Terms of Trade Fluctuations and Sudden Stops in A Small Open Economy

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Abstract

We examine how terms-of-trade fluctuations can shape the vulnerability of emerging economies to self-fulfilling financial crises and sudden stops. Building on a small open economy endowment model with importables, exportables, and nontradables, we allow the borrowing constraint to depend explicitly on the relative price of exports. This channel links terms-of-trade movements to the economy's collateral capacity. We find that while terms-of-trade shocks may play a limited role in routine business-cycle dynamics, their importance intensifies under stressed conditions. Favorable terms-of-trade can deter the emergence of multiple equilibria and prevent expectation-driven crises. Our findings contribute to understanding the high relevance associated to the terms-of-trade in emerging economies, even in presence of the limited evidence of their importance as a fundamental driver during normal times.

JEL Codes: E44, F32, F41, F44, G01

Key words: Terms of Trade, Sudden Stops, Multiple Equilibria, Collateral Constraints.

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1 Introduction

The global economy has witnessed how binding financial conditions and sudden stops of capital inflows can push emerging countries into severe downturns. Such episodes are often accompanied by abrupt current account reversals, sharp depreciations of real exchange rates, and a collapse in domestic absorption—hallmarks of financial crises that have been studied in the literature (see Edwards, 2004; Mendoza, 2010; Mendoza and Quadrini, 2010, among others). While the origins of these crises are diverse, a common thread is the presence of credit constraints that can be represented as collateral requirements that link external borrowing capacity to the value of domestic output. In these frameworks, it has been studied recently how adverse outcomes may arise as the result of self-fulfilling crises (Schmitt-Grohé and Uribe, 2021). In that spirit, understanding how some fundamentals can help avert these events remains a central question in international macroeconomics.

In parallel, practitioners and policymakers often emphasize the importance of the terms-of-trade for shaping macroeconomic outcomes. The terms-of-trade represents the relative price of a country's exports in terms of its imports, and improvements in this ratio are frequently associated with enhanced national income and improved external balances. Policy institutions, especially in commodity-exporting emerging economies, regularly highlight terms-of-trade movements as key fundamentals. Yet, the empirical and theoretical evidence on whether their fluctuations indeed play a central role in driving macroeconomic dynamics is mixed. Empirical estimations, such as those in Broda (2004) and Schmitt-Grohé and Uribe (2018), suggest that the contribution of terms-of-trade shocks to explaining output or trade balance fluctuations is present but can be modest. On the other hand, (general equilibrium) models that assume a fully tradable output, such as Mendoza (1995) or Kose (2002), assign a more substantial role to the terms-of-trade. When nontradability is introduced, however, as in Schmitt-Grohé and Uribe (2018), the potency of terms-of-trade shocks in explaining aggregate outcomes recedes —although such result may still vary across country-specific estimates. Thus, while widely believed to matter, the empirical support for terms-of-trade as a dominant driver is ambiguous and context-dependent.[1]

[1] Other studies also elaborate on the complexity of this effect, for example, Fernández, Schmitt-Grohé, and Uribe (2017), and Petrella, Di Pace, and Juvenal (forthcoming) disaggregate the prices within the terms-of-trade —either in terms of main commodity prices, or in terms of separate exports and imports indicators—and find that its format as a single indicator can lead to underestimating its relevance. On the other hand, other works such as Broda (2004) and Jacho, Cruz, and Carrillo-Maldonado (2024) explain how these effects can depend on the exchange rate regime of choice, leading to stronger terms-of-trade-driven fluctuations in pegs.

In this paper, we attempt to bridge these two perspectives: the role of binding financial conditions and the role of the terms-of-trade. We ask whether the terms-of-trade can be critical not as a driver of normal business-cycle fluctuations, but rather as a safeguard against particularly adverse outcomes—situations where financial conditions tighten and give rise to self-fulfilling crisis equilibria resembling sudden stops. In other words, while terms-of-trade shocks may not consistently drive day-to-day macroeconomic dynamics, they might become crucial in preventing the economy from slipping into a bad equilibrium associated with financial crises.

To explore this possibility, we build on the framework of Schmitt-Grohé and Uribe (2021), who consider a small open economy model with tradable and nontradable goods and a collateral constraint tied to the domestic output of these goods. They show that multiple equilibria can arise, including self-fulfilling crisis equilibria that capture the essence of sudden stops. We extend their setup by introducing three categories of goods—importables, exportables, and nontradables (an MXN structure)—and by allowing the collateral constraint to depend on the value of each category. This richer environment highlights that the presence of multiple equilibria is not only related to the output of nontradables, as in the original model, but also interacts with the terms-of-trade. In particular, a sufficiently large deterioration in the terms-of-trade together with weak fundamentals in the nontradable sector—can trigger the emergence of self-fulfilling crisis equilibria.

