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The asymmetric effects of commodity price shocks in emerging economies☆

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ABSTRACT

This paper estimates the asymmetric effects of commodity price shocks in emerging economies. We employ non-linear panel local projections to show that negative commodity price shocks induce more abrupt effects on output and investment than positive shocks. The response of financial conditions, in terms of increased country spreads and reduced net capital inflows, is crucial in driving the sign-dependent responses. In contrast, neither the exchange rate regime nor fiscal policy explain the asymmetry. These empirical findings are consistent with a small open economy model with occasionally binding borrowing constraints proposed in previous works.

1. Introduction

Commodity price shocks are a key driver of business cycles in emerging economies (henceforth, EMEs).[1] Consistently with a vast empirical literature, Fig. 1 (left panel) shows a strong and positive correlation between the growth rates of output and the country-specific commodity export prices (often referred also as commodity terms of trade - CTOT) for a set of selected EMEs.[2]

Previous works have mostly analyzed how plain fluctuations in terms of trade affect EMEs' business cycles. However, recent contributions have undertaken a deeper characterization of the effects of different types of terms of trade shocks. Di Pace et al.

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[1] See, for example, Shousha (2016), Ben Zeev et al. (2017), Schmitt-Grohé and Uribe (2018), Fernández et al. (2018), Drechsel and Tenreyro (2018), Fernández et al. (2023), Di Pace et al. (2024b) and Juvenal and Petrella (2024).

[2] We use the country-specific commodity price index computed by Gruss and Kebhaj (2019) deflated by the U.S. Producer Price Index (PPIACO in FRED), which constitutes a proxy for global manufacturer prices. The commodity price index is computed using fixed weights calculated, similar to Shousha (2016) and Fernández et al. (2018), as the ratio of country j's commodity i exports to total commodity exports over several decades. Using fixed weights ensures that the measure of commodity prices captures variations in commodity prices rather than supply responses due to those variations.

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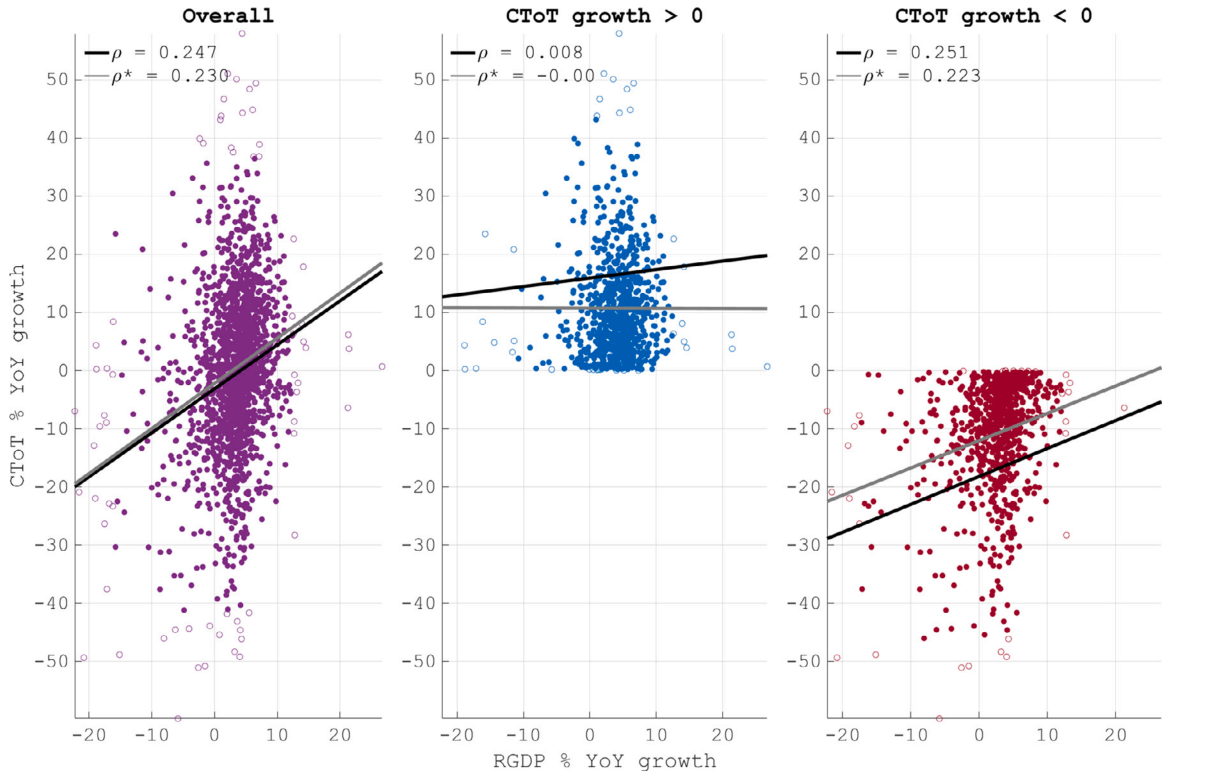

Fig. 1. Correlation between output and commodity prices.
Note. Scatter plot of output and commodity prices (CTOT) annual growth rate at quarterly frequency. Each point in the graph represents the growth rates of output and commodity prices for one EME in one particular quarter. The first plot (Overall) considers all the changes in CTOT, while the other two focus on positive (CTOT growth > 0) and negative changes in CTOT (CTOT growth < 0). Variables are defined in Section 3.1. Section 3.1 describes the countries included in the analysis, sample selection criteria, and the definition of the variables used for the analysis. The black lines refer to the full sample correlation ρ. The gray lines refer to the correlation $\rho*$ on the sample where outliers (extreme 1% of the distribution in both variables — displayed as unfilled dots) have been excluded.

(2024b) show that EMEs and developing economies respond asymmetrically to changes in export and import prices; the former turns out to be more important than the latter. Juvenal and Petrella (2024) focus instead on the origins of commodity price fluctuations and show that their effect is heterogeneous depending on whether the underlying source is a commodity-specific or global financial shock.[3]

This paper extends such a line of research by estimating the sign-dependent effects of commodity price shocks on EMEs. Fig. 1 (middle and right panels) shows that, indeed, the correlation between output and CTOT annual growth rate is different depending on the sign of the latter. The middle panel, which conditions on positive values of CTOT growth, displays a slightly positive but not statistically significant correlation. On the contrary, the right panel, which conditions on negative values, presents a positive correlation that is statistically equal to the one presented in the left panel. In other words, the overall (unconditional) correlation between these variables is exclusively driven by the observations where CTOTs fall.

To test for the potentially asymmetric effects of CTOT shocks, we estimate a non-linear local projections model using an unbalanced panel of commodity-exporting EMEs with quarterly data between 1994:Q1 and 2019:Q4. Restricting our analysis to small open economies allows us to assume that domestic macro-financial conditions do not affect global commodity prices. To document the transmission channels, we delve into the asymmetric effects of CTOT shocks on macroeconomic aggregates and financial variables, including capital flows.

In the first year, negative CTOT shocks induce stronger effects on GDP and investment than positive ones, whose transmission is more gradual. While the immediate response of the trade balance-to-output ratio to positive shocks is not significant, negative shocks induce an improvement in this variable. These results are robust to three different identification strategies for CTOT shocks: *(i)* in a plain baseline, we directly employ the fluctuations in CTOT; *(ii)* in a first robustness exercise, we purge fluctuations in CTOT

[3] Charnavoki and Dolado (2014) analyze the effects of different types of CTOT shocks in Canada. They also find that the origin of the shock matters for understanding the effects.

from the global financial (and real) cycles; (iii) in a second robustness exercise, we identify CTOT shocks exploiting an instrument for commodity-specific shocks (Juvenal and Petrella, 2024).

Three main mechanisms could explain, in theory, the differential response of macroeconomic aggregates to commodity price shocks. First, the deterioration of commodity prices may tighten the external borrowing constraint and force the country to deleverage, improving the current account. The shift in commodity prices can be regarded as a shift in the tradable endowment in theoretical models that have been used to analyze *Sudden Stops* (see, for example, Bianchi, 2011). Second, the differential response of macroeconomic variables to positive and negative CTOT shocks can be rationalized by the combination of downward wage rigidities and a fixed exchange rate regime. In this context, a negative price shock induces a fall in aggregate demand for tradable and non-tradable goods. Considering that the nominal wage is rigid downwards and the country has a fixed exchange rate, real wages cannot fall, and the shock induces an increase in unemployment (see, for example, Schmitt-Grohé and Uribe, 2016). If the fall in tradable demand is stronger than the decrease in tradable output, this shock may also lead to an improvement in the trade balance. Third, the asymmetric response of macroeconomic variables could be explained by the pro-cyclicality of fiscal policy in EMEs (see, for example, Kaminsky et al., 2004).

We assess the relevance of these mechanisms in explaining the results. First, we estimate the responses of macroeconomic variables using simulated data from the theoretical model of Bianchi (2011). We uncover that the asymmetry in the response of capital flows and exchange rate in the data is consistent with the results from the theoretical model. Then we document that country spreads increase and net capital flows fall on impact in response to negative shocks, reflecting tighter financial conditions for EMEs. Positive CTOT shocks do not induce a significant effect on these variables. We also exclude that the asymmetry generated by this financial channel is due to U.S. monetary policy and uncertainty shocks, considered the main drivers of the Global Financial Cycle (Rey, 2013). Additionally, we show that negative CTOT shocks increase the probability of *Sudden Stop* episodes. Second, countries with flexible and fixed exchange rate regimes display comparable impulse responses. Third, we show that the response of fiscal policy does not explain the asymmetric response of macroeconomic variables. Thus, our analysis suggests that the financial channel is the main driver of the sign-dependent asymmetric response of EMEs to CTOT shocks. Our empirical findings can inform the design of optimal policies in commodity-exporting EMEs (and developing countries).

