5	Crude oil	23.0	Food	6.7	Rice	6.4	Cocoa	40.4	Crude oil	9.8	Rubber	6.2
Dominican Republic	33.4	43.6	Crude oil	7.4	Food	5.5	Natural gas	3.6	Gold	11.4	Tobacco	7.6	Food	4.6
Egypt, Arab Rep.	39.2	52.0	Food	4.8	Crude oil	4.2	Natural gas	3.8	Crude oil	12.1	Food	11.1	Gold	6.3
Equatorial Guinea	21.2	96.5	Met. & Min.	8.9	Beverages	4.0	Food	2.4	Crude oil	76.7	Natural gas	18.4	Timber	0.9
Gabon	26.0	96.2	Met. & Min.	5.3	Food	5.2	Chicken	2.7	Crude oil	72.9	Met. & Min.	13.3	Timber	8.7
Ghana	25.5	92.1	Food	5.5	Met. & Min.	4.6	Rice	3.0	Gold	34.7	Cocoa	23.2	Crude oil	14.1
Guatemala	27.0	60.2	Food	5.9	Crude oil	3.5	Met. & Min.	2.8	Food	13.2	Sugar	9.6	Coffee	7.9
Honduras	26.4	62.0	Food	7.4	Crude oil	3.5	Met. & Min.	2.5	Coffee	20.2	Food	14.3	Palm oil	5.3
India	54.6	27.6	Crude oil	25.1	Gold	8.8	Coal	3.6	Precious	4.4	Food	3.6	Met. & Min.	2.8
Indonesia	30.5	59.7	Crude oil	9.2	Food	3.0	Met. & Min.	2.7	Coal	11.4	Palm oil	10.3	Natural gas	7.2
Jordan	40.0	44.2	Crude oil	10.1	Food	5.9	Natural gas	3.7	Fertilizers	20.7	Food	10.8	Met. & Min.	2.8
Kenya	29.1	65.4	Crude oil	10.4	Palm oil	3.4	Met. & Min.	2.4	Tea	21.2	Other Raw Mat.	12.9	Food	12.3
Madagascar	30.2	60.5	Met. & Min.	5.7	Food	4.8	Rice	3.6	Food	29.7	Nickel	13.3	Met. & Min.	8.6
Malawi	30.4	86.7	Fertilizers	9.7	Met. & Min.	3.4	Tobacco	3.1	Tobacco	48.2	Sugar	9.3	Tea	6.3
Malaysia	36.6	39.2	Food	13.8	Crude oil	3.0	Met. & Min.	3.0	Food	19.2	Sugar	11.8	Precious	1.8
Mauritius	16.4	23.0	Met. & Min.	3.7	Food	2.0	Natural gas	1.4	Crude oil	9.1	Food	4.0	Met. & Min.	2.6
Mexico	33.0	41.1	Crude oil	7.4	Natural gas	4.2	Met. & Min.	3.0	Food	16.1	Fertilizers	13.7	Met. & Min.	2.7
Morocco	32.6	67.1	Rice	6.9	Food	6.7	Met. & Min.	2.9	Met. & Min.	38.7	Rice	6.2	Palm oil	5.8
Niger	25.5	90.3	Food	6.7	Met. & Min.	4.0	Wheat	3.6	Crude oil	76.4	Natural gas	8.9	Rubber	1.6
Nigeria	39.2	25.9	Crude oil	12.9	Palm oil	4.5	Food	3.2	Rice	8.7	Food	4.8	Met. & Min.	2.2
Pakistan	26.5	84.3	Crude oil	8.2	Met. & Min.	3.2	Food	2.9	Copper	26.1	Gold	21.7	Food	10.7
Panama	27.9	18.4	Crude oil	9.0	Food	4.0	Met. & Min.	1.6	Food	3.7	Copper	2.1	Coconut oil	2.0
Peru	44.9	58.5	Crude oil	12.8	Rice	6.7	Food	5.7	Food	24.0	Gold	11.9	Met. & Min.	4.3
Philippines	28.0	52.8	Crude oil	14.2	Met. & Min.	2.2	Food	1.9	Platinum	8.5	Gold	7.9	Met. & Min.	7.3
Senegal	26.5	97.5	Sugar	6.0	Food	5.8	Met. & Min.	4.1	Crude oil	48.1	Gold	27.3	Grains	8.9
South Africa	36.3	26.6	Crude oil	13.5	Gold	4.3	Met. & Min.	3.9	Food	7.2	Rubber	3.4	Met. & Min.	3.0
Sudan	24.5	24.8	Iron ore	3.5	Gold	3.0	Crude oil	2.5	Food	6.5	Met. & Min.	5.3	Gold	4.0
Thailand	30.5	72.6	Crude oil	10.9	Food	4.4	Fertilizers	2.7	Beef	22.4	Food	13.7	Soybeans	10.4
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
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
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	28.0	63.5		7.4		4.0		2.9		20.7		10.8		6.1

Table C.6: Commodity Terms of Trade: Descriptive Statistics

	$\sigma(p_c^{x,\$})/\sigma(p^{x,\$})$	$\sigma(p_c^{m,\$})/\sigma(p^{m,\$})$	$\sigma(ToT^c)/\sigma(ToT)$
Median	1.47	2.99	0.76
# countries > 1	38	38	8

Notes: σ denotes standard deviation; $p_c^{x,\$}$ ($p_c^{m,\$}$) and $p^{x,\$}$ ($p^{x,\$}$) are the commodity export (import) price and our export (import) price indices, respectively; ToT^c is the commodity terms of trade measure while ToT is the terms of trade measure calculated using our export and import price indices. The standard deviations are the standard deviation of the percentage deviations of the series from the trends.