To anchor the connection between external financial conditions and the terms-of-trade, we begin by considering how terms-of-trade fluctuations comove with various categories of capital flows in a sample of emerging European Union economies. While the overall relationship appears modest, certain types of inflows, such as those associated with foreign direct investment or banking instruments, show more pronounced responses under conditions suggesting heightened financial pressure. This empirical evidence, though not conclusive, hints that the terms-of-trade may become especially pertinent during episodes characterized by constrained external financing, motivating our choice to allow their fluctuations to interact with collateral-driven borrowing limits in the theoretical framework.

By introducing the terms-of-trade into the model with non-tradable goods by allowing separate exportable and importable sectors, new possibilities open that are absent in setups that treat tradables as a single composite good. For example, the collateral constraint, set in terms of the income streams, now includes the terms-of-trade. Thus, changes in the relative price of exportables alter the value of the economy's effective collateral and, by extension, its borrowing capacity. We show that the terms-of-trade can shift the region of the parameter space in which such multiplicities occur (in the steady-state). In other words, a deterioration in terms-of-trade, coupled with low nontradable output, amplifies the risk of bad equilibria characterized by sudden stops. Conversely, we also illustrate how under moderate or strong fundamentals—including relatively stable terms-of-trade dynamics our model admits a unique equilibrium that resembles conventional small open economy dynamics.

Our analysis shows that, for reasonable parameterizations, the terms-of-trade can indeed be an important factor conditioning the existence of multiple equilibria and thus the potential for self-fulfilling crises. While this result echoes the multiplicity findings of Schmitt-Grohé and Uribe (2021), it also emphasizes the terms-of-trade significance in scenarios where financial constraints bind. These relative prices acquire a critical stabilizing (or destabilizing) role under unusual circumstances. This perspective aligns with the idea that terms-of-trade shocks, and their associated external income windfalls or losses, matter most in moments of severe external financing stress—a situation particularly relevant for emerging economies whose terms-of-trade volatility is roughly twice that of developed countries (Baxter and Kouparitsas, 2006).

Our paper contributes to two strands of literature. First, it connects to the body of work investigating the role of terms-of-trade in shaping macroeconomic outcomes. Early studies by Harberger (1950) and Laursen and Metzler (1950) established the notion that improvements in the TOT could boost the current account, setting off a debate known as the Harberger-Laursen-Metzler (HLM) effect (see Svensson and Razin, 1983; Bouakez and Kano, 2008). While some empirical and theoretical analyses support the idea that terms-of-trade improvements strengthen external balances, recent evidence has been more cautious, suggesting a more modest role. Our paper offers a different angle: even if terms-of-trade fluctuations are not always the prime mover of ordinary cycles, they may be crucial in off-equilibrium scenarios associated with financial fragility.

Second, our paper relates to a growing literature using MXN frameworks. The inclusion of importable, exportable, and nontradable goods, initially proposed in simpler contexts by Komiya (1967), allows for richer cross-price elasticities and a more nuanced understanding of how external shocks and financial constraints interact. Schmitt-Grohé and Uribe (2018) apply an MXN structure to show that allowing for a reasonable extent of nontradability can reduce the explanatory power of terms-of-trade shocks. Teresiński (2019) extends an MXN model to assess the impact of terms-of-trade improvements on future productivity growth, while Contreras (2023) studies how global financial risk affects economies specialized in different types of commodities. By combining the MXN setting with collateral constraints, we highlight that terms-of-trade movements and sectoral composition matter not just for standard cyclical dynamics, but for the possibility of detrimental, self-fulfilling downturns.

On the policy side, our findings suggest that monitoring the terms-of-trade could be valuable for understanding vulnerability to financial crises. When fundamentals weaken—due to terms-of-trade deteriorations or declining nontradable output—the probability of landing in a bad equilibrium featuring sudden stops and current account reversals rises. Managing terms-of-trade volatility may therefore have indirect benefits in mitigating the risk of falling into crisis equilibria. In addition, our results complement insights from related work such as Bianchi (2011), which emphasizes overborrowing and pecuniary externalities. Unlike this study, we find that under certain conditions, multiple equilibria can lead to less, rather than more, borrowing, reflecting the results found in Bianchi and Coulibaly (2023) which also examines a scenario in which multiplicity of equilibria can lead to deleveraging. Importantly, by focusing on how terms-of-trade shocks interact with financial constraints, we shed new light on conditions under which fear of floating or other policy measures designed to stabilize external conditions might find additional rationale.