Relationship with the literature. Fluctuations in commodity prices are a relevant source of business cycle fluctuations in EMEs, accounting for up to half of business cycle fluctuations (see, for example, Fernández et al., 2018; Ben Zeev et al., 2017; Di Pace et al., 2024b). Previous works have used small open economy models to characterize the effects of CTOT shocks in EMEs (see, for example, Kohn et al., 2021). A strand of the literature assumes that the interest rate at which countries can borrow from international capital markets depends negatively on commodity prices (see, for example, Shousha, 2016; Drechsel and Tenreyro, 2018; Fernández et al., 2018).[4] This specification is based on the empirical fact that the country spread declines (increases) when commodity prices increase (decline). In these models, the financial channel amplifies the effects of commodity price shocks on business cycles without inducing asymmetric effects. Another strand of the literature assumes that small open economies are subject to an *Occasionally Binding Borrowing Constraint* (henceforth, OBCs) which depends on capital or current income (see, for example, Mendoza, 2010; Bianchi, 2011). In this type of models, popular to analyze *Sudden Stops*, a decline in tradable income induces a tightening of the external borrowing constraint, which may force the country to deleverage, inducing non-linear effects. Consistent with these models, this paper documents that commodity price shocks induce sign-dependent macroeconomic effects whose heterogeneity is quantitatively sizeable. These empirical facts have important implications for the models used to analyze CTOT shocks in EMEs and the design of optimal policies in these economies.

Previous empirical works have analyzed different kinds of asymmetries in EMEs' business cycles in response to terms of trade shocks. Broda (2004) shows that changes in terms of trade induce stronger effects on countries with a fixed exchange rate regime. Edwards and Levy-Yeyati (2005) document that the response to changes in terms of trade depends on the exchange rate regime and the sign of the change. We differ from their analysis along several dimensions. First, while they estimate the effects of unconditional changes in broadly defined terms of trade (ToT), our definition of CTOT changes is conditional (and thus orthogonal to) on the past values of CTOT itself and other macro-financial variables. The latter definition is consistent with the concept of structural shocks in theoretical models and aligned with the latest empirical research on the topic. Second, we focus on business cycle dynamics and shed light on the role of the financial channel in determining the sign-dependent responses of EMEs to CTOT shocks. While we also consider the role of exchange rates in explaining the asymmetry, we document comparable responses of countries with flexible and fixed exchange rate regimes. Third, rather than relying on traditional panel regression, we employ local projections methods that are specifically designed to estimate dynamic effects and allow us to study the response of domestic economic conditions at farther horizons to CTOT shocks.[5]

Our findings echo and complement those in Ben Zeev (2019), who documents that global risk appetite shocks produce an asymmetry in EMEs' business cycles. Our analysis shows that commodity price shocks are an additional source of the documented asymmetry and are generated by financial frictions, consistently with the interpretation in Ben Zeev (2019). Recently, Di Pace et al. (2024b) evaluate whether business cycles in a broad set of EMEs and low-income countries respond asymmetrically to a ToT shock on the export or import price index. They find that the former is twice as important in explaining business cycle dynamics in EMEs. This paper contributes to the literature by shedding light on CTOT shocks' asymmetric effects on EMEs' business cycles. We focus

[4] Hamann et al. (2023) rationalize this negative comovement between spreads and commodity prices for oil exporters using a model with sovereign default and oil extraction.

[5] Additionally, our analysis covers more recent years, while their analysis stops in 2000.

on the role of export price index, which according to Di Pace et al. (2024b) is the main component of the terms of trade to explain business cycle fluctuations. While our results confirm that commodity price shocks induce sign-dependent effects on EMEs' output, we also show that other relevant macroeconomic variables display significant asymmetric responses. We show that the asymmetric response of macroeconomic variables is tightly intertwined with the response of capital flows and country spreads. Conversely, nominal rigidities coupled with a fixed exchange rate regime do not explain the sign-dependent effects of CTOT shocks.

Structure of the paper. The remainder of the paper is structured as follows. Section 2 presents the empirical specification and data used for documenting the main empirical facts. Section 3 documents the empirical findings of CTOT shocks on macroeconomic and financial variables. Section 4 analyzes the role of financial frictions and exchange rate regimes in explaining the asymmetric responses. Section 5 presents several robustness exercises. Finally, Section 6 concludes.

2. Econometric framework

In this section, we describe the identification strategy for commodity price shocks and the baseline empirical specification we use to estimate the effects of positive and negative CTOT shocks.

We estimate non-linear local projections (Jordà, 2005; LP) to uncover the heterogeneous effects of positive and negative CTOT shocks on the outcome variables. Our specification follows Caravello and Martinez-Bruera (2024) who suggest using piece-wise linear methods, albeit shocks are not observed ex-ante in our analysis. As the sign asymmetry might be plagued by size non-linearity, we run a battery of tests suggested in Gonçalves et al. (2021) and Caravello and Martinez-Bruera (2024) that do not diagnose a contamination of our results by spurious factors.

Following Jorda and Taylor (2024), the baseline non-linear LP specification includes the outcome variables as long-differences:

$$\begin{aligned} y_{j,t+h} - y_{j,t-1} = {} & \mathbb{I}_{j,t}\left[\alpha^p_{j,h} + \tau^p_h T_t + \phi^p_h \epsilon^{ctot}_{j,t} + \Gamma^p_h(L) y_{j,t-1} + \Xi^p_h(L) x_{j,t-1}\right] + \\ & \left(1-\mathbb{I}_{j,t}\right)\left[\alpha^n_{j,h} + \tau^n_h T_t + \phi^n_h \epsilon^{ctot}_{j,t} + \Gamma^n_h(L) y_{j,t-1} + \Xi^n_h(L) x_{j,t-1}\right] + u_{j,t+h} \\ & \forall \quad 0 \le h \le 20 \end{aligned} \tag{1}$$

where h corresponds to the projection horizon, j denotes a country, T_t is a linear time trend included as suggested in Ramey and Zubairy (2018), $y_{j,t+h} - y_{j,t-1}$ denotes the cumulative change in the variable of interest h periods ahead, $\mathbb{I}_{j,t}$ represents an indicator function that takes the value of one when the CTOT quarterly growth rate is positive and zero when negative, $\epsilon^{ctot}_{j,t}$ denotes the CTOT shock for country j in period t, $\Gamma(L)$ and $\Xi(L)$ are a polynomial in the lag operator L up to order 4, $x_{j,t-1}$ is the set of control variables, $\alpha_{j,h}$ are country-specific fixed-effect, and $u_{j,t+h}$ is the error term clustered at the country level.[6] All estimated coefficients are specific to the horizon h. Hence, ϕ^p_h and ϕ^n_h are the coefficients of interest, i.e., the dynamic effects or impulse response functions (IRFs), to positive (p) and negative (n) shocks, respectively. Notice that we are assuming that the coefficients are common across countries, i.e., we are computing a pooled estimator as it is standard in the literature (see, for example, Fernández et al., 2017).[7]

The outcome variables we use are output, investment, trade balance-to-output ratio, nominal exchange rate, net capital flows, and the country-specific J.P. Morgan Emerging Markets Bond Index (henceforth, EMBI) as a proxy for country credit spread. EMBI is an essential country-specific variable for our analysis since it allows us to explore the financial friction channels (see Section 4.1). $x_{j,t-1}$ denotes the set of control variables that includes lagged values of all the outcome variables. Macro variables are expressed in real terms. Other than EMBI, the rest of the variables are from the IMF International Financial Statistics database. Appendix A contains a detailed description of the data we use and its sources.

Baseline identification strategy. Previous works assume that shifts in terms of trade or commodity prices are completely exogenous with respect to the domestic economic conditions of small open economies (see, for example, Mendoza, 1995; Schmitt-Grohé and Uribe, 2018). Consequently, shocks are identified in a VAR model where ToT or CTOT only depend on its past values and, in some cases, also on lags of the BAA Corporate Spread or the U.S. real interest rate (see, for example, Schmitt-Grohé and Uribe, 2018; Fernández et al., 2017). Commodity price shocks can be defined as the changes in commodity prices that are orthogonal to past values of CTOT and controls:

$$\mathrm{CTOT}_{j,t} = \beta_0 + \sum_{k=1}^{4} \beta_k \mathrm{CTOT}_{j,t-k} + \epsilon^{ctot}_{j,t} \tag{2}$$

[6] We assume a common linear trend for all the economies in our sample. We assess the robustness of our results to alternative trend specifications and to removing the deterministic trend in Appendix B.4.

[7] We prefer the LP estimation to the VAR modeling due to its flexibility to estimate non-linear state-dependent impulse responses. As Sekine and Tsuruga (2018) and Auerbach and Gorodnichenko (2013) highlight, using LP to compute IRFs has several advantages. First, they can be estimated using OLS for each horizon. This feature allows economizing on parameters by avoiding adding all analyzed outcome variables as controls to guarantee the shock's exogeneity. At the same time, it is easier to include interaction terms to estimate non-linear sign-dependent specifications than other popular methodologies in applied macroeconomics, e.g., an SVAR. Second, LPs are robust to misspecification of the data-generating process since they do not constrain IRFs' dynamics. Such a characteristic can lessen specification errors arising from the lag structure of regressions. All these advantages come with no costs in terms of the characterization of EMEs' business cycles.

where $\text{CTOT}_{j,t}$ is the value of CTOT of country j and $\epsilon^{ctot}_{j,t}$ are the identified series of CTOT shocks, which are the object of interest.[8] Within a two-step procedure, one could estimate Eq. (2) first and then recover $\epsilon^{ctot}_{j,t}$ in a second step to obtain its dynamic causal effects through Eq. (1). However, Eq. (2) can be expressed as:

$$\epsilon^{ctot}_{j,t} = \text{CTOT}_{j,t} - \beta_0 - \sum_{k=1}^{4} \beta_k \text{CTOT}_{j,t-k} \tag{3}$$

Thus, instead of plugging in ϵ^{ctot}_{t} directly in our main empirical specification, we can include current and lagged values of CTOT and the set of controls in a one-step estimation procedure. Combining Eqs. (1) and (3) yields:

$$\begin{aligned} y_{j,t+h} - y_{j,t-1} \ = \ & \mathbb{I}_{j,t} \left[\tilde{\alpha}^p_{j,h} + \tau^p_h T_t + \sum_{z=0}^{4} \tilde{\phi}^p_{h,z} \text{CTOT}_{j,t-z} + \Gamma^p_h(L) y_{j,t-1} + \Xi^p_h(L) x_{j,t-1} \right] + \\ & \left(1 - \mathbb{I}_{j,t}\right) \left[\tilde{\alpha}^n_{j,h} + \tau^n_h T_t + \sum_{z=0}^{4} \tilde{\phi}^n_{h,z} \text{CTOT}_{j,t-z} + \Gamma^n_h(L) y_{j,t-1} + \Xi^n_h(L) x_{j,t-1} \right] + u_{j,t+h} \\ & \forall \quad 0 \leq h \leq 20 \end{aligned} \tag{4}$$

This direct approach has a set of advantages relative to the aforementioned two-step alternative: (i) provides more precise estimates; (ii) controls for domestic macroeconomic conditions which may reflect future movements in CTOT (see Ben Zeev et al., 2017); (iii) allows for differential persistence, which is typically considered to play a key role for the effects of CTOT shocks (Mendoza, 1995), across positive and negative shocks. Nonetheless, our main results are robust to the two-stage estimation procedure where CTOT shocks are identified in a separate step from an univariate $AR(4)$ process as typically done in the literature (see Section 5).