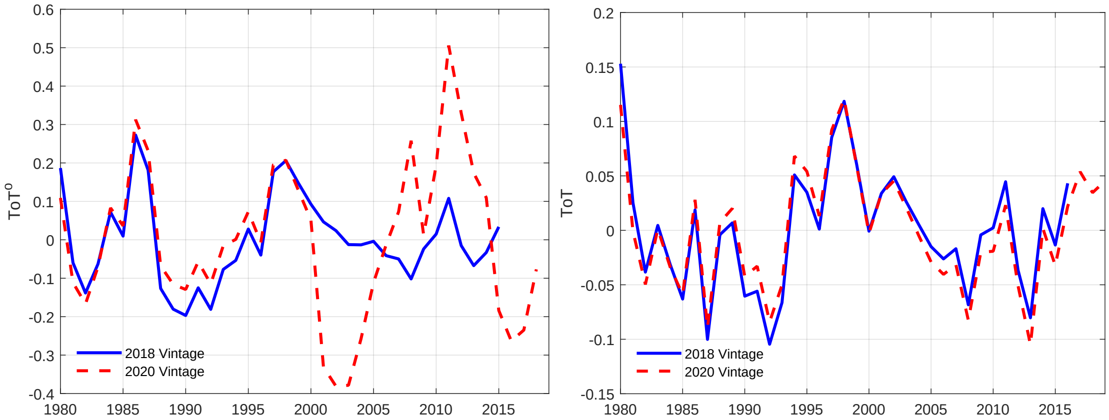
C.1 Data Revisions Across Vintages

Macroeconomic data are often plagued by large revisions (see Aruoba, 2008). In the process of writing this paper we came across two vintages of WDI data: one was downloaded in 2017 and the other in 2020. One striking feature of the official measure of terms of trade, ToT^o, is that it was subject to substantial data revisions between the two data vintages. Figure C.1 illustrates some of the more visible data revisions in the official ToT measure. The charts on the left contain a comparison between the data for the 2017 and 2021 vintages for ToT^o while the charts on the right show the evolution of our measure of ToT. The top panel includes the results for Honduras and the bottom for Guatemala. From the Figure it is clear that ToT^o revisions were major and this is actually the case beyond these two country examples. By contrast, the revisions from our ToT measure are generally smaller and mainly stemming from revisions of the PPI data and the re-estimation of the quadratic trend over the two samples. Following Aruoba (2008), we evaluate how revisions are behaved by computing the noise-to-signal ratio, which is given by the variance of the revision divided by the variance of the terms of trade obtained from the 2020 vintage. Large numbers suggest that the revisions are sizable. Table C.7 shows the list of the eight countries with the largest data revisions and it turns out that some ratios are extremely large for ToT^o. For Honduras and Guatemala, for example, the noise-to-signal ratio of ToT^o is 80 percent and 71 percent, respectively. By contrast, the revisions from our ToT measure are more limited and mainly originated in revisions of the PPI data.

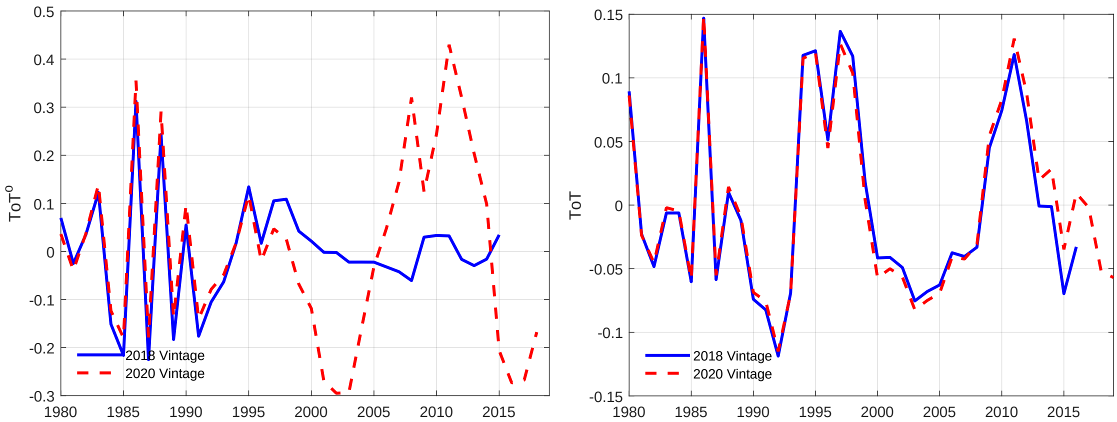
Table C.7: Noise-to-Signal Ratio (%)

Country	ToT^o	ToT
Honduras	80	8
Guatemala	71	2
Mauritius	50	1
Sudan	29	9
Bolivia	26	9
Algeria	22	11
Nigeria	20	12

Figure C.1: Data revisions. ToT^o vs. ToT



(a) Honduras



(b) Guatemala

Notes: The figures show a comparison between different data vintages for the unit value Terms of Trade from the WDI (ToT^o) and the Terms-of-Trade measure constructed as discussed in Section 3. The top chart displays the results for Honduras and the bottom chart for Guatemala. The data have been quadratically detrended.

Appendix D 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. 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, major geopolitical events, 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.

D.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.[20] 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, São 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 with the 26-28 million bag harvest which might have been expected with normal weather on

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

an off-year in the 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):[21]

"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.[22] 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):[23]

"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[24]

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

De Winne and Peersman (2016) document 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 some progress was made in the USSR and Eastern Europe."[25] Our

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

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

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

[24] 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`.

[25] Available at: `http://www.fao.org/docrep/017/ap664e/ap664e.pdf`.

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 De Winne and Peersman (2016), in 1996 the FAO issued a favorable forecast for world 1996 cereal output.[26] 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.

De Winne and Peersman (2016) report 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."[27]

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.[28] 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):[29]

"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."

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[26] The FAO document is available at: `http://www.fao.org/docrep/004/w1690e/w1690e02.htm#I2`.
[27] Available at: `http://www.fao.org/docrep/012/ak354e/ak354e00.pdf`.
[28] `https://www.icco.org/about-us/international-cocoa-agreements/cat_view/30-related-documents/45-statistics-other-statistics.html`.
[29] 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.[30] 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):[31]

"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):[32]

"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.[33] 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 in the 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

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

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

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

[33] 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.[34] 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):[35]

"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.[36] 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 corn syrup, New York Times (November 7, 1984):[37]

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

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[34] http://documents.worldbank.org/curated/en/443751468739336774/Summary-energy-matals-and-minerals.

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

[36] http://www.fao.org/3/a-ap664e.pdf.

[37] Article available at: https://www.nytimes.com/1984/11/07/business/coke-pepsi-to-use-more-corn-syrup.html.

D.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, and India.[38] 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 dissolution of the Soviet Union in the early 1990s.[39]

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."[40]

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

[38] 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.

[39] Article available at: https://www.cotton.org/issues/2005/upload/WorldCottonMarket.pdf.

[40] 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.[41] The application of such policies is confirmed in the list of environmental actions taken by President Clinton and Vice President Al Gore and is documented in the White House Archives.[42] 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):[43].

"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 worldwide shortage of this type of tobacco.[44] 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.[45] Our data reveal that tobacco prices declined 22 percent between 1992 and 1993.