The remainder of this paper is structured as follows. Section 2 provides an initial empirical exploration of how terms-of-trade fluctuations relate to financial conditions and capital flows, offering preliminary evidence that motivates our theoretical exercise. Section 3 presents the baseline MXN model with a modified collateral constraint. Section 4 characterizes the steady-state equilibrium, and Section 5 explores the existence of self-fulfilling crisis equilibria. Section 6 then examines the model's stochastic dynamics, assessing how terms-of-trade shocks and endowment variations affect equilibrium selection and the risk of sudden stops. Finally, Section 7 concludes.

2 The Role of Terms of Trade in Shaping Financial Conditions

We can start by examining the relevance of the terms-of-trade in influencing macroeconomic and financial conditions in emerging economies. We focus on capital flows as a proxy for financial conditions, motivated by established links between current account reversals, sudden stops, and binding financial constraints (Edwards, 2004; Mendoza, 2010; Mendoza and Quadrini, 2010).

Our objective is to ascertain whether fluctuations in the terms-of-trade matter for capital flows and, thus, indirectly for financial conditions. While theory often predicts that improvements in terms-of-trade—particularly in economies reliant on exports—should stimulate capital inflows by enhancing growth prospects and investor confidence, the empirical relationship is far from trivial. For example Aslam et al. (2016) finds that among commodity exporters, decreases in commodity prices were associated with higher increases in net capital inflows than increases in commodity prices. Several offsetting mechanisms may dampen or even overturn the expected positive effect. For instance, higher terms-of-trade may reduce a country's need for external financing (thus lowering inflows) or increase domestic wealth to the point that local investors seek opportunities abroad, reducing net inflows. In addition, higher terms-of-trade stemming primarily from rising export prices may erode international competitiveness, and any initial positive impact on inflows could be tempered.

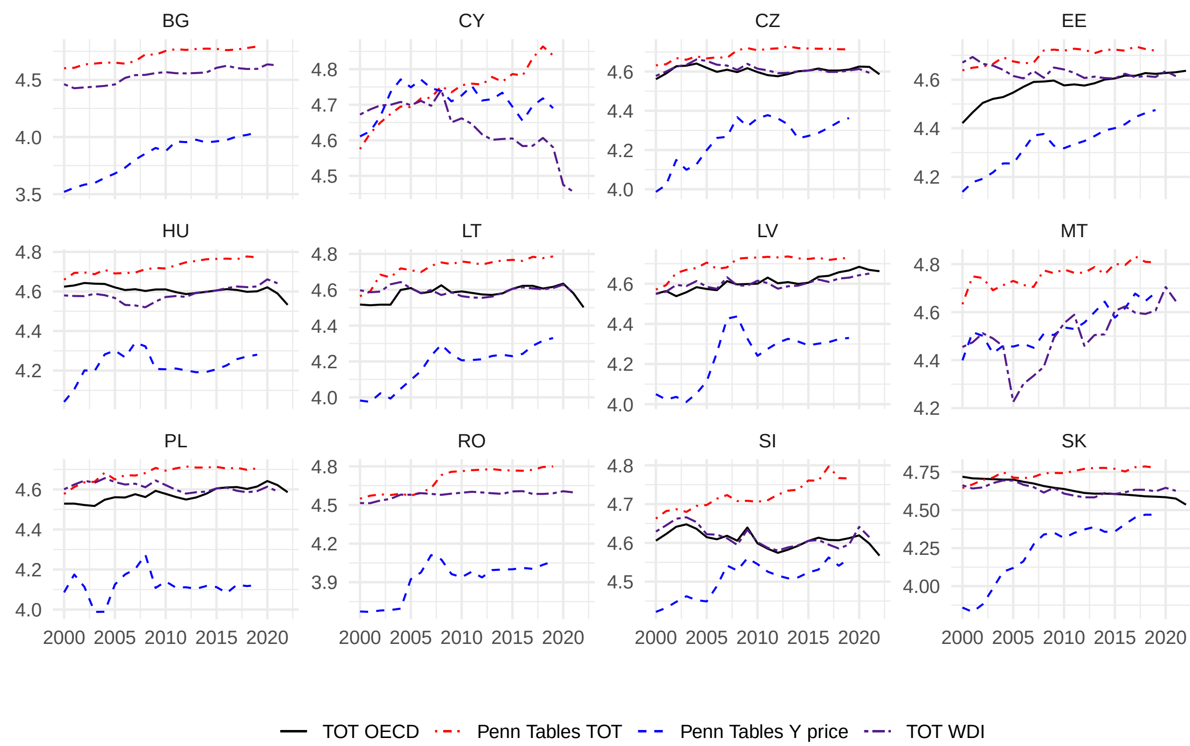
On the other hand, if the HLM effect holds and the improvements in the terms-of-trade are followed by trade balance and current account increases, then, by definition within the balance of payments (and the double-entry accounting principle), it is possible to see a countervailing negative effect on components of the capital account, including the capital (investment) flows. This clearly may change with different exchange rate regimes, but if something, it only makes the relationship between capital flows and terms-of-trade more complex than one might think (even in emerging markets).