Alternative identification strategy. Juvenal and Petrella (2024) argue that fluctuations in CTOTs may be driven by commodity-specific shocks or may reflect the global financial cycle. They exploit a series of events related to commodity markets as a source of exogenous variation in CTOT. In Section 3.4 we exploit the same set of events to estimate the asymmetric effects of CTOT shocks using LP-IV and we find consistent effects relative to our baseline specification.

3. Empirical evidence

This section presents the estimated responses of EMEs to CTOT shocks. Section 3.1 describes the data employed in that analysis. Section 3.2 displays the estimated effects for EMEs using Eq. (4). Section 3.3 assesses the role of global shocks and conditions in driving the results. Section 3.4 displays the estimated effects using the series of events proposed by Juvenal and Petrella (2024) as an IV. Finally, Section 3.5 presents the estimated linear effects and compares them with those of previous works.

3.1. Data

The data set is an unbalanced quarterly panel of commodity-exporting EMEs small-open economies between 1994:Q1–2019:Q4. The criteria we use to include a country in the data set are: (i) the country is a small open economy such that domestic macro-financial conditions cannot affect global commodity prices; (ii) the median share of commodity exports to total exports between 1990:Q1–2019:Q4 is higher than 10% and (iii) the country belongs to the J.P. Morgan Emerging Market Bond Index (EMBI); (iv) the availability of capital flows data.[9] In this way, we can study the effect of commodity price shocks on commodity-exporting EMEs and investigate the relevance of the financial channel as a source of their asymmetric effects. Our final sample is unbalanced due to the data availability of each country. It comprises 13 commodity-exporting EMEs: Argentina, Brazil, Bulgaria, Chile, Colombia, Indonesia, Malaysia, Mexico, Peru, Poland, Romania, South Africa, and Ukraine. Output and investment are expressed in real terms and in percentage deviations from a quadratic trend (see, for example, Schmitt-Grohé and Uribe, 2018). EMBI yield, trade balance-to-GDP ratio are expressed in percentage points. Precise definitions of the variables, sample periods for each country, main commodity exported by each country and data sources are included in Appendix A.

Commodity export price index. We compute country-specific CTOT indexes following (Gruss and Kebhaj, 2019):

$$CTOT_{j,t} = \frac{\sum_{i=1}^{n} \omega_{j,i} P_{i,t}}{PCPI_t} \tag{5}$$

The numerator on the right-hand side of Eq. (5) corresponds to the commodity export price index from the Commodity Terms of Trade database computed by the International Monetary Fund.[10] This index is a fixed weighted price average $\omega_{j,i}$ of commodity i for country j's and $P_{i,t}$ is the commodity i's price at time t. The weights are calculated, similar to Shousha (2016) and Fernández et al. (2018), as the ratio of country j's commodity i exports to total commodity exports over several decades.[11] The original series are available at monthly frequency, hence we compute the quarterly average. The denominator is the U.S. Producer Price Index (PPIACO from FRED) calculated by the U.S. Bureau of Labor Statistics, which we use as a proxy for global manufacturing prices.

[8] While we include a country fixed effect ($\beta_{j,0}$), we assume that the persistence of the process is the same across countries.

[9] We compute the commodity export shares using data from the World Development Indicator database published by the World Bank. Commodity exports are defined as the sum of agricultural raw materials, fuels, and metals exports as a share of total exports.

[10] See https://data.imf.org/commoditytermsoftrade.

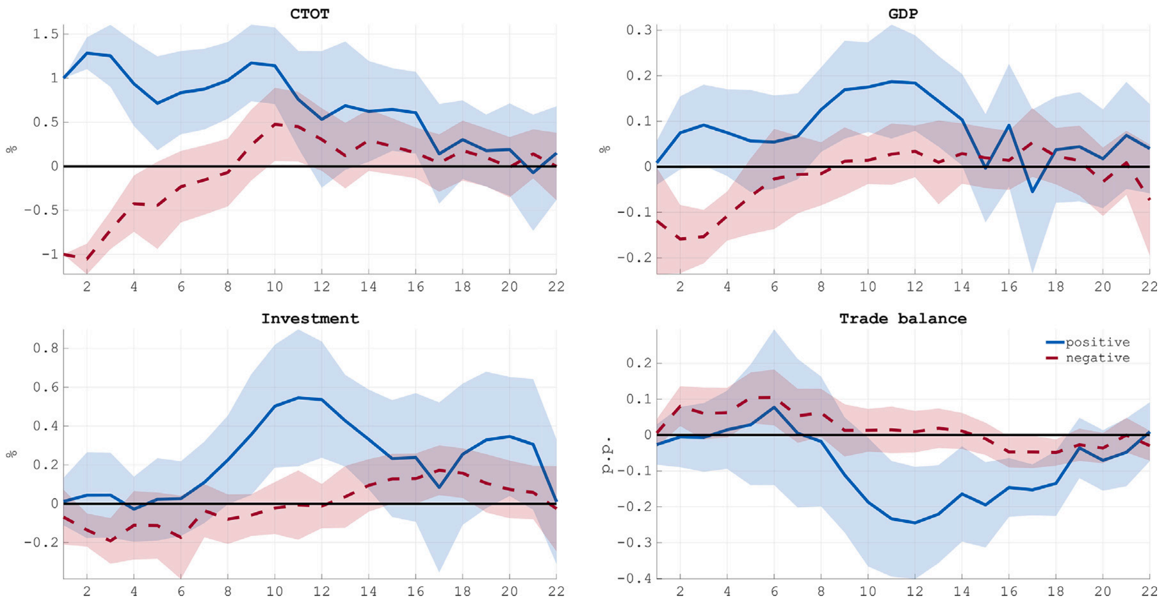

Fig. 2. Sign-dependent IRFs to CTOT shocks - Macroeconomic aggregates.
NOTE. Estimated Sign-Dependent Impulse Response Functions (IRFs) of Commodity Terms of Trade (CTOT), GDP, Gross Fixed Capital Formation (Investment), and trade balance-to-output ratio (Trade balance) computed using local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a positive (negative) CTOT shock that induces a contemporaneous increase (decrease) of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll and Kraay standard errors. Horizon is in quarters.

3.2. Sign-dependent macroeconomic effects

Prior to the sign-dependent estimation of the dynamic effects of CTOT shocks, we assess whether the distribution of positive and negative CTOT shocks is statistically different (reversing the latter's sign). We apply both the Kolmogorov–Smirnov test over the two sub-samples and cannot reject that they are drawn from the same distribution (p-value = 0.7, KS-stat = 0.3) and the triples test developed by Randles et al. (1980) that fails to reject the asymmetry (p-value = 0.4). This result holds both for the CTOT growth rates and the residuals from an estimated AR(4) process of the CTOT. Furthermore, Section 5 reports two exercises that do not diagnose substantial contamination of our asymmetric results by spurious factors such as size asymmetries. In particular, we estimate size-asymmetric responses following Caravello and Martinez-Bruera (2024) that display a strong homogeneity. We also correct the LP estimates following Gonçalves et al. (2021) and obtain very similar results to our baseline.

Fig. 2 reports the EMEs' estimated response to positive and negative CTOT shocks. The persistence of CTOT shocks is crucial to characterize their effects on EMEs' business cycles (see, for example, Mendoza, 1991). Positive CTOT shocks induce a more persistent response in CTOT compared to negative CTOT shocks. On the one hand, positive shocks induce a persistent increase in CTOT, lasting more than 15 quarters. On the other hand, negative shocks dissipate after five quarters. This differential persistence may be related to the strong influence of the early 2000's commodity super cycle on our sample.[12]

Macroeconomic variables react faster in response to a negative CTOT shock. Real GDP falls by almost 0.2% two quarters after the shock, but the effect dies out relatively fast after 5 quarters. Conversely, the output response to a positive shock is positive but more delayed, increasing only two years after the shock. Similarly, for investment, a negative CTOT shock quickly impacts but dissipates rapidly. In contrast, positive CTOT shocks produce statistically significant effects only after six quarters and reach a peak after ten quarters. Finally, the trade balance-to-output ratio improves by almost one percentage point in response to a negative shock. In contrast, it falls after two years in response to a positive shock. These differential responses of macroeconomic variables are striking if we consider that positive shocks have a more persistent effect on CTOT. Small open economy models predict that more persistent shocks induce a quicker effect on consumption and investment on impact.

[11] Di Pace et al. (2024b) develop a chain export index using granular export data for each country. They show that, for some cases, there is a significant variation of export bundle. However, this measure is only available at annual frequency and we do not have access to the information needed to compute a quarterly counterpart. Considering that our sample covers a shorter time span, we use a fixed-weight CTOT index in our baseline analysis and exploit this alternative CTOT measure as robustness (see Section 5.4).

[12] Fernández et al. (2023) show that commodity supercycles' contribution in explaining aggregate economic activity at the country level is rather small compared to stationary world shocks. With this in mind, our results should still be valid regardless of the influence the latest commodity supercycle has on our sample.

3.3. Accounting for global financial conditions

The *Global Financial Cycle* (GFC) may potentially affect CTOT as documented in Juvenal and Petrella (2024). Rey (2013, 2015) describe the GFC as the comovement of asset prices worldwide. U.S. monetary policy and the global risk appetite of investors are key drivers of the GFC (see, for example, Bruno and Shin, 2015; Avdjiev et al., 2022; Miranda-Agrippino and Rey, 2020).