D.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.

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

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

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

[44] 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.

[45] 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.[46] 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."[47] A study from the Federal Reserve Bank of San Franciso documents the natural gas price increase in 2000.[48] 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.[49]

"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:[50]

"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."

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

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

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

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

[50] 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.[51]

"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."

D.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.[52] This observation is supported by the "Proceedings of the 34th Annual Meeting of the Fertilizer Industry Round Table 1984."[53] 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.

D.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.

D.6 El Niño / La Niña Events

El Niño is a local warming of surface waters that takes place in the entire equatorial zone of the central and eastern Pacific Ocean of the Peruvian coast and which affects the atmospheric circulation worldwide (Kiladis and Diaz, 1989). La Niña is the cold equivalent of El Niño. These weather events take place approximately every two to seven years.

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

The Southern Oscillation is an East-West balancing movement of air masses between the Pacific and the Indo-Australian areas. It is associated with typical wind patterns and measured by the Southern Oscillation Index (SOI) (Parker, 1983). El Niño is the oceanic component, while the Southern Oscillation is the atmospheric one. This combination gives rise to the term ENSO (El Niño Southern Oscillation), which could have climatic impacts, including flash floods or intense hurricanes that could influence the crop season, disrupting agricultural activities and damaging crops. What distinguishes these type of weather events from others is that they tend to affect all the regions in the world.

The literature suggests that the Niño episodes of 1982-1983 and 1997-1998 were particularly severe (Brenner, 2002). Therefore, we investigate how were commodity prices affected in light of these event and how we can use them for narrative restrictions. Since we already have a narrative restriction for 1997 we concentrate on the 1982-1983 episode. One challenge that we face in the presence weather events which have worldwide implications is that when we impose the narrative restrictions that are driven due to weather conditions or political events of a specific country, we exclude such event for that country. In selecting the dates for export and import price shocks we are very careful to avoid events which have the characteristic of being both an export or import price shock and a capital or productivity shock at the same time.[54] This means that if crops of a certain commodity were affected by a weather phenomena in all the exporting countries we cannot use that as part of the narrative since it would mimic a negative productivity shock. Therefore, we searched in the literature for Niño weather events which originated in one region of the world so that we can use the narrative for the regions not directly affected by drastic weather conditions.

After searching for the origin and impacts of El Niño/La Niña events, we found two potential narratives which we could use: (i) a positive price shock for soybeans in 1983 and (ii) a positive price shock for cocoa also in 1983. For soybeans, Brenner (2002) suggests that the price increase was driven by draughts in Australia and New Zealand. Therefore, this event in the pacific can be used for soybean exporting countries in the Atlantic such as Brazil and Argentina. For Cocoa, Brenner (2002) documents that the price increase was caused by droughts in South East Asia and floods in South America. Therefore, we cannot use these events for South America or Asia but we could for Africa. In fact, Ghana and Ivory Coast were cocoa exporters during this period. Drilling deeper, we found evidence that these countries were actually fueling the cocoa price increase due to country-specific political events unrelated to the El Niño.[55] In particular, Ivory Coast was facing fires and Ghana some political unrest which were driving the price of coca upwards. For these reasons, this Niño event for cocoa.

To sum up, as a result of El Niño events, we added a narrative restriction for a positive price shock to soybeans in 1983. Our data depict a sharp increase of 15 percent in soybean prices in 1983. This is a positive export price restriction for Argentina and Brazil where overall soybean exports accounted for 10 percent and 13.3 percent of overall exports in 1983, respectively.

[54] For instance, when the increase in the price of a particular agricultural commodity is associated with a drought in a given country, the country is effectively facing a combination of shocks: (a) the fall in production (akin to a negative productivity shock in the agricultural sector) and (b) a positive windfall from the (worldwide) increase in the price of the commodity.

[55] https://www.nytimes.com/1983/06/13/business/commodities-cocoa-prices-on-the-rise.html.

D.7 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, 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 oil exports for both Cameroon and Congo 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.

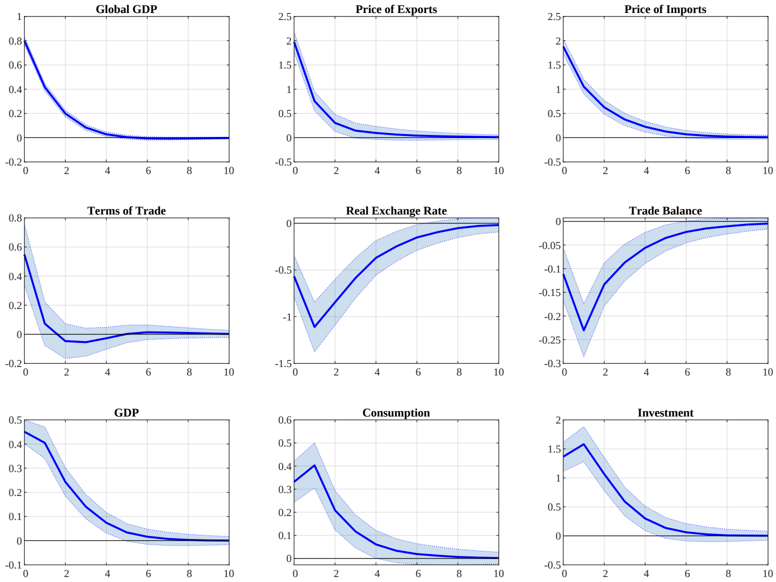
- When an event is due to weather conditions or political events of a specific country, we exclude such event for that country. These cases are:
  - The coffee price shock in 1986 which was caused by droughts in Brazil. We therefore did not use this shock as part of the narrative restrictions for Brazil.
  - 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 these cases, we attributed the narrative to an export or import price shock depending on the trade share. If the export (import) share is larger, then it is linked to an export (import) price shock.[56] In our sample these happens in these cases:
  - The negative oil price shock in 1986 implies a negative export price shock and a negative import price shock for Indonesia and Nigeria. In both cases the export share of oil is higher and therefore these events are attributed to an export price shock
  - All the cereal events imply a export and import price shock for Senegal. Since the export share for cereal is higher than the import share, we linked these events to export price shocks.

[56] An exception to this rule is present for the case of Turkey. The positive oil price shock in 1990 serves as a positive export price shock and a positive import price shock for Turkey. While the export share is higher, it is the only narrative for import prices so we kept the narrative for both export and import price shocks.