2.1 Data and Empirical Strategy

Terms of Trade Measures We consider a sample of 12 emerging European Union (EU) member countries—Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia—most of which joined the EU during the 2000s.[2] Our choice of these countries aims to enhance comparability in TOT indicators, which are based on aggregate price indexes rather than on individual goods-specific comparable prices.

[2]These countries are often grouped together as emerging European economies. Due to data availability constraints, our final sample covers the period 1999–2024, or until the last year for which we have TOT data.

Figure 1: Compared Terms of Trade



Note: Comparison of Selected Terms of Trade Measures (log scale) across Countries. The figure shows the terms-of-trade as reported by the OECD and measures constructed using indicators from the Penn Tables 10.0. The first measure (Penn Tables TOT) takes the ratio of the price of exports over the price of imports. The second measure (Penn Tables TOT py) consists of the ratio between the price of output of each country and a population-weighted average of the price of output of the EU27 group.

Obtaining suitable terms-of-trade data for emerging economies is challenging. In principle, due to different availability and potentially limited comparability of the prices across countries, considering we are dealing with aggregate price indexes. To deal with the potential issues involved, we will consider several data sources, each with their relative merits. We will consider TOT indexes reported by the OECD, and by the World Bank (World Development Indicators). In addition, and to broaden our coverage, we construct two alternative terms-of-trade measures based on information from the Penn Tables 10.0. The first uses the ratio of export-to-import prices (p_x/p_m), while the second follows Berka, Devereux, and Engel (2018) and employs relative output prices (p/p^*). Although these measures differ in coverage, frequency, assumptions, and data availability (Penn Tables data typically end in 2019), using them in tandem allows us to test the robustness of our findings. Figure 1 presents the resulting indicators.

A first noticeable feature we can see in Figure 1 is that these terms-of-trade indicators do not always comove closely, reflecting that each measure captures different facets of price dynamics, product baskets, and international competitiveness. In light of these differences, we report results for all TOT measures rather than relying on a single indicator.

Capital Flows We use annual capital flow data from the IMF-IFS database. We consider total flows as well as several subcomponents, including foreign direct investment (FDI), portfolio flows, other investments (mostly related to banking), and derivatives. When possible, we disaggregate these flows into equity and debt components. All flows are expressed as a percentage of GDP (scaled by 100). To capture the complexity of capital movements in emerging economies, where outflows are no longer negligible and original sin constraints have eased (Kalemli-Özcan, 2019), we examine three formats for each flow: gross inflows, gross outflows, and net inflows. This approach increases the granularity of our analysis and helps to ensure that we are not masking significant effects by aggregating flows with conflicting dynamics (or drivers).

Additional Controls We include several controls to isolate the effect of terms-of-trade fluctuations from other macro-financial dynamics. These controls encompass the 10-year bond yield spread relative to the EU27 average (from ECB data), which serves as a proxy for financing conditions and country-specific risk; the annual GDP growth rate and exchange rate depreciation (both from IMF-IFS); and CPI inflation (from Eurostat). All these rates are included in the panel as percentage points. Finally, we include time fixed effects, which play the same role as global controls. By including these controls, we better account for potentially confounding domestic and global factors that may comove with the terms-of-trade effects.

2.2 Empirical Specification

We estimate a panel model with country and time fixed effects as the following:

$$y_{i,t} = \alpha + \beta_1 \log(TOT_{i,t}) + \delta X_{i,t} + \mu_i + \gamma_t + \epsilon_{i,t}, \tag{1}$$

where $y_{i,t}$ represents one of the capital flow measures for country i in year t, and $TOT_{i,t}$ is one of our terms-of-trade measures. The vector $X_{i,t}$ includes the interest rate spread, exchange rate depreciation, GDP growth, and inflation. The country fixed effects (μ_i) control for unobserved time-invariant heterogeneity, while time fixed effects (γ_t) account for common global shocks. This setup allows us to identify whether terms-of-trade movements matter for capital flows once we control for other local and global factors. Given the structure of our data, we estimate one panel for every flow and terms-of-trade measure combination. Depending on the availability of the terms-of-trade measure considered, our estimation sample begins in 1999 or 2000 and ends in 2019, 2021 or 2022.