In this section, we aim to rule out that an underlying financial shock drives our findings in light of the potential relevance of financial conditions in driving the asymmetric effect of CTOT (see Section 4.1). Specifically, following Juvenal and Petrella (2024), we augment the specification of Eq. (4) with the series of U.S. monetary policy shocks computed by Jarociński and Karadi (2020) and uncertainty shocks computed by Piffer and Podstawski (2018) as controls. Figures B.1 and B.2 presented in the Appendix display the IRFs. The responses remain unaffected by controlling for these shocks, suggesting that U.S. monetary shocks and uncertainty shocks are not the drivers of the asymmetric responses.

3.4. Instrumenting CTOT with commodity specific shocks

Commodity prices comove with the Global Financial Cycle. Thus, the identified series of CTOT shocks may mix CTOT with other shocks that influence the financial cycle, which differs from U.S. monetary or uncertainty shocks. Juvenal and Petrella (2024) identify major episodes specific to commodity markets and exploit them to build an instrument (IV) for commodity-specific shocks. Unlike U.S. monetary policy and uncertainty shocks, this series satisfies both the exclusion restriction and the relevance.

Although we cannot use their IV directly because our sample is at the quarterly frequency (instead of annual), and our CTOT measure is computed using fixed weights (instead of rolling weights), we build upon their narrative events to create a country-specific IV within our framework. We assume that the events that affected a commodity market in a given year affect that commodity for all quarters in that year. Following Juvenal and Petrella (2024), the IV takes the value of $1(-1)$ if the shock induces a positive (negative) effect on that commodity price. Then, we compute a country-specific IV using the weights from the CTOT series. Finally, we use these series as IVs in our non-linear LP setup.[13] Albeit the IV estimates are by construction less precise than those from a one-step procedure, we obtain a marked asymmetry in the aggregate responses to positive and negative shocks (Figures B.3-B.4 in the Appendix). The muted macroeconomic response to positive shocks suggests that the IV provides more statistical power in the case of negative shocks compared to positive shocks.

3.5. Comparison with the estimated linear effects

Previous works have mostly estimated the effects of EMEs in response to CTOT shocks using linear models (see, for example, Shousha, 2016; Fernández et al., 2018; Ben Zeev et al., 2017; Fernández et al., 2017; Schmitt-Grohé and Uribe, 2018). To link our findings with those of previous works, we estimate the effects of a CTOT shock without distinguishing by the sign of the shock using the following specification:

$$y_{j,t+h} - y_{j,t-1} = \tilde{\alpha}_{h,j,t} + \tau_h T_t + \sum_{z=0}^{4} \tilde{\phi}_h^z \mathrm{CTOT}_{j,t-z} + \Gamma_h(L) y_{j,t-1} + \Xi_h(L) x_{j,t-1} + u_{j,t+h} \qquad \forall \quad 0 \le h \le 20 \tag{6}$$

where the variables and controls are the same as in Eq. (4). Fig. 3 displays the estimated IRFs of macroeconomic and financial variables in response to a CTOT shock.

A positive CTOT shock induces an increase in output and investment and a deterioration of the trade balance-to-output ratio. The response of output and consumption is consistent with those of previous works (see, for example, Shousha, 2016; Ben Zeev et al., 2017; Fernández et al., 2017; Drechsel and Tenreyro, 2018). The response of the trade balance-to-output ratio is consistent only with the one found by Drechsel and Tenreyro (2018) and not in line with a standard small open economy model (see, for example, Schmitt-Grohé and Uribe, 2018). This response can be explained by negative CTOT shocks improving the trade balance-to-output ratio. In contrast, positive CTOT shocks do not significantly affect this variable during the first quarters. When we combine positive and negative shocks in a linear estimation, the trade balance to output deteriorates as a combination of the disaggregated effects. Thus, looking at the differential effects is crucial to better understand the response of this variable.

3.6. CTOT shocks from an AR process

An alternative empirical specification to the one presented in Eq. (4) is a two-stage estimation procedure that identifies CTOT

[13] In particular, following Wooldridge (2010) (see Section 9.5) we employ the IV that takes positive (negative) values for the CTOT residuals extracted from an AR(4) process that lies in the positive (negative) domain. This corresponds to the steps described in Eqs. (1)–(3). The procedure passes the Kleibergen and Paap (2006) weak IV test.

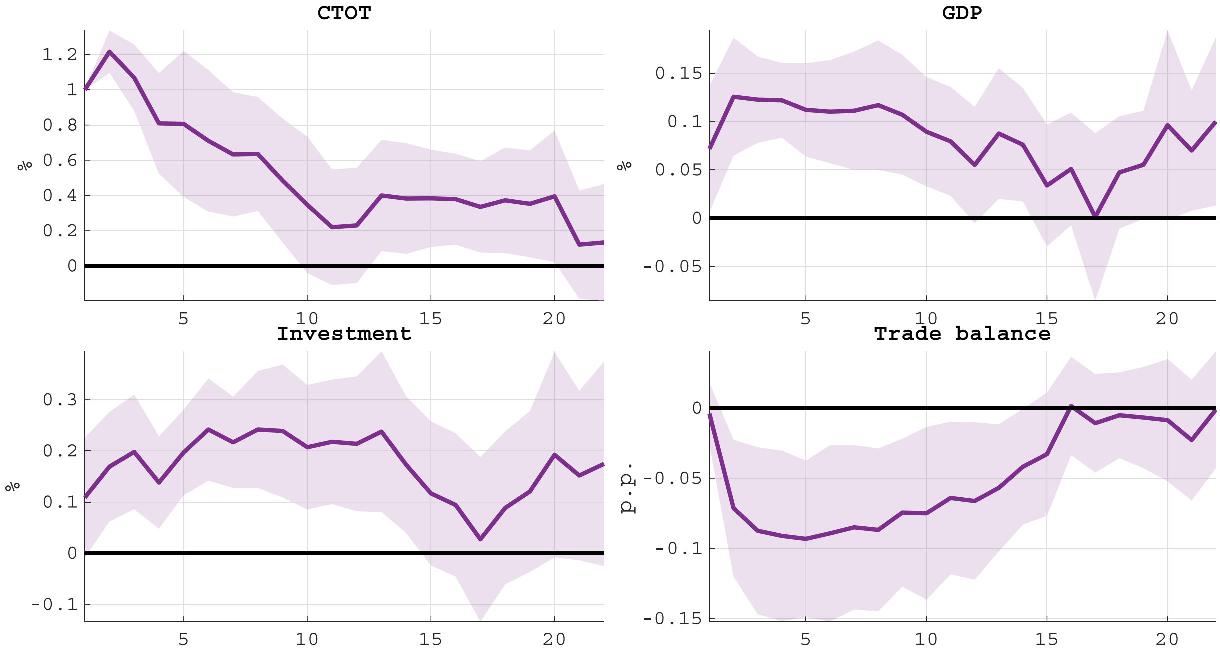

Fig. 3. Linear IRFs to a CTOT shock - Macroeconomic aggregates.
Note. Estimated Linear Impulse Response Functions (IRFs) of Commodity Terms of Trade (CTOT), GDP, Gross Fixed Capital Formation (Investment), and trade balance to output ratio computed using local projections defined in Eq. (6). Continuous purple lines denote the median IRFs in response to a CTOT shock that induces a contemporaneous increase of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll and Kraay standard errors. Horizon is in quarters.

shocks in a first stage from an univariate $AR(4)$ process as typically done in the literature (see, for example, Schmitt-Grohé and Uribe, 2018). In this alternative, CTOT shocks are identified as in Eq. (3), and then included in a second-stage regression similar to Eq. (1), where the contemporaneous series of CTOT shocks replace CTOT and lagged values of CTOT. This specification closely follows Barnichon et al. (2022) and Caravello and Martinez-Bruera (2024) as, in this case, shocks are assumed to be observed. The advantage of this specification, relative to the baseline one, is that we can define the states based on the sign of the shock instead of on the sign of the CTOT change. Figures B.11-B.12 included in the Appendix display the estimated IRFs computed with this alternative empirical specification. The main empirical findings are robust to this change in the empirical specification.

4. Understanding the source of asymmetry

This section explores the role of different propagation mechanisms that could explain the heterogeneous responses to positive and negative CTOT shocks. Section 4.1 assesses the role of the financial channel in explaining the estimated asymmetries. Section 4.1.3 explicitly analyzes the asymmetric relationship between CTOT and Sudden Stops. Sections 4.2 and 4.3 consider two alternative sources of asymmetry: the role of exchange rate regimes and the role of fiscal policy.

4.1. The role of financial frictions

The fast and strong response of macroeconomic variables can be explained by financial frictions. Mendoza (2010) develops a small open economy (SOE) model with incomplete financial markets to explain *Sudden Stop* dynamics. The model incorporates a Fisherian endogenous collateral constraint that limits the amount of debt that the economy can issue to a fraction of the physical capital held by the economy. Bianchi (2011) develops a two-sector (tradable and non-tradable) SOE model where the amount of debt is limited by current income. In this case, a negative income shock induces a tightening of the borrowing constraint and a fall in consumption of tradable and non-tradable goods, generating a real exchange rate depreciation that further tightens the borrowing constraint.

4.1.1. Asymmetry in the SOE model with borrowing constraints

We extend the model of Bianchi (2011) to analyze the asymmetric effects of CTOT shocks. This model considers a small open economy with access to international financial markets at the interest rate r subject to a borrowing constraint depends on tradable and nontradable income. We depart from the original version by assuming that: (i) the tradable endowment is a good that the economy exports but it does not consume domestically; (ii) the tradable good is an importable good that the economy does not receive as an endowment but consumes. The rest of the model follows Bianchi (2011).[14] The problem of the representative household is:

$$\max_{\{c_t^M, c_t^N, b_{t+1}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{\left[\left(\omega \left(c_t^M\right)^{-\eta} + (1-\omega) \left(c_t^N\right)^{-\eta} \right)^{-\frac{1}{\eta}} \right]^{1-\sigma}}{1-\sigma} \right]$$

subject to:

$$b_{t+1} + c_t^M + p_t^N c_t^N = b_t (1+r) + p_t^X y_t^X + p_t^N y_t^N \tag{7}$$

$$b_{t+1} \geq -\left(\kappa^N p_t^N y_t^N + \kappa^X p_t^X y_t^X \right) \tag{8}$$

where c_t^M and c_t^N denote the consumption of the importable and the nontradable goods, b_{t+1} denotes the net foreign asset position of the economy at the end of period t denominated in the importable good, κ^N and κ^X denote the fraction of nontradable and exportable income that determines the borrowing limit, y_t^N and y_t^X are the nontradable and exportable endowments, and p_t^N and p_t^X denote the relative price of nontradable and exportable goods with respect to the importable one. The price of the exportable good p_t^X is exogenous for this economy. Appendix C displays the optimality conditions from this problem. When the borrowing constraint is not binding, the response of the economy to positive and negative shocks is symmetric. Conversely, when the constraint is binding, an asymmetry arises: after a negative shock, the economy is forced to reduce its level of debt, amplifying the negative effects of the shock. This mechanism is not at work instead when the shock is positive. In this setting, a reduction in CTOT (p_t^X) that makes the borrowing constraint binding affects both current income and the borrowing constraint of the economy, generating an amplification effect in response to negative shocks relative to positive ones.