Appendix E Evidence on Global Economic Activity Shocks

Figure E.1: Impulse Responses to a Global Economic Activity Shock: All Countries



Notes: The figure shows the impulse responses to a one standard deviation shock in y^g for all countries using a VAR with sign and narrative restrictions. The blue solid lines denote the mean responses weighted using inverse variance weights and the dashed lines represent the 16^{th} and 84^{th} percentile error bands.

Table E.1: Forecast Error Variance Decomposition: Global Economic Activity Shock

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

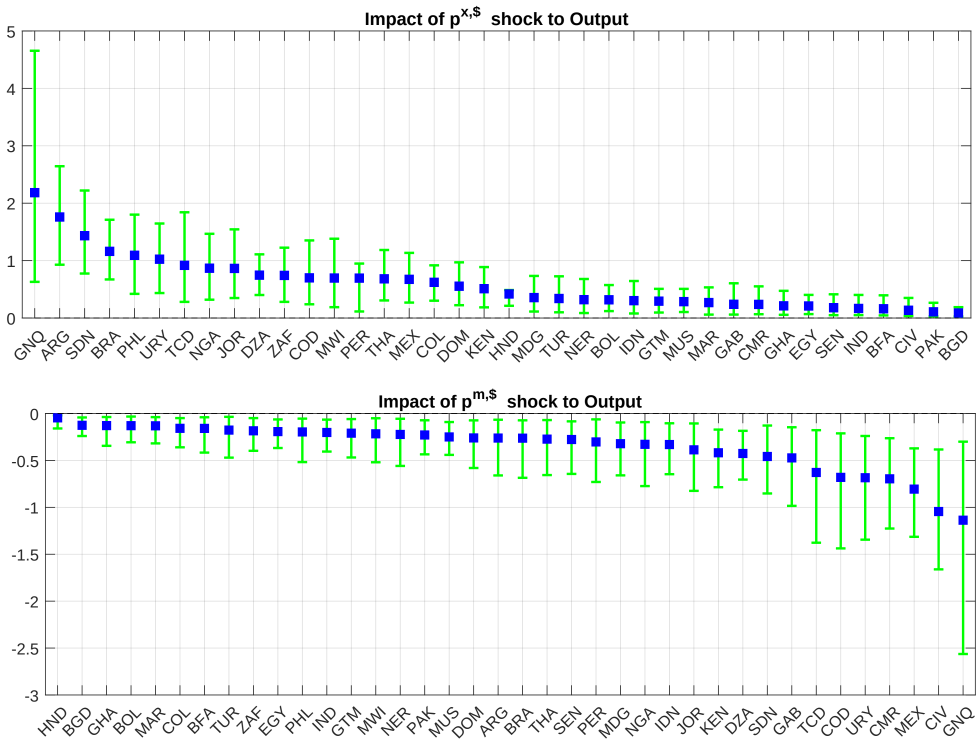
Notes: The table shows the forecast error variance decomposition of all the variables in the VAR for global economic activity shocks on impact, at a 1-year, 2-year, 4-year and 10-year horizons. Reported are mean values weighted using inverse variance weights.

Appendix F Cross-Country and Group Heterogeneity

F.1 Cross-Country Heterogeneity: Export and Import Price Shocks

Figure F.1 shows the impact impulse response (blue square) of output, for each country, to a one standard deviation shock in $p^{x,\$}$ and $p^{m,\$}$. In Table F.1 we analyze the determinants of the impact impulse responses for output, the trade balance and the terms of trade in response to export and import price shocks. The results of this subsection are summarized in Section 6 of the main text.

Figure F.1: Heterogeneous Effects of Export and Import Price 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 export and import prices. The green lines represent 16th and 84th percentile error bands.

Table F.1: Determinants of the Impulse Responses to Export and Import Price Shocks

	IRF y to a $p^{x,\$}$			IRF tb to a $p^{x,\$}$			IRF tot to a $p^{x,\$}$		
GDP Per Capita (PPP)	0.122	0.0747	0.119***	0.146	0.311***	0.322***	-0.848***	-0.803***	-0.296
	(0.241)	(0.0863)	(0.0245)	(0.487)	(0.0882)	(0.0393)	(0.147)	(0.168)	(0.178)
Commodity Export Share	0.0357	1.633***	1.450***	0.992	-0.424	2.132***	7.562***	7.447***	4.898***
	(0.445)	(0.220)	(0.173)	(3.003)	(0.471)	(0.244)	(0.444)	(0.675)	(0.421)
H Index Exports (commodities)			0.737***			1.679***			13.22***
			(0.136)			(0.159)			(0.687)
Comm. Groups Dummies		✓	✓		✓	✓		✓	✓