In Table 1, we report the selected regressions where the terms-of-trade coefficient is significant. Across all terms-of-trade measures considered, there are capital flow components that react significantly to the terms-of-trade variations. The typical response is positive, which aligns with the notion that improved terms-of-trade can enhance growth prospects and reduce perceived external vulnerabilities (Broda, 2004). Notably, FDI net inflows (including equity components) respond positively to terms-of-trade improvements, as do some banking-related inflows. The responses for these financially oriented flows, while generally smaller, suggest that terms-of-trade becomes more relevant under conditions approaching financial stress—precisely when binding constraints matter most. Under normal conditions, terms-of-trade may not be a key driver of most capital flows, but during episodes where financial frictions are binding, its role may become more pronounced.

We also consider specifications that interact the terms-of-trade variable with the interest rate spread. The interest rate spread is generally positively associated with inflows, as predicted by standard uncovered interest parity logic, where higher yields attract foreign investors. However, for some flows (e.g., derivatives, banking, and FDI), the interaction terms with the terms-of-trade are negative. This indicates that improvements in the relative price of exports can mitigate the sensitivity of certain capital flows to changes in interest rates. In other words, a favorable terms-of-trade position may confer a form of resilience, partially dampening the transmission of external financial shocks to domestic flows.

Table 1: Selected Regression Results: Significant TOT Effects on Capital Flows

TOT Measure	Flows	Coefficient	p-value
TOT OECD			
	Banking equity inflows	0.002*	0.071
	Derivatives inflows	0.276**	0.017
	Derivatives outflows	0.298***	0.005
	FDI net inflows	9.74**	0.017
	FDI equity net inflows	8.614*	0.060
	(inter) Derivative inflows	-0.063***	0.006
	(inter) Derivative outflows	-0.073***	0.001
Penn Tables 1: p_x/p_m			
	Portfolio inflows	2.754*	0.079
	Portfolio debt inflows	2.001*	0.080
	Banking equity net inflows	0.009*	0.089
	(inter) Derivatives net inflows	-0.039*	0.090
Penn Tables 2: p/p^*			
	(inter) Banking equity outflows	0.001*	0.066
	(inter) FDI equity net inflows	-0.292*	0.089
	(inter) Banking equity net inflows	-0.001**	0.045
	(inter) Derivatives net inflows	-0.007*	0.056
TOT WDI			
	FDI debt inflows	1.686**	0.035
	Derivatives inflows	0.137***	0.001
	FDI equity outflows	2.685**	0.043
	Derivatives net inflows	0.065*	0.069

Notes: The table shows the significant coefficients of regressions for different classifications of capital flows, and different measures of the terms of trade (TOT) based on equation (1). Results for an alternative model where the interaction between the credit spread and TOT are also shown and indicated in the flows column as "(inter) flow." * p<0.10, ** p<0.05, *** p<0.01. Standard errors and p-values are calculated using a panel corrected standard errors method as in Beck and Katz (1995)

While these results are indicative rather than definitive, they show that the terms-of-trade can become relevant during times when financial constraints bind more tightly. During normal conditions, they role may be limited, aligning with studies that downplay its role as a central driver of the business cycle. However, in more turbulent episodes, favorable terms-of-trade conditions may help prevent multiple equilibria or severe current account reversals. In the following section, we offer a theoretical framework that rationalizes these empirical findings, illustrating how terms-of-trade shocks can modulate vulnerability to external financial shocks when constraints are occasionally binding.

Additional Evidence from Defaulted Debt: While capital flows serve as a useful proxy for assessing the role of terms-of-trade in financial conditions, they may not fully capture rare but severe forms of distress. Ideally, we would examine more direct measures of acute financial turmoil, such as episodes of default. However, data on defaulted debt are limited and sporadic. Despite these limitations and to have an alternative perspective, we re-estimate our panel models using the log-change in defaulted debt as the dependent variable, incorporating capital flows as controls. These results, presented in Appendix A, are tentative due to the sparse coverage and low frequency of default events.

In this case, we also find suggestive evidence that terms-of-trade improvements coincide with reduced financial strain. In particular, the terms-of-trade measure constructed from the Penn Tables and related to final production goods (following Berka et al., 2018) is associated with declines in defaulted debt. Although these findings must be interpreted with caution, they reinforce the notion that the terms-of-trade can become relevant when financial conditions deteriorate.