We simulate data from this model assuming that exportable and nontradable income follow a first-order Markov process, as in Bianchi (2011). We estimate the effects of positive and negative export price shocks using non-linear local projections similar to our empirical specification (Eq. (4)) that includes the positive and negative shocks plus lags of the dependent variables.[15] Each period in the model represents a year, while our empirical analysis is at a quarterly frequency. Considering that the objective of this analysis is to understand the transmission of CTOT shocks and to assess if the model is qualitatively consistent with the empirical patterns, we employ the calibration and frequency of the original model. Fig. 4 displays the IRFs from the theoretical model to positive and negative export price shock.[16]

In response to an export price shock of the same size, the responses of the trade balance-to-output ratio, the multiplier of the borrowing constraint, and the real exchange rate are significantly larger in the case of a negative shock than for a positive one. Moreover, the peak negative responses to a negative shock occur on impact while it is more gradual in the positive case, in line with the empirical findings. The reason is that agents are constrained by the collateral constraint in the former case while unconstrained in the latter. This asymmetry aligns with our empirical results (Fig. 2). The trade balance-to-output ratio improves after both a negative and positive shock, which is also consistent with our empirical findings.

The theoretical model is useful to rationalize the asymmetric response of the economy to CTOT shocks, although it misses some important dimensions. First, the interest rate that the economy faces in credit markets is constant in this model. The increase in the multiplier of the borrowing constraint in response to the negative CTOT shock reflects a tightening in borrowing conditions. Second, this endowment economy misses investment dynamics that are an important component of the trade balance and the current account. Unfortunately, we cannot compare output dynamics since real output is constant in this endowment economy.

To further investigate this financial transmission mechanism, we estimate the responses of some additional financial and macroeconomic variables to both CTOT shocks. We focus on EMBI dynamics, which reflect borrowing conditions, and on exchange rate dynamics, which are crucial in the model. We also assess whether negative shocks increase the probability of experiencing a *Sudden Stop*, as in Bianchi (2011).

4.1.2. Additional evidence on the financial channel

Financial frictions are essential in explaining how commodity price shocks transmit into EMEs' business cycles (see, for example, Céspedes and Velasco, 2012; Shousha, 2016; Drechsel and Tenreyro, 2018; Fernández et al., 2018). Based on the negative relation between emerging economies' country credit spread and the terms of trade (see, for example, Hilscher and Nosbusch, 2010; Byrne et al., 2013), previous works using small open economy models have assumed the country interest rate depends negatively on commodity prices (see, for example, Shousha, 2016; Drechsel and Tenreyro, 2018). This negative relation may reflect the fact that when commodity prices increase (decrease), the probability of default decreases (increases) since economies have fewer (more) incentives to default. In this framework, a negative CTOT shock that decreases the emerging economy's current income would also increase the country's interest rate, reducing the incentives to issue debt. Considering this critical interaction between

[14] Faris and Granados (2025) also extend the model of Bianchi (2011) to analyze how terms of trade shock may affect the probability of a Sudden Stop. Their model differs from ours in two important dimensions. First, they assume that both the importable and exportable good are consumed domestically. Second, they assume that the economy also has an endowment of importable goods every period. They also find that terms of trade fluctuations may induce Sudden Stops.

[15] We simulate 80,000 observations from the model's original calibration and discard the first 50,000 to avoid any dependence on initial conditions.

[16] The real exchange rate is expressed as in the empirical analysis. A decline (increase) means a depreciation (appreciation). See Eq.(C.5) included in the Appendix.

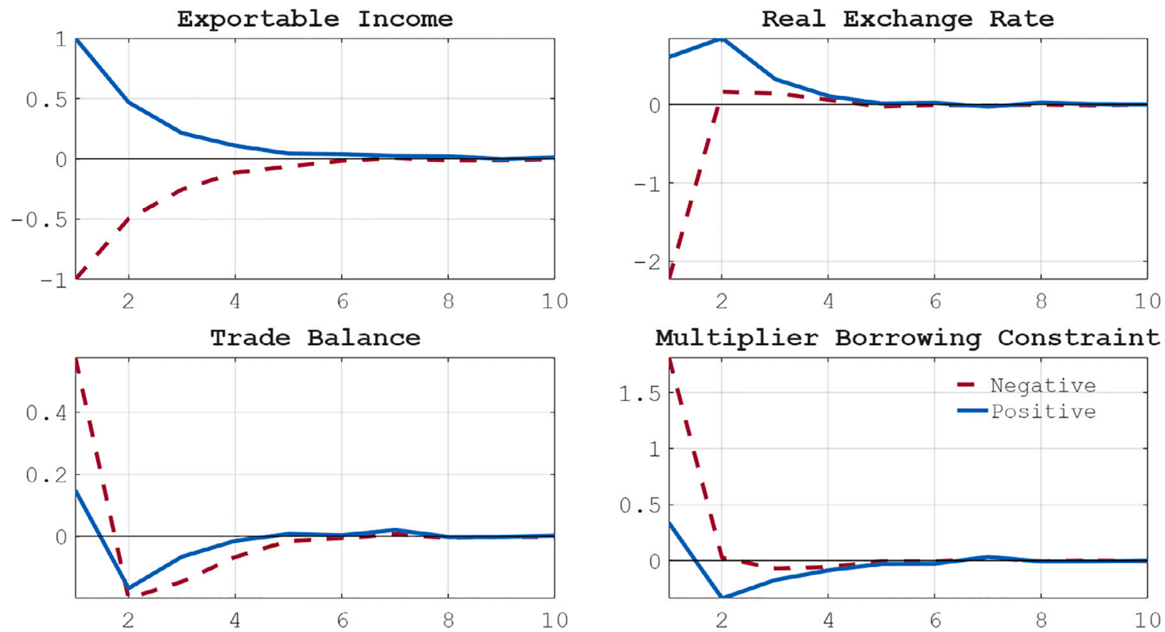

Fig. 4. Sign-dependent IRFs to export price shocks.
Note. Estimated Sign-Dependent Impulse Response Functions (IRFs) of export price shock, Real Exchange Rate, and trade balance-to-output ratio (Trade Balance) computed using simulated data from the theoretical model presented in Section 4.1.1 and local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a CTOT shock that induces a contemporaneous increase (decrease) of 1% in tradable income.

commodity prices and the country's interest rate, we estimate the non-linear effects of CTOT shocks on the sovereign spreads and net capital flows to assess if they are important in explaining the asymmetric response of macroeconomic variables. Following the results from the model presented before, we also include the response of the nominal exchange rate to both shocks.[17] Fig. 5 displays the estimated IRFs.

EMBI spread spikes after a CTOT deterioration and net capital flows drop immediately and persistently, whereas after a positive shock both the EMBI and net capital flows almost do not react.[18] This increase in the EMBI reflects a deterioration of borrowing conditions, consistent with the observed increase in the multiplier of the borrowing constraint of Fig. 4. The sharp and persistent decline in net capital flows is explained by the stronger fall in gross capital inflows relative to gross capital outflows (see Figure B.13 included in the Appendix). Thus, the decrease in CTOT induces a significant tightening of the credit conditions, which can be essential to explain the estimated macroeconomic dynamics.

The sharp reduction in capital flows coupled with the increase in sovereign spread and the improvement in the trade balance-to-output ratio in response to a fall in CTOT is consistent with the effects described in the theoretical model. We also observe a strong and persistent depreciation of the nominal exchange rate (NEER in Fig. 5), which is consistent with the real depreciation of the domestic currency (see Figure B.15 included in the Appendix).

4.1.3. Relationship with sudden stops

The decline in commodity prices induces a strong increase in the EMBI, a reversal in the trade balance-to-output ratio, and a decline in capital flows consistent, at least qualitatively, with a *Sudden Stop*. In this section, we explore more in detail the link between negative commodity price shocks and *Sudden Stops*. First, we identify *Sudden Stop* episodes for the economies of our sample using the definition proposed by Calvo et al. (2008).[19] Table A.3 included in Appendix displays the *Sudden Stops* events identified in our sample. Then, we define a dummy variable ss that captures the beginning of a *Sudden Stop* episode. Due to the specific nature

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[17] The response of the real exchange rate is consistent with the nominal one and is presented in Figure B.15 included in the Appendix.

[18] EMBI displays a hike after about 17 quarters, likely reflecting the delayed macroeconomic response to a positive CTOT shock.

[19] In particular, we compute the monthly proxy of capital flows as defined (Calvo et al., 2008) and identify a *Sudden Stop* as periods when: (i) there is at least one observation where the year-on-year decline in capital flows lies at least two standard deviations below its sample mean; this condition fulfills the 'unpredicted' prerequisite of a *Sudden Stop*, (ii) the period of *Sudden Stop* phase ends when the annual change in capital flows surmounts one standard deviation below its sample mean. This commonly suggests persistence, which is a common fact of *Sudden Stops*, (iii) additionally, to ensure symmetry, the onset of a *Sudden Stop* phase is ascertained by the first time the annual change in capital flows drops one standard deviation below the mean. Both the first and second moments of the capital flow series are calculated each period using an expanding window with a minimum of 24 (months of) observations, which intends to capture the evolving behavior of the series. Table A.3 included in the Appendix displays the *Sudden Stop* events of the sample.