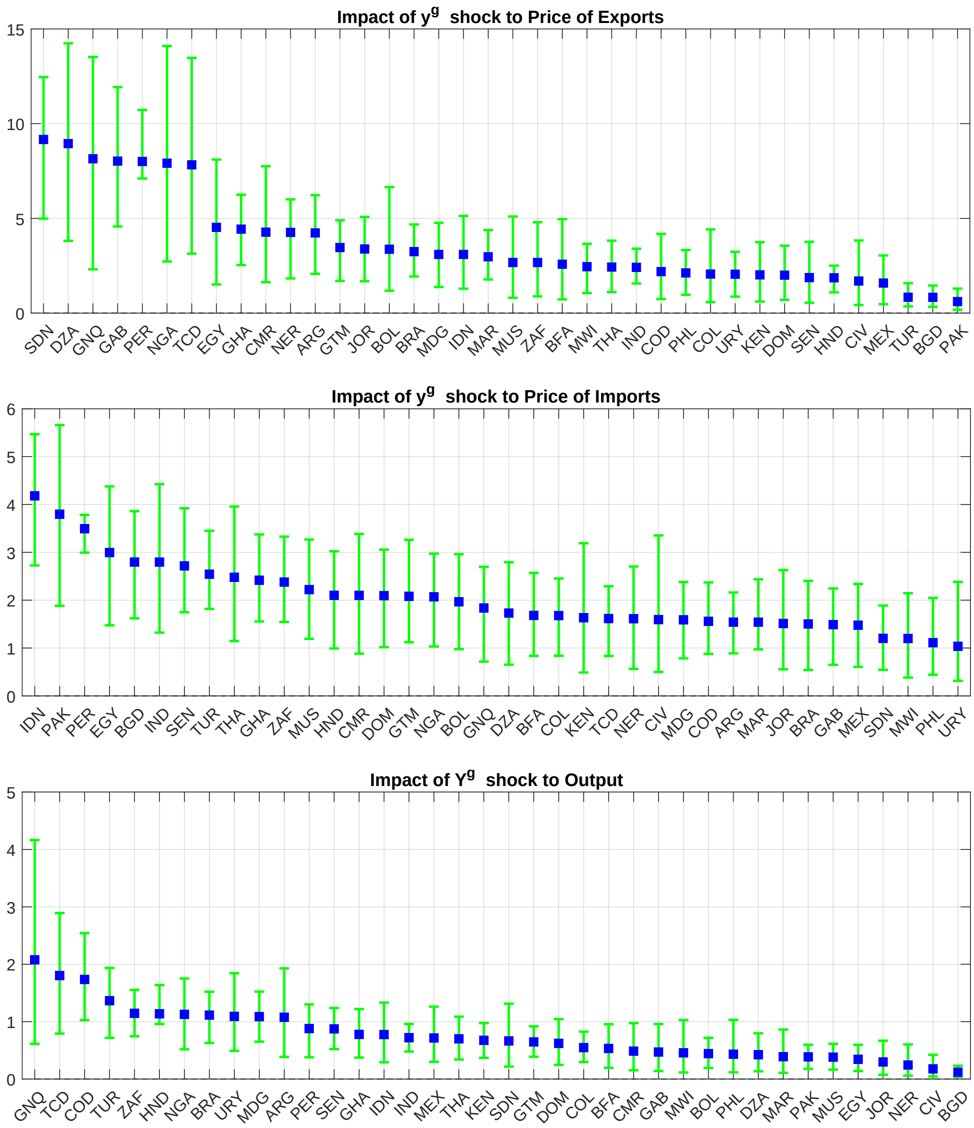
	IRF y to a $p^{m,\$}$			IRF tb to a $p^{m,\$}$			IRF tot to a $p^{m,\$}$		
GDP per Capita (PPP)	-0.0118	-0.0146	-0.0111	-0.249	0.325***	0.264	0.152**	0.146**	0.151**
	(0.0156)	(0.0177)	(0.0170)	(0.156)	(0.0358)	(0.302)	(0.0724)	(0.0549)	(0.0568)
Commodity Import Share	-0.130	-0.0182	0.0248	0.574	-3.291***	-3.566	-6.757***	-7.035***	-7.499***
	(0.219)	(0.491)	(0.396)	(2.329)	(1.054)	(3.120)	(0.782)	(1.120)	(1.663)
H Index Imports			-0.487			-3.395			3.410
			(0.618)			(9.264)			(2.573)
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.

F.2 Cross-Country Heterogeneity: Global Economic Activity Shocks

Figure F.2 depicts the impact impulse response (blue square) of export prices, import prices and output to a one standard deviation shock in y^g. 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 global economic activity shock do not coincide with those showing the largest increase in import prices. The impact on output is heterogeneous across countries but large.

Figure F.2: Heterogeneous Effects of Global Economic Activity Shocks



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 y^g. The green lines represent 16th and 84th percentile error bands.

Table F.2 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 global economic activity shock for the cross-section of countries.[57] Since in this case we are looking at the

[57]As before, the impact impulse response is defined as a 1 standard deviation shock in y^g multiplied by 100

Table F.2: Determinants of the Impulse Responses to a Global Economic Activity Shock

	IRF $p^{x,\$}$	IRF $p^{m,\$}$	IRF tot	IRF y	IRF tb
GDP Per Capita (PPP)	0.599***	0.160***	0.527*	0.139**	-0.260
	(0.163)	(0.0533)	(0.287)	(0.0679)	(0.370)
Commodity Export Share	4.152***	-0.591**	4.507***	0.359*	0.164
	(0.811)	(0.273)	(1.048)	(0.180)	(1.288)
Commodity Import Share	6.904***	7.004***	4.823	-2.625	-1.750
	(2.128)	(0.961)	(2.947)	(1.596)	(3.059)

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.

impact of one shock we use as regressors the GDP per capita (PPP), the commodity export share and the commodity import share.[58] 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 global economic activity 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 global economic activity shock.

F.3 Analysis by Export and Import Group

We analyze the effects of export price, import price and global economic activity 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).[59] 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.[60] 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.[61]

and we perform robust to outliers regressions.

[58]We also run separate specifications in which we have export and import characteristics in separate regressions as in Table F.1. and the results remain robust. We do not include them here to preserve space but are available upon request.

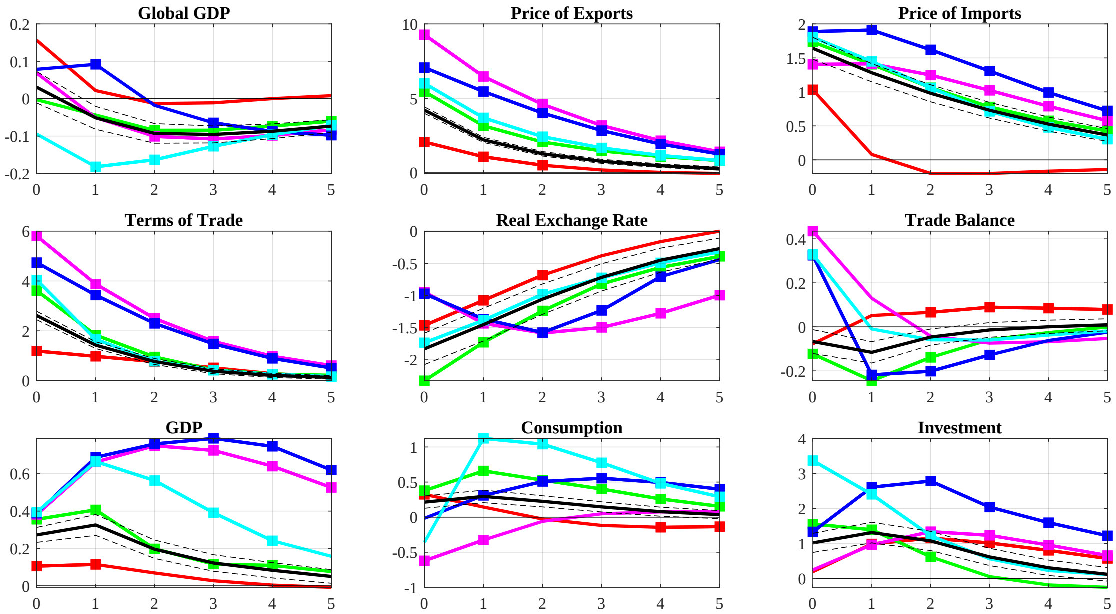
[59]We bundled precious metals into the metal category as otherwise we would have no countries in the precious metal exporters category. This happens because precious metal exports do not represent a large enough share of exports. Therefore, we can think of this group as related to mining activity and 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.