3 The Model

Consider a small open economy where the representative household maximizes expected lifetime utility according to preferences of the form:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t) \tag{2}$$

Here $U()$ is an increasing and concave period utility function following a CRRA form given by $U(c) = (c^{1-\sigma} - 1)/(1-\sigma)$, where $\sigma > 0$. β is the subjective discount factor, and $\mathbb{E}_t$ is the expectation operator where the subscript t denotes the time period of the information set that the expectation operator depends upon. Finally, c_t is consumption, which is a composite of importable, exportable, and nontradable goods in the following nested Constant Elasticity of Substitution Function form:

$$
\begin{aligned}
c_t = A\left(B(c_t^M, c_t^X), c_t^N\right) \equiv \left(a(B(c_t^M, c_t^X))^{1-\frac{1}{\xi_{TN}}} + (1-a)(c_t^N)^{1-\frac{1}{\xi_{TN}}}\right)^{1/(1-\frac{1}{\xi_{TN}})} \\
B(c_t^M, c_t^X) = \left(b(c_t^M)^{1-\frac{1}{\xi_{MX}}} + (1-b)(c_t^X)^{1-\frac{1}{\xi_{MX}}}\right)^{1/(1-\frac{1}{\xi_{MX}})}
\end{aligned}
\tag{3}
$$

In this setup, ξ_{MX} and ξ_{TN} represent the elasticity of substitution between importable and exportable goods and the tradable composite good and nontradable goods respectively. Further, b denotes the expenditure share on importable goods if $\xi_{MX} = 1$ and a denotes the expenditure share on exportables if $\xi_{TN} = 1$. Finally, the output of the function $B(c_t^M, c_t^X)$ can be thought of as a intermediate composite traded good, i.e. $B(c_t^M, c_t^X) = c_t^T$.

Consumers maximizing lifetime utility are subject to two constraints. The first constraint is a typical Budget Constraint, in which debt is denominated in the price of importable goods:

$$
c_t^M + p_t^X c_t^X + p_t^N c_t^N + d_t = y_t^M + p_t^X y_t^X + p_t^N y_t^N + \frac{d_{t+1}}{1+r} \tag{4}
$$

Here, d_t denotes the amount of debt due in period t and d_{t+1} denotes the amount of debt that is assumed in period t and is due in period $t+1$. Note also that because all prices are relative to the price of importable goods, the p_t^X term represents the terms of trade.

Consumers are also subject to a collateral constraint taking the following form:

$$
d_{t+1} \leq \kappa(y_t^M + p_t^X y_t^X + p_t^N y_t^N) \tag{5}
$$

Here $\kappa > 0$ is a parameter that limits the amount of borrowing to a fraction of the value of the output of the economy.

Key to note here is that since the collateral constraint includes the relative price of nontradables p_t^N, this allows for certain parameterizations of the model to create a constraint that tightens when agents reduce their level of debt from one period to the next, even though on an individual level the constraint loosens as the debt level decreases. This feature of the model is investigated in Section 4.

The households will maximize (2) subject to (3), (4), and (5) holding in each period. The First Order Conditions of this problem can be expressed as the following (the Lagrange Multipliers are denoted $\beta\lambda_t$ and $\beta\lambda_t\mu_t$ respectively for the budget and collateral constraints, and the choice variables are c_t^M, c_t^X, c_t^N, d_{t+1}). In this way a competitive equilibrium is defined as a set of processes c_t^M, c_t^X, d_{t+1}, and μ_t that, given the exogenous processes p_t^X and y_t^N and the initial condition d_0, satisfy the following equations:

$$U'(A(B(c_t^M, c_t^X), c_t^N)) \cdot A_1(B(c_t^M, c_t^X), c_t^N) \cdot B_1(c_t^M, c_t^X) = \lambda_t \tag{6}$$

$$c_T^X = \left(\frac{1-b}{b}\right)^{\xi_{MX}} \cdot (p_t^X)^{-\xi_{MX}} \cdot c_t^M \tag{7}$$

$$p_t^N = \frac{1-a}{a}\left(\frac{B(c_t^M, c_t^X)}{c_t^N}\right)^{\frac{1}{\xi_{TN}}} = \frac{1-a}{a}\left(\frac{c_t^T}{c_t^N}\right)^{\frac{1}{\xi_{TN}}} \tag{8}$$

$$\left(\frac{1}{1+r} - \mu_t\right)\lambda_t = \beta\mathbb{E}_t\lambda_{t+1} \tag{9}$$

$$\mu_t \geq 0 \tag{10}$$

$$\mu_t\left[d_{t+1} - \kappa(y_t^M + p_t^X y_t^X + p_t^N y_t^N)\right] = 0 \tag{11}$$

Equation (7) gives the optimal ratio of the 2 choices of tradable consumption, with p_t^X being the terms of trade, b being the share parameter on importable goods in the CES aggregator between importables and exportables, and ξ_{MX} being the elasticity of substitution of importables and exportables. Meanwhile, equation (8) gives the endogenously determined price of nontradeables based on the ratio of tradable composite good consumption to nontradable consumption, the share parameter a, and the elasticity of substitution parameter ξ_{TN}.