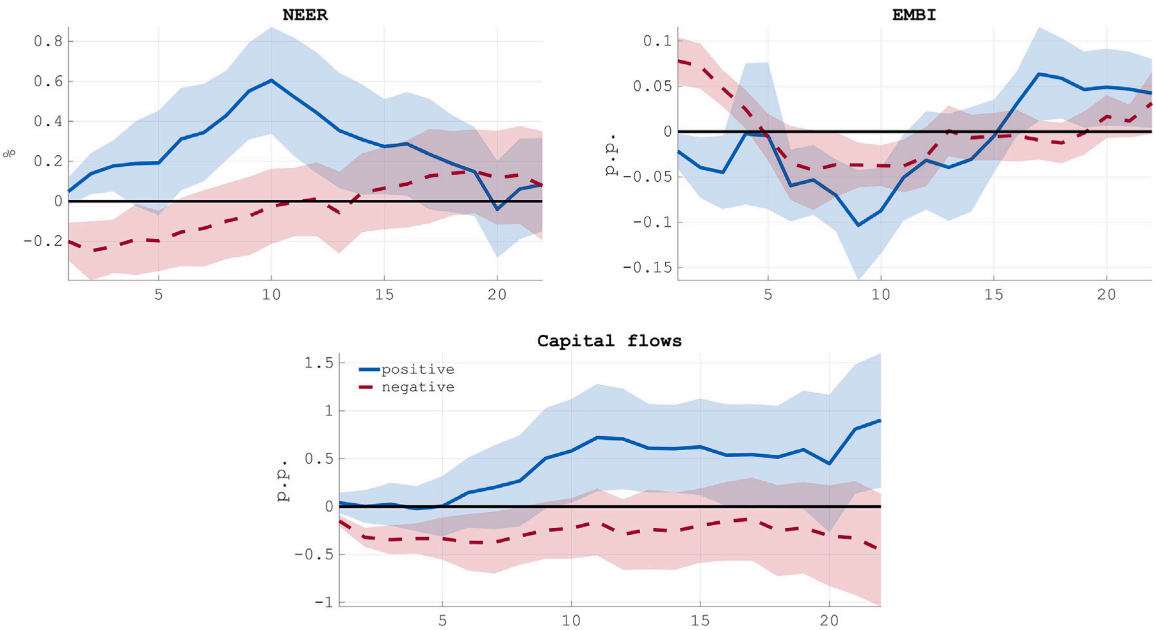

Fig. 5. Sign-dependent IRFs to CTOT shocks - Exchange rate and financial channel.
Note. Estimated Sign-Dependent Impulse Response Functions (IRFs) of the nominal exchange rate (NEER), J.P. Morgan Emerging Market Bond Index (EMBI), and net capital flows to output ratio (Capital flows) computed using local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a positive (negative) CTOT shock that induces a contemporaneous increase (decrease) of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll and Kraay standard errors. Horizon is in quarters.

of our dependent variable, which is a binary and quite a sparse variable, because it measures the beginning of a *Sudden Stop*, we do not aim at estimating dynamic effects but focus on the CTOT asymmetric influence on the probability of this type of crises only contemporaneously. Moreover, the response of capital flows displayed in Fig. 5 shows that the impact of negative CTOT shocks materializes in the first two quarters, suggesting that focusing on the static effects may fully capture the dynamics at play.

Finally, we model the probability of occurrence of a *Sudden Stop* ($ss_{j,t}$) as a function of positive and negative CTOT shocks using Eq. (9):

$$ss_{j,t} = \alpha + \beta CTOT^{p}_{j,t} + \gamma CTOT^{n}_{j,t} + \delta X_{j,t} + u_{j,t} \tag{9}$$

where $CTOT^{p}_{j,t}$ and $CTOT^{n}_{j,t}$ denote positive and negative CTOT shocks, which we estimated as the residuals from an AR(4) of CTOT process for easy of interpretation in the coefficients as in Eq. (3). β and γ are the parameters of interest. $X_{j,t}$ denotes the set of controls that we employed in the LP analysis in Eq. (4).

Table 1 reports the results from a linear probability model (LPM), estimated with fixed effects by OLS, since we are interested in the average marginal effects (column 1). Columns (2–3) display instead the estimates from a logit with fixed and random effects, respectively. Additionally, Table B.1 reports similar results obtained when CTOTs enter directly in growth rates.

The results indicate that negative shocks to CTOT increase the probability of occurrence of a *Sudden Stop* while the positive shocks' influence is faint and less precisely estimated. A 1% decline in CTOT leads to an increase in the probability of a *Sudden Stop* equal to about 0.3 percentage points.[20] Thus, negative CTOT shocks increase the probability of a Sudden Stop, while positive shocks do not have any substantial influence.

4.2. *The role of the exchange rate regime*

The asymmetric macroeconomic responses of EMEs' business cycles to CTOT shocks could alternatively arise from a combination of nominal frictions in the form of downward wage rigidity and a fixed exchange rate regime (see, for example, Schmitt-Grohé and Uribe, 2013, 2016). Under a freely floating exchange rate regime, a negative commodity price shock induces local currency depreciation. Hence, real wage decreases through the exchange rate. Conversely, under a fixed exchange rate regime, the lack of currency depreciation and the rigidity of nominal wages prevent real wages from adjusting, leading to increased unemployment. The initial adverse effect on economic activity stemming from a negative CTOT gets amplified due to this mechanism. Such an amplification effect is not in place in the case of a positive CTOT shock, as upward nominal wage movements are not restricted,

[20] If we convert the estimates from the logit models in terms of the average marginal effects, we obtain an estimate equal to 0.049 percentage points.

Table 1
CTOT shocks and *Sudden Stops*.

Dependent variable: Probability of a Sudden Stop			
	(1) LPM-FE	(2) Logit-FE	(3) Logit-RE
CTOT positive	0.170	4.723	5.033
	(0.156)	(6.338)	(5.884)
CTOT negative	−0.310**	−5.667*	−6.113**
	(0.127)	(3.439)	(3.405)
Constant	0.014		−5.064***
	(0.009)		(0.519)
Macro-financial controls	✓	✓	✓
Observations	925	808	925
Countries	13	10	13

NOTE. The dependent variable is a dummy that takes values 1 when a Sudden Stop episode starts as defined by Calvo et al. (2008). CTOT enters as the residuals from an AR(4) process. In column (1), a linear probability model with FE is estimated by OLS. Columns (2) and (3) report the results from a logit model with FE and RE, respectively. All specifications include the same macro-financial controls as Eq. (4).
Standard errors in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

and real wages can adjust. In line with this exposition, Broda (2004) estimates the effects of terms of trade shocks on developing economies without focusing on the sign of the shock. He finds that GDP and prices respond more to terms of trade shocks if they have a fixed exchange rate regime. Thus, countries with more flexible regimes better insulate the effects caused by this kind of shock.

In order to evaluate the role of exchange rates in explaining the asymmetric response of EMEs to CTOT shocks, we estimate Eq. (4) allowing CTOT shocks to have differential effects on economies with a flexible and fixed exchange rate regime.[21] We classify countries following the exchange rate classification of Ilzetzki et al. (2019). In particular, we use their fine classification and define countries with currency boards or crawling peg regimes within a corridor smaller or equal to 2 percent as countries with fixed exchange rate regime (see Table A.4 in the Appendix).[22] If the exchange rate regime explains the asymmetry, economies with flexible exchange rates will not display any asymmetry in response to CTOT shocks.

Figs. 6–7 show the estimates for flexible exchange rate regimes. Figures B.16-B.17 included in the Appendix report the estimates for fixed exchange rate regime.[23] In the case of fixed exchange rates, we dispose of a limited sample size and the responses to both types of shocks are less asymmetric. Nonetheless, the results are qualitatively in line with our baseline. Most importantly, the responses of macroeconomic and financial variables under a flexible exchange rate regime are not significantly different from the ones presented in Figs. 2 and 5. These results strongly suggest that the estimated asymmetry is not driven by countries with a fixed exchange rate regime.

4.3. The role fiscal of policy

The asymmetric macroeconomic responses of EMEs' business cycles to CTOT shocks could also stem from the fiscal policy response that is typically regarded as pro-cyclical (see, for example, Kaminsky et al., 2004; Vegh and Vuletin, 2015). A pro-cyclical fiscal policy could amplify the recessionary effect of a negative CTOT shock and create or reinforce the asymmetry that we have documented. However, recently (Di Pace et al., 2024a) have documented that, within a linear framework, the pro-cyclicality of fiscal policy in EMEs (and developing economics) holds unconditionally but not in response to a CTOT shock. On the contrary, after a CTOT shock, fiscal policy actually proves to be counter-cyclical.

To evaluate the role of fiscal policy in explaining the asymmetric response of EMEs to CTOT shocks, we estimate Eq. (4) by adding a fiscal deficit-to-GDP as a dependent variable and including its lagged values as a control. Figs. 8–9 show the IRFs to a CTOT shock in this enlarged specification. The responses of macroeconomic and financial variables are very similar to the baseline, suggesting that fiscal policy is not the source of the asymmetry. Moreover, the response of fiscal deficit is consistent with the results in Di Pace et al. (2024a) on the counter-cyclicality of fiscal policy after a CTOT shock (see also Figure B.6 included in the Appendix for the linear case; deficit improves after a CTOT shock).

[21] We report the specification that we estimate in Appendix B.8.

[22] This corresponds to all the countries that belong to categories from 1 to 8 in the classification. For our analysis, we consider the exchange rate regime of each period (i.e., we allow countries to shift regimes in our sample). While countries that belong to categories from 1 to 4 in this classification are usually considered as fixed exchange rate regimes, focusing only on these countries would considerably shrink our fixed exchange rate regimes subsample. In Section 5.3, we extend the sample of EMEs and repeat this exercise considering countries under fixed exchange rate regimes as those that belong to categories 1 to 4 (see Figure B.27 included in the Appendix).

[23] Due to the limited sample size for countries with a fixed exchange rate regime in this estimation, we truncate the local projection horizon to 15 quarters.