[60]The following countries are agriculture (food and beverages) exporters: Argentina, Brazil, Colombia, Cote d'Ivoire, Ghana, Guatemala, Honduras, Kenya, Madagascar, Malawi, Mauritius, Senegal, Sudan, 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, Jordan, Malawi, and Sudan.

[61]The country split is as follows. Manufacturing importers is composed of Argentina, Bolivia, Burkina Faso, Chad, Colombia, Congo, Dominican Republic, Gabon, Ghana, Guatemala, Honduras, Kenya, Madagascar, Malawi, Mauritius, Mexico, Niger, Nigeria, Philippines, South Africa and Sudan. The group of agriculture

The impulse responses for each export group are summarized in Figures F.3, F.4, F.5 while for each import group they are included in Figures F.6, F.7, F.8. 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). In all cases shocks have been normalized to a 1 percent increase in $p^{x,\$}$, $p^{m,\$}$, and y^{g}, respectively. 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.

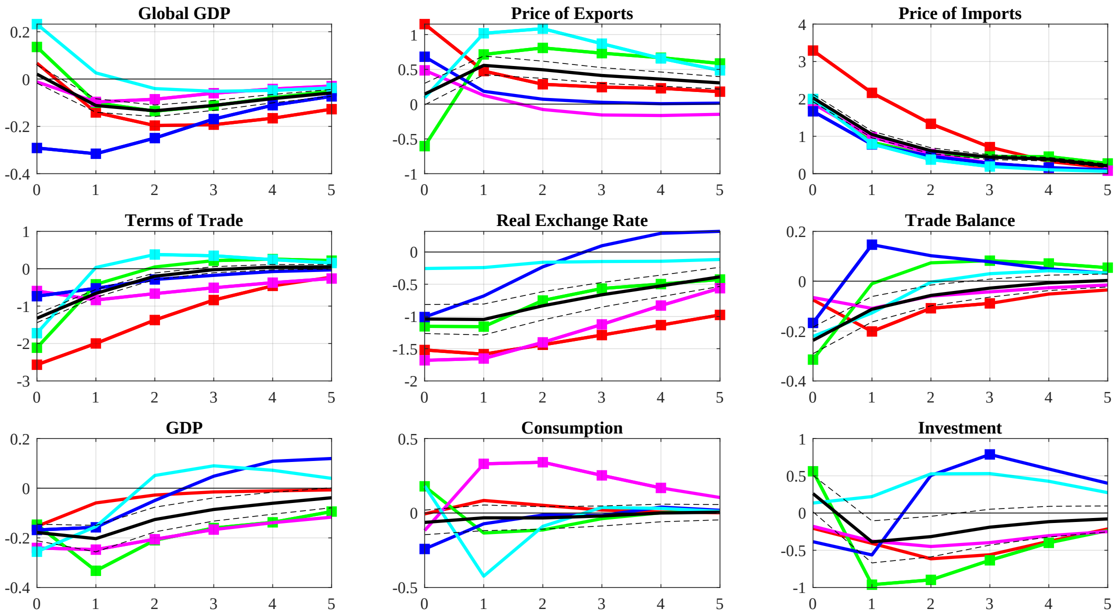
Figure F.3: Impulse Responses to an Export Price Shock by Export Group



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. Reported are mean responses weighted using inverse variance weights. 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 16$^{\text{th}}$ and 84$^{\text{th}}$ percentile error bands.

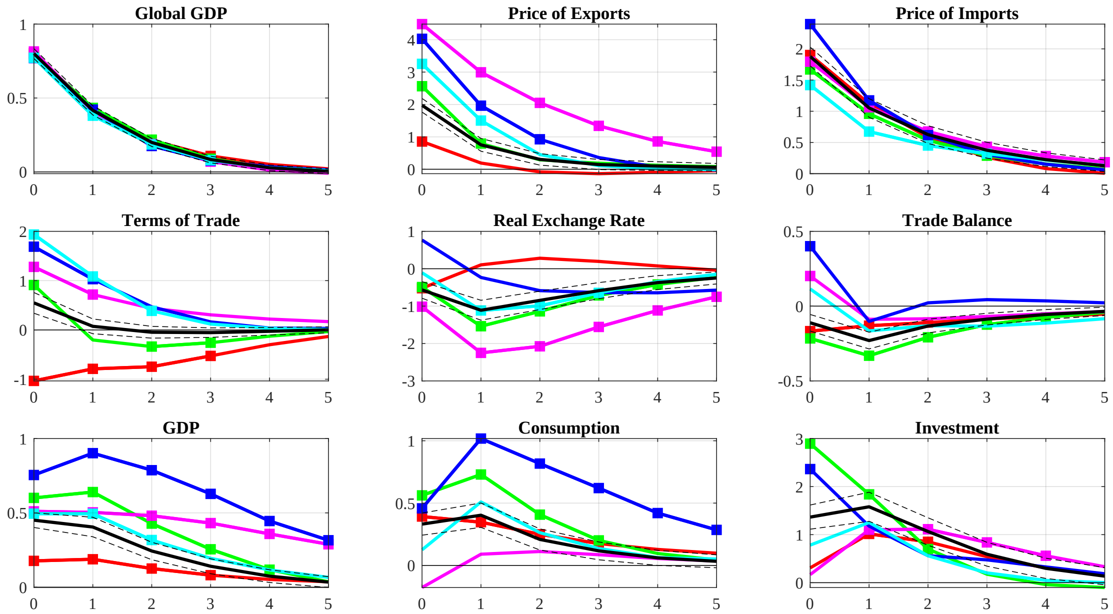
(food and beverages) importers includes Algeria, Bangladesh, Burkina Faso, Congo, Cote d'Ivoire, Egypt, Equatorial Guinea, Jordan, Madagascar, Mauritius, Niger, Senegal and Sudan. Energy importers are Brazil, Cote d' Ivoire, India, and Pakistan.