The market for nontradables must clear in equilibrium so $c_t^N = y_t^N$, and using this along with equation (6) we can rewrite the budget constraint as:

$$c_t^M = \frac{y_t^M + y_t^T p_t^X + d_{t+1}/(1+r) - d_t}{1 + \left(p_t^X\right)^{1-\xi_{MX}}\left(\frac{1-b}{b}\right)^{\xi_{MX}}}$$

Likewise for c_t^X,

$$c_t^X = \frac{y_t^M + y_t^T p_t^X + d_{t+1}/(1+r) - d_t}{p_t^X + (p_t^X)^{\xi_{MX}} \left(\frac{1-b}{b}\right)^{-\xi_{MX}}}$$

These expressions can then be rearranged based on the definition of $B(\cdot)$ to obtain an expression for the consumption of the tradable composite good as a function of parameters, endowments (exogenously given), the terms of trade (p_t^X), and the change in debt. Note that there is only one choice variable here, d_{t+1}, that c_t^T is dependent on, since we have solved for the optimal level of importable and exportable consumption.

$$c_t^T = \left(b \left(\frac{y_t^M + y_t^X p_t^X + d_{t+1}/(1+r) - d_t}{1 + (p_t^X)^{1-\xi_{MX}} \left(\frac{1-b}{b}\right)^{\xi_{MX}}} \right)^{1-\frac{1}{\xi_{MX}}} + \right.$$

$$\left. (1-b) \left(\frac{y_t^M + y_t^X p_t^X + d_{t+1}/(1+r) - d_t}{p_t^X + (p_t^X)^{\xi_{MX}} \left(\frac{1-b}{b}\right)^{-\xi_{MX}}} \right)^{1-\frac{1}{\xi_{MX}}} \right)^{1/\left(1-\frac{1}{\xi_{MX}}\right)}$$

To simplify and explore further this environment analytically, we can consider the case of a unitary elasticity of substitution between importables and exportables ($\xi_{MX} = 1$) so that the function $B(\cdot)$ takes on the following Cobb-Douglas form: $B(c_t^M, c_t^X) = (c_t^M)^b (c_t^X)^{(1-b)}$.

In that case, we can characterize the relationship of the price of non-tradables (p^N) —and thus, of the collateral constraint— with the rest of the fundamentals in the model. For this, we can begin by rewriting equation (7), that is, the consumption of exportables for this simpler case as follows:

$$c_T^X = \left(\frac{1-b}{b}\right) \cdot \frac{1}{p_t^X} \cdot c_t^M$$

We simplify further by fixing the endowments of importables and exportables so that $y_t^M = y^M$ and $y_t^X = y^X$. This is done to make more feasible the simulation of the economy with a discretized state space in section 6.[3] With these assumptions, the equation for consumption of the tradable

[3]In making this assumption we do not lose the ability to gain insights about how changing the endowments of importables and exportables could affect the vulnerability of the economy to self-fulfilling crises as it is shown in section 5.

composite good can be expressed as:

$$c_t^T = b\left(y^M + p_t^X y^X + \frac{d_{t+1}}{1+r} - d_t\right)^b \cdot \frac{1-b}{p_t^X}\left(y^M + p_t^X y^X + \frac{d_{t+1}}{1+r} - d_t\right)^{1-b}$$

Now, using the equation for p_t^N and substituting the market clearing condition for the non-tradable goods market ($c_t^N = y_t^N$) we can get:

$$p_t^N = \frac{1-a}{a}\left(\frac{\left(b(y^M + p_t^X y^X + \frac{d_{t+1}}{1+r} - d_t)^b \cdot \frac{1-b}{p_t^X}(y^M + p_t^X y^X + \frac{d_{t+1}}{1+r} - d_t)^{1-b}\right)}{y_t^N}\right)^{\frac{1}{\xi_{TN}}}$$

Which we can use to rewrite the collateral constraint as:

$$d_{t+1} \leq \kappa\left(y^M + p_t^X y^X + \frac{1-a}{a} \cdot \left(\frac{(1-b)\, b \cdot \left(y^M + p_t^X y^X + \frac{d_{t+1}}{1+r} - d_t\right)}{y_t^N p_t^X}\right)^{\frac{1}{\xi_{TN}}} y_t^N\right) \tag{12}$$

This result of equation (12) is similar to the one obtained in Schmitt-Grohé and Uribe (2021) but with the key difference that the value of collateral now is explicitly dependent on the terms of trade (relative price of exports p_t^X) —and in fact will increase with this price for our baseline calibration. Note also that depending on the the values of the parameters, an improvement in the terms of trade could increase or decrease the level of debt for which the collateral constraint becomes binding. On the other hand, this expression retains important features with respect to its analog version in a model without terms of trade, namely, d_{t+1} is in the left hand side of the constraint but is also seen in the numerator of the right hand side, meaning that the limit of debt that we can borrow in the next period increases in this debt choice itself. As a consequence, this expression does not represent a solution for the debt choice (when binding), but we still can explore the equilibria implications of the value of collateral when depicting the debt choice as a fixed point. This is done in section 5.