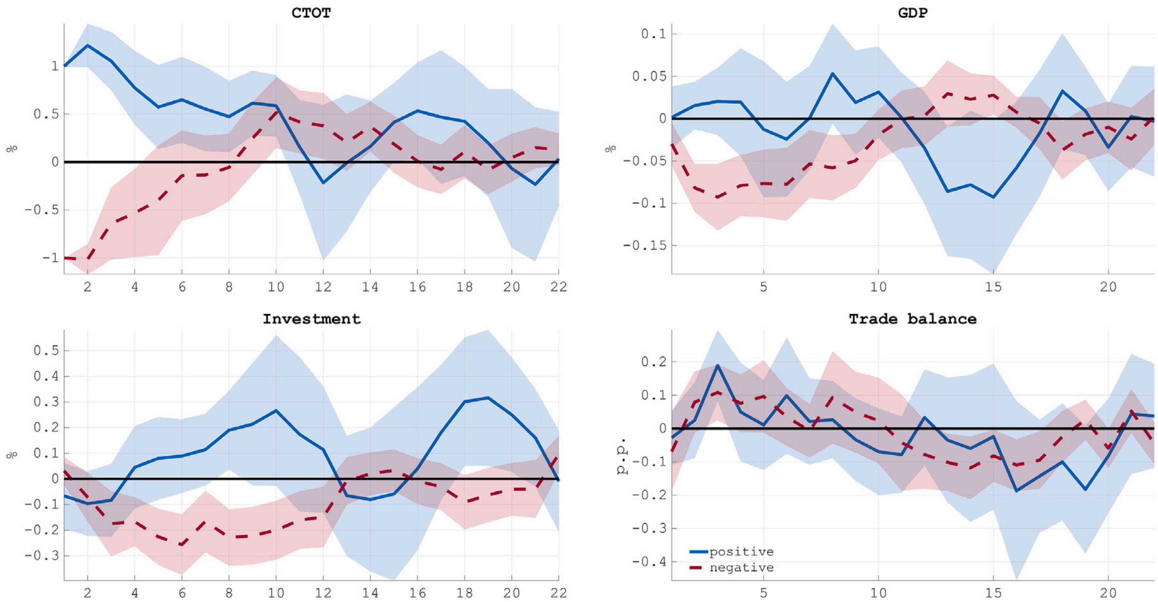

Fig. 6. Sign-dependent IRFs to CTOT shocks- Flexible exchange rate regime - Macroeconomic aggregates.
Note. Estimated Sign-Dependent Impulse Response Functions (IRFs) of Commodity Terms of Trade (CTOT), GDP, Gross Fixed Capital Formation (Investment), and trade balance-to-output ratio (Trade balance) computed using local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a positive (negative) CTOT shock that induces a contemporaneous increase (decrease) of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll and Kraay standard errors. Horizon is in quarters.

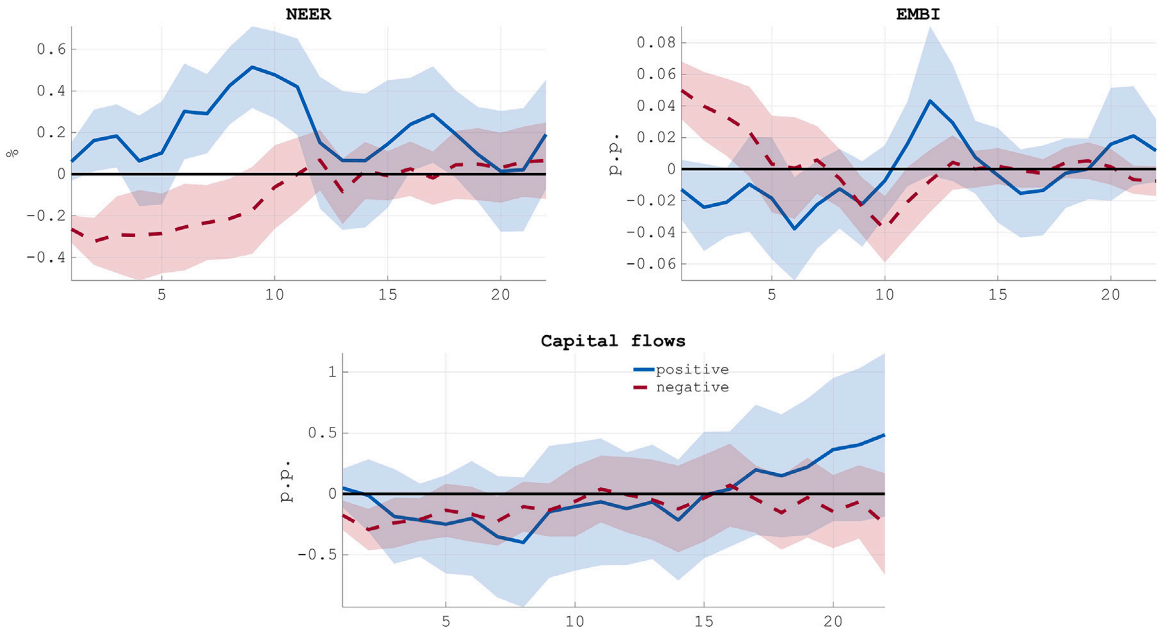

Fig. 7. Sign-dependent IRFs to CTOT shocks - Flexible exchange rate regime - Exchange rate and financial channel.
Note. Estimated Sign-Dependent Impulse Response Functions (IRFs) of Commodity Terms of Trade (CTOT), GDP, Gross Fixed Capital Formation (Investment), and trade balance to output ratio computed using local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a positive (negative) CTOT shock that induces a contemporaneous increase (decrease) of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll and Kraay standard errors. Horizon is in quarters.

5. Robustness and additional results

In this section, we consider alternative specifications to assess the robustness of our findings. For ease of exposition, the impulse responses are included in Appendix B, and here we only summarize the exercises together with their main results.

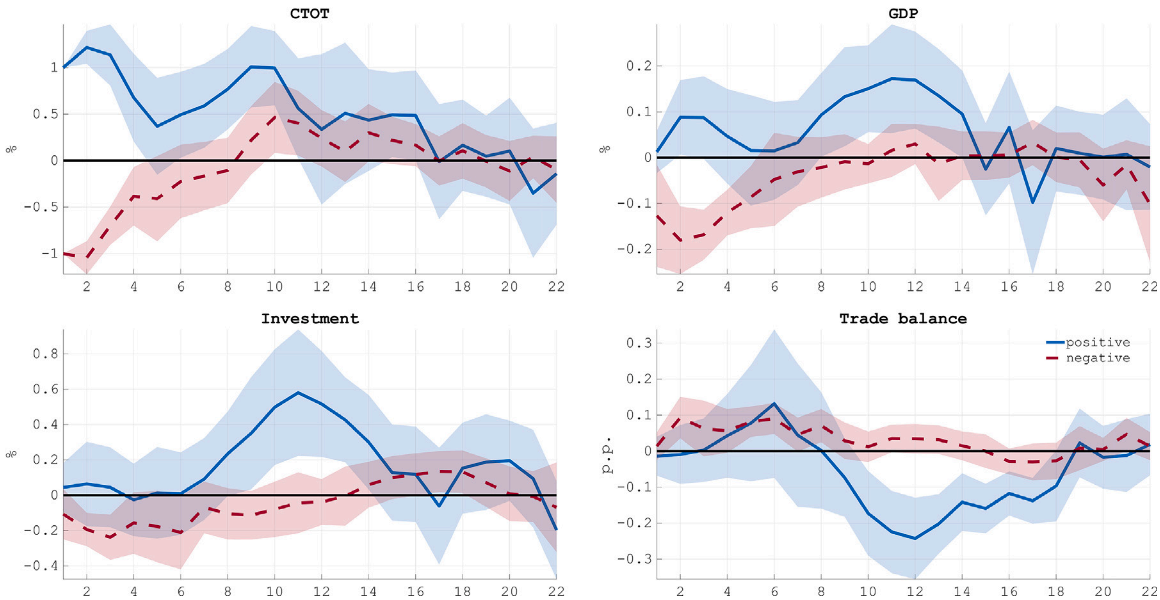

Fig. 8. Sign-dependent IRFs to CTOT shocks - Fiscal deficit - Macroeconomic aggregates.
Note. Estimated Sign-Dependent Impulse Response Functions (IRFs) of Commodity Terms of Trade (CTOT), GDP, Gross Fixed Capital Formation (Investment), and trade balance to output ratio computed using local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a positive (negative) CTOT shock that induces a contemporaneous increase (decrease) of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll and Kraay standard errors. Horizon is in quarters.

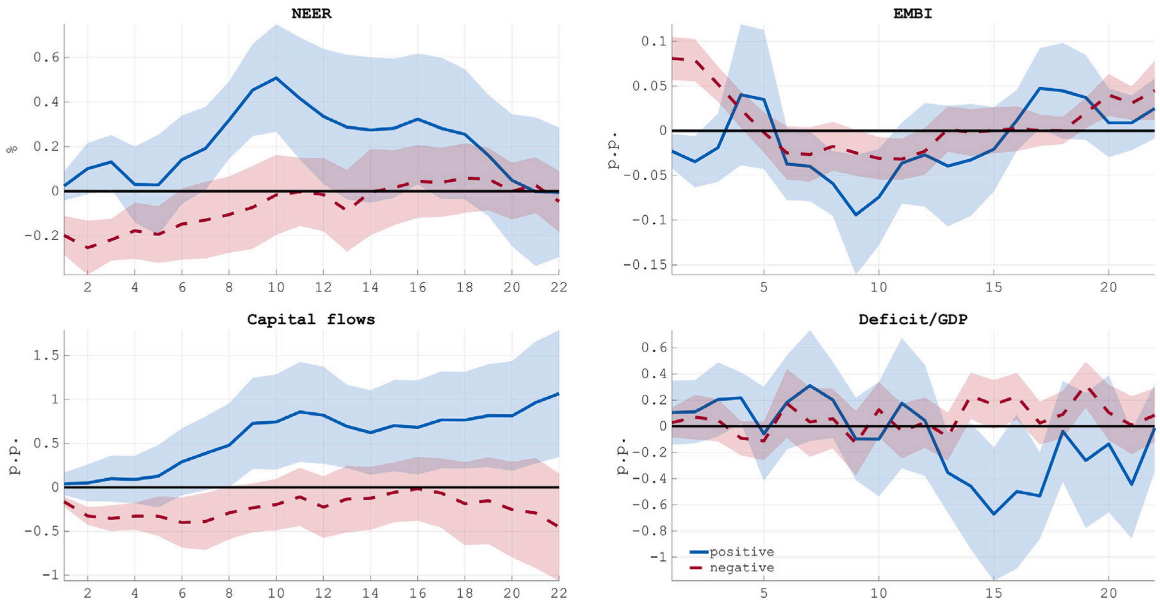

Fig. 9. Sign-dependent IRFs to CTOT shocks - Fiscal deficit - Additional variables.
Note. Estimated Sign-Dependent Impulse Response Functions (IRFs) of Commodity Terms of Trade (CTOT), GDP, Gross Fixed Capital Formation (Investment), and trade balance to output ratio computed using local projections defined in Eq. (4). Continuous blue (dashed red) lines denote the median IRFs in response to a positive (negative) CTOT shock that induces a contemporaneous increase (decrease) of 1% in CTOT. Shaded areas denote 90% confidence bands based on Driscoll–Kraay standard errors. Horizon is in quarters.