Figure F.4: Impulse Responses to an Import Price Shock by Export Group



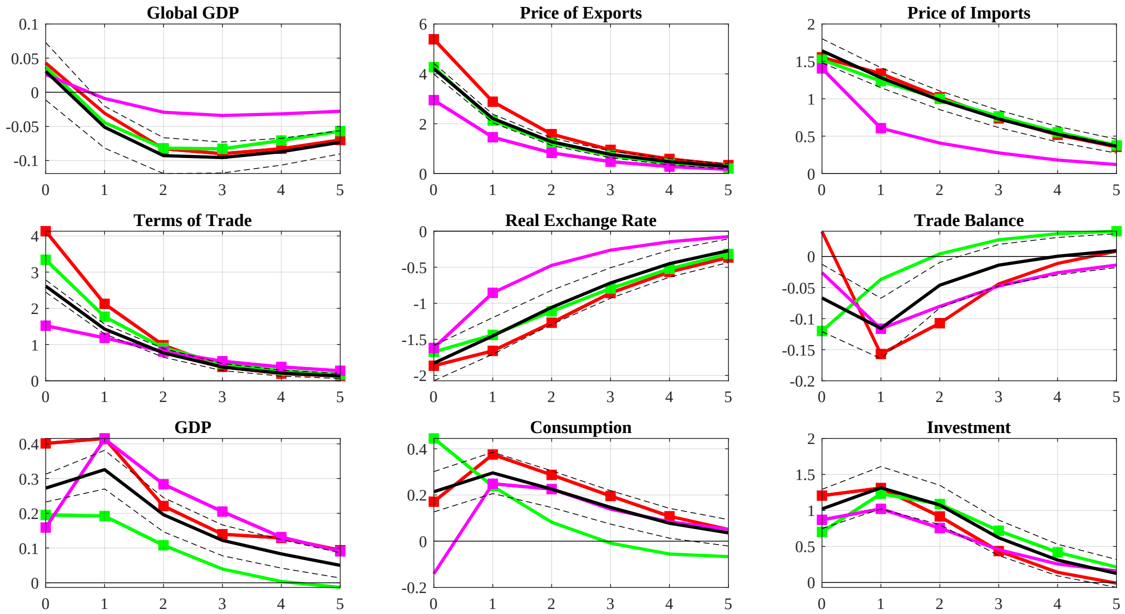
Notes: The figure shows the impulse responses to an import price shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different export group: agriculture (food and beverages) exporters are in green, energy exporters in magenta, manufacturing exporters in red, metal exporters in blue and agriculture raw material (plus fertilizers) exporters in turquoise. Reported are mean responses weighted using inverse variance weights. 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 F.5: Impulse Responses to a Global Economic Activity Shock by Export Group



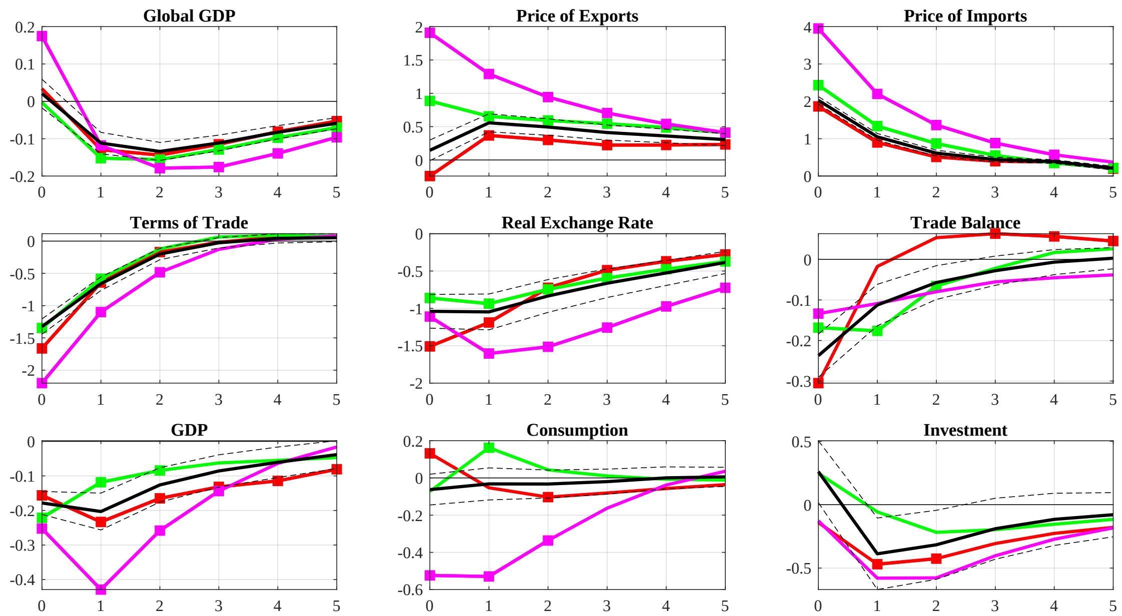
Notes: The figure shows the impulse responses to a global economic activity shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different export group: agriculture (food and beverages) exporters are in green, energy exporters in magenta, manufacturing exporters in red, metal exporters in blue and agriculture raw material (plus fertilizers) exporters in turquoise. Reported are mean responses weighted using inverse variance weights. 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 F.6: Impulse Responses to an Export Price Shock by Import Group



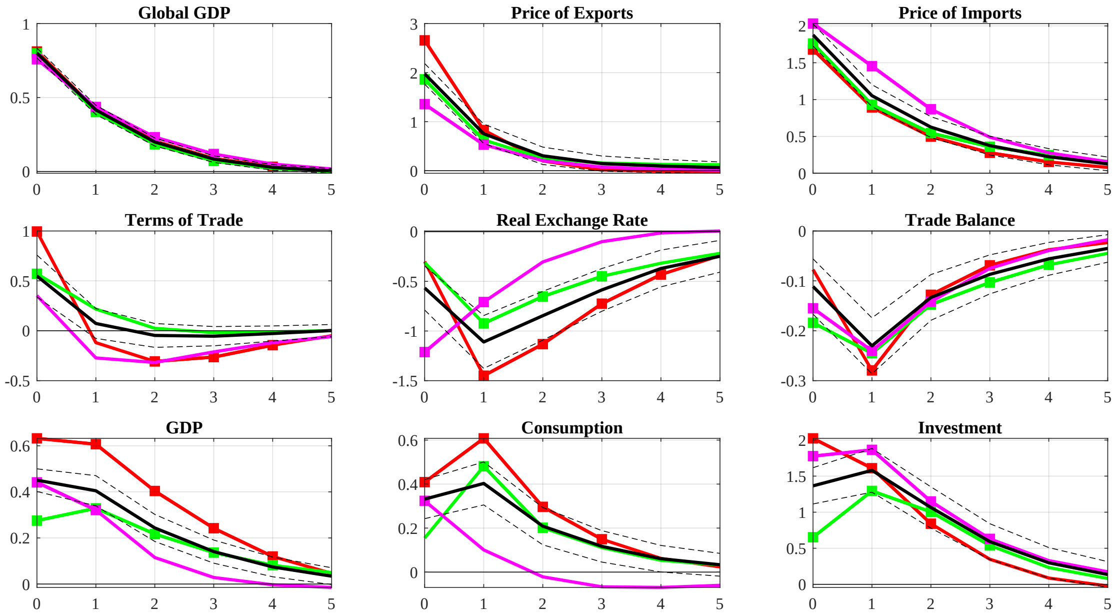
Notes: The figure shows the impulse responses to an export price shock for countries in each commodity group using a VAR with sign and narrative restrictions. Each color represents a different import group: agriculture (food and beverages) importers are in green, energy importers in magenta, and manufacturing importers in red. Reported are mean responses weighted using inverse variance weights. 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 16$^{\text{th}}$ and 84$^{\text{th}}$ percentile error bands.

Figure F.7: 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. Reported are mean responses weighted using inverse variance weights. 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 16$^{\text{th}}$ and 84$^{\text{th}}$ percentile error bands.

Figure F.8: Impulse Responses to a Global Economic Activity Shock by Import Group



Notes: The figure shows the impulse responses to a global economic activity 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. Reported are mean responses weighted using inverse variance weights. 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 16$^{\text{th}}$ and 84$^{\text{th}}$ percentile error bands.

Table F.3: FEVD by Commodity Groups: International Prices

	Price of Exports			Price of Imports			Terms-of-Trade		
	y^g	$p^{x,\$}$	$p^{m,\$}$	y^g	$p^{x,\$}$	$p^{m,\$}$	y^g	$p^{x,\$}$	$p^{m,\$}$
	Agriculture (Food and Beverages) Exporters								
0	19.82	72.92	7.26	23.37	28.12	48.51	11.10	69.00	19.90
10	19.60	65.23	15.17	25.08	34.68	40.24	16.72	62.16	21.12
	Energy Exporters								
0	24.44	73.83	1.73	34.67	24.26	41.07	16.97	79.46	3.57
10	24.65	72.02	3.33	32.12	39.08	28.80	22.01	71.55	6.44
	Manufacturing Exporters								
0	18.80	55.90	25.29	29.86	11.71	58.44	31.52	18.96	49.52
10	20.79	45.98	33.23	29.62	17.31	53.07	26.90	24.78	48.31
	Metals Exporters								
0	29.98	67.77	2.25	46.19	27.56	26.25	15.29	80.21	4.50
10	28.01	67.78	4.21	37.66	45.03	17.31	21.65	70.60	7.75
	Agriculture Raw Materials (plus Fertilizers) Exporters								
0	24.26	69.53	6.21	21.21	30.23	48.56	20.34	65.33	14.33
10	25.65	58.49	15.86	24.40	35.92	39.69	26.74	53.86	19.40
	Agricultural Importers								
0	20.60	72.29	7.11	25.80	24.86	49.34	13.54	77.12	9.34
10	24.27	62.16	13.57	26.97	34.90	38.13	21.54	63.12	15.33
	Energy Importers								
0	21.51	51.43	27.06	22.04	16.88	61.08	16.35	32.81	50.84
10	21.29	45.37	33.34	25.25	19.74	55.02	18.26	38.05	43.69
	Manufacturing Importers								
0	21.73	73.15	5.12	28.44	25.38	46.18	11.48	74.34	14.18
10	22.77	65.06	12.17	28.46	34.81	36.73	18.46	62.38	19.16

Table F.4: FEVD by Commodity Groups: Business Cycle Variables

	Trade Balance			Output			Consumption			Investment		
	y^g	$p^{x,\$}$	$p^{m,\$}$	y^g	$p^{x,\$}$	$p^{m,\$}$	y^g	$p^{x,\$}$	$p^{m,\$}$	y^g	$p^{x,\$}$	$p^{m,\$}$
Agriculture (Food and Beverages) Exporters												
0	6.43	6.89	8.28	14.77	8.67	4.14	8.10	7.63	7.49	9.78	8.28	4.62
10	13.95	14.06	14.12	23.15	22.65	13.32	17.14	19.40	15.97	19.16	14.92	12.76
Energy Exporters												
0	7.53	8.90	3.99	6.63	5.00	3.05	6.99	8.98	4.16	5.84	4.61	5.40
10	14.29	19.99	8.38	17.91	23.87	10.70	13.26	20.55	11.22	15.35	19.08	12.51
Manufacturing Exporters												
0	12.58	5.17	5.89	7.11	4.75	4.84	10.11	14.72	4.98	4.83	6.97	6.26
10	20.18	11.18	20.51	14.19	12.65	14.31	17.22	20.94	15.84	13.41	22.19	22.82
Metals Exporters												
0	8.50	8.32	5.11	9.60	4.10	1.71	10.58	7.31	2.85	8.03	6.42	2.56
10	12.19	15.79	9.48	22.53	24.04	6.92	22.74	18.19	6.56	17.08	22.33	8.13
Agriculture Raw Materials (plus Fertilizers) Exporters												
0	9.32	5.90	5.10	6.01	6.56	1.98	5.80	6.78	3.26	3.29	6.92	5.81
10	13.60	12.05	8.57	14.50	16.05	11.84	12.16	14.81	8.26	11.28	15.06	12.25
Agricultural Importers												
0	9.46	10.44	5.53	6.75	4.93	3.54	7.40	9.29	6.72	7.57	6.73	5.22
10	16.71	17.72	11.93	17.46	14.05	12.62	16.86	19.06	16.12	16.48	14.64	11.92
Energy Importers												
0	5.71	5.42	8.00	14.04	4.85	7.69	7.94	6.83	17.61	7.60	4.77	4.83
10	14.59	12.86	15.28	20.95	18.02	19.98	14.28	19.36	27.85	18.75	11.12	14.36
Manufacturing Importers												
0	8.01	8.52	7.17	10.19	6.17	2.83	7.79	8.01	6.00	8.36	7.29	4.23
10	14.66	16.48	12.16	20.55	19.74	11.71	15.64	17.09	12.53	17.61	16.46	11.60

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