5.1. Estimation country by country

Canova (2024) documents that if the units of a panel are dynamically heterogeneous, the local projection estimator is inconsistent. We employ an average time series estimator (Pesaran, 2006; Canova, 2024) to investigate whether this issue may plague our results.

We separately estimate each country's LP Eq. (4).[24] Then, we build a weighted average of the IRFs where the weights are proportional to the precision of the IRFs for each country as typically done in meta-analyses (see, for example, Ben Zeev et al., 2017). Results reported in Figure B.18 and B.19 are qualitatively similar to our baseline pooled estimator, thus suggesting that the countries are sufficiently homogeneous in a dynamic sense.

5.2. Non-oil exporters

The sample of EMEs includes some economies for which oil represents the most important commodity exported (see Table A.2 included in the Appendix). Given the important role of oil in the global economy, the asymmetric responses we document could be driven by oil dynamics. To investigate this further, we estimate the baseline specification (4) for a subset of countries for which oil represents less than 15% of total commodity exports.[25] Figures B.20 and B.21 included in the Appendix display the IRFs to a positive and negative CTOT shocks for this set of countries. The main conclusion remains unchanged: countries that do not rely mainly on oil exports also display an asymmetric response to CTOT shocks.

5.3. Extended sample of EMEs

Our baseline sample considers EMEs for which commodity exports account for at least 10% of their exports. However, it can be the case that non-commodity EME exporters are also affected asymmetrically by CTOT shocks. The asymmetric effect in this case may be explained by the same financial constraints, financial contagion from commodity exports, and the decline in exports to other economies, among other factors. To assess if CTOT shocks induce asymmetric effects in other EMEs, we estimate our baseline specification using an extended sample of 30 EMEs using the same sample period. The only criterion is to have continuous macro data.[26] Figures B.24 and B.25 included in the Appendix display the IRFs to a positive and negative CTOT shock. Negative CTOT shocks also induce a stronger response than positive ones in this extended sample, with the EMBI increasing on impact in response to the negative shock. Unlike the baseline case, we do not find a significant reversal in the trade balance-to-output ratio. This difference can be explained by the fact that these economies are less affected by the shift in commodity prices because they are not commodity exporters. However, the financial channel is predominant and the remaining macro variables display a similar pattern relative to our baseline sample.

Using this extended sample, we also assess if the exchange rate regime matters to explain the asymmetric responses to positive and negative CTOT shocks. We classify economies according to the same exchange rate classification that we use in Section 4.2. Figure B.26 included in the Appendix displays the responses of economies with flexible exchange rate regime to positive and negative CTOT shocks. We still find a stronger and more immediate response to negative CTOT shocks relative to positive ones for economies with flexible exchange rate regimes. Thus, the asymmetric responses are not driven by economies with fixed exchange rate regime. Figure B.27 included in the Appendix displays the responses of economies with fixed exchange rate regime to positive and negative CTOT shocks. While negative CTOT shocks induce a decline in output and investment, positive CTOT shocks do not induce a significant effect. The EMBI also reacts significantly in response to a negative CTOT shock. Overall, the asymmetric response holds for both set of economies but it is more significant for economies with flexible exchange rate regime. The asymmetric responses are not explained by the combination of fixed exchange rate regime and nominal rigidities.

5.4. Estimation with annual data

Previous works have estimated the effects of CTOT shocks using annual data (see, for example, Fernández et al., 2017; Schmitt-Grohé and Uribe, 2018; Drechsel and Tenreyro, 2018; Di Pace et al., 2024b). The advantage of using annual data is that we can cover a longer period for each country and consider more cycles. The disadvantages, relative to our baseline sample, are the lower number of available observations and the potential bias of temporal aggregation of macroeconomic and financial variables on the estimated effect. Moreover, the EMBI series only starts in 1994, so we do not have an alternative index to proxy country spreads, which is a significant transmission channel for these shocks. In order to compare with previous works, we estimate our baseline specification with annual data for the same set of countries but with a longer time span. The estimation is based on an unbalanced panel that spans 1980 to 2019 for the following countries: Argentina, Brazil, Bulgaria, Chile, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Poland, Romania, South Africa, and Ukraine. The difference with respect to the quarterly sample is due to data availability. Instead of using our baseline measure of CTOT, we rely on the country-specific CTOT index computed by Di Pace et al. (2024b). Figure B.28 included in the Appendix displays the IRFs of output, capital flows, and CTOT estimated using annual data. The main conclusions remain unchanged when we consider this specification.

24 We rely on a bivariate specification in this case that includes CTOT and the endogenous variable of interest.

25 This sample comprises: Argentina, Brazil, Chile, Peru, Poland, and South Africa.

26 The sample consists of the baseline sample plus: Bolivia 2012Q4–2019Q4, Costa Rica 2012Q3–2019Q4, Georgia 2003Q1–2019Q4, Croatia 1997Q1–2019Q4, Hungary 1999Q1–2019Q4, India 2012Q4–2019Q4, Lithuania 2009Q4–2019Q4, Latvia 2012Q3–2018Q4, Morocco 2014Q1–2019Q4, Nigeria 2011Q1–2019Q4, Philippines 1995Q1–2020Q1, Paraguay 2013Q1–2019Q4, Serbia 2005Q2–2019Q4, Russia 1997Q4–2019Q4, Slovakia 2013Q3–2019Q4, Thailand 1997Q4–2006Q2, and Turkey 1998Q1–2019Q4. Some countries do not have official national account statistics published at the IMF. In these cases, we rely on alternative data sources.

Extended cross-section. We also consider an exercise in which we rely on the whole cross-section available from Di Pace et al. (2024b).[27] This allows us to extend our results to a broader set of countries. The estimated effects in the response to positive and negative shocks are also asymmetric (see Figure B.30 included in the Appendix).

5.5. *Alternative empirical specifications*

Specification in differences. Our baseline specification defines the dependent variables as cumulated differences while the lagged controls enter in levels. We employ this type of hybrid specification as often done in the literature (see, for example, Juvenal and Petrella, 2024). The baseline results are nonetheless robust if we specify Eq. (4) with the controls expressed in differences as suggested in Piger and Stockwell (2023) (see Figures B.32–B.33 included in the Appendix).

Alternative trend specifications. We include a trend in our LP specification because it typically improves the fit of the model – and consequently the precision of the estimates – by capturing the low-frequency component in the data (see Ramey and Zubairy, 2018). However, our results are broadly unchanged if we include country-specific trends or do not include any trend rather than the common trend in our baseline specification. Appendix B.4 contains the corresponding IRFs.

Sign-dependent regressors. We employ another alternative specification where only our regressor of interest (CTOT) enters as sign-dependent, whereas the set of controls is common. Results from this specification, either with CTOT in growth rates (Figure B.36) or as an AR(4) process (Figure B.37), yield comparable results to the baseline.

Sign versus size asymmetry. Following Caravello and Martinez-Bruera (2024), we compute the size-asymmetric response of our variable of interest to large versus small CTOT shocks to gauge whether the size of the shocks in the positive and negative domain may contaminate the sign asymmetry. We define large shocks as the CTOT growth rates belonging to the first, second, ninth, and tenth quantiles of their distribution. The remaining shocks are labeled as small. Results in Figure B.38–B.39 display a high degree of homogeneity, suggesting that the evidence of size asymmetry is mild. Figures B.40–B.41 display the same results using CTOT shocks as residuals from AR(4) processes that lead to similar conclusions.

Correction for LP estimation. The asymmetry in response to CTOT shocks remains strong and qualitatively similar to the baseline even if we apply the correction method for local projections proposed in Gonçalves et al. (2024) (Figures B.34–B.35). Quantitatively, the asymmetry appears slightly more muted, likely due to the endogeneity of the state (the sign of the shock), although the broad economic conclusions from the analysis are unchanged compared to the baseline. See Alessandri et al. (2023) for a detailed description of the procedure in a similar setup to ours.

6. Conclusion

CTOT shocks are an essential driver of business cycle conditions in EMEs. This paper shows that negative CTOT shocks induce stronger effects on output and investment during the first year coupled with an improvement in the trade balance, a significant increase in country spread, and a drop in capital inflows. Thus, at least qualitatively, the response to a negative CTOT shock is consistent with a *Sudden Stop*. The exchange rate regime and the fiscal response do not explain the asymmetric response to the shocks. These results are consistent with a crucial role for non-linear financial frictions like the occasionally binding borrowing constraints that depend on tradable income (see, for example, Bianchi, 2011).

Policymakers should expect a faster and stronger spillover from faltering – rather than surging – commodity prices to the macro-financial conditions of commodity-exporting EMEs. Taking into account the asymmetry documented in this paper is particularly important in light of the importance of commodity cycles in emerging economies. As the process of real fragmentation underway in the world economy and transition towards a low-emission economy is likely to increase the volatility of commodity prices (Alvarez et al., 2023), shocks that lead the commodity-exporting economy to hit the occasionally binding borrowing constraint they face are likely to become more and more frequent. Given that financial frictions drive the sign-dependent implications of CTOT, optimal policies should consider the importance of this transmission channel. For instance, fiscal rules and sovereign wealth funds related to commodity prices could allow exporters to accumulate a precautionary buffer during booms to smooth the impact of the busts (Eyraud et al., 2023). Analyzing the optimal design of macroeconomic policies and sovereign wealth funds to mitigate the asymmetric effects of CTOT shocks represents a promising area for future research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.euroecorev.2025.105219.

[27] The countries are Argentina, Bangladesh, Bolivia, Brazil, Chile, Colombia, Cote d'Ivoire, Ecuador, Egypt, Ghana, India, Indonesia, Kenya, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, South Africa, Tanzania, Thailand, Turkey, Uruguay, and Venezuela.

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