4 Steady State Equilibria

A steady state equilibria in this model is defined as an equilibrium where, for a given initial level of debt d_0, consumption and the level of debt remain constant such that $c_t = c_0$ and $d_t = d_0$ for all $t \geq 0$. For this section we will also assume that the price of exportables and the endowment of nontradables is constant, that is, this corresponds to an exploration of the deterministic steady state. This assumption will be relaxed in section 6, but for now it is made to allow for a simple definition of the steady state equilibrium as one in which the consumers choice variables do not change across time periods. With an unchanged debt level the steady state collateral constraint can be expressed as the following:

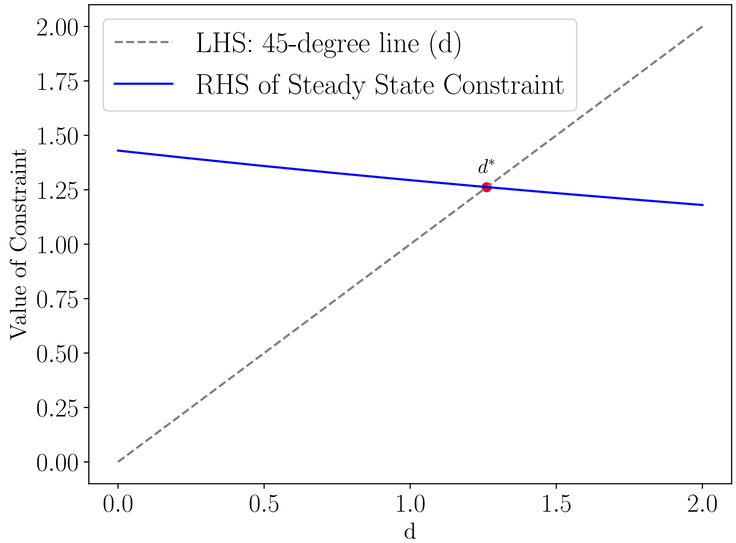
$$d \leq \kappa \left(y^M + p^X y^X + \frac{1-a}{a} \cdot \left(\frac{(1-b)\, b \cdot \left(y^M + p^X y^X - \frac{rd}{1+r} \right)}{y^N p^X} \right)^{\frac{1}{\xi_{TN}}} y^N \right)$$

The collateral constraint is well behaved for steady state levels of debt, as the right hand side of the equation is decreasing in the steady state level of debt, so as the steady state level of debt increases the constraint tightens (gets closer to holding with equality). We define the level of debt that allows the constraint to hold with equality as d^*, such that:

$$d^* = \kappa \left(y^M + p^X y^X + \frac{1-a}{a} \cdot \left(\frac{(1-b)\, b \cdot \left(y^M + p^X y^X - \frac{rd^*}{1+r} \right)}{y^N p^X} \right)^{\frac{1}{\xi_{TN}}} y^N \right) \tag{13}$$

Figure 2 compares on the y-axis the value of the Left hand side of the collateral constraint to the value of the right hand side of the collateral constraint for given levels of debt. As the Figure illustrates, these two functions intersect at a point d^* where the constraint holds with equality. For any steady state level of debt below d^*, the collateral constraint is not binding, as the value of right hand side of the constraint is greater than the value of the left hand side. For any level of debt above d^*, the constraint is violated and therefore is not a valid steady state, since agents would have to deleverage in the following period. If agents are forced to deleverage, then the definition of a steady state is not met, since in the steady state $d_t = d_0$ for all $t \geq 0$. We solve numerically for the value of d^* and obtain that $d^* = 0.907$ for a set of parameters partly borrowed from Schmitt-Grohé and Uribe (2021) and given by $\kappa = 0.33, a = 0.25, b = 0.5, y^M = 1, y^X = 1, p^X = 1, r = 0.04, y^N = 1, \xi_{TN} = 0.5$ and $\xi_{MN} = 1$.

Figure 2: Feasible debt levels in the Steady State



Note: This figure shows the value of the left and right-hand-side of the collateral constraint for the given parameterization for a range of debt levels. The point of equality d^* then represents the highest possible level of debt consistent with a steady state equilibrium.

5 Self-Fulfilling Crises

We now characterize the conditions under which multiple equilibria can coexist with the steady state equilbria. In these alternative equilibria, the period-0 collateral constraint plays an important role, and is defined as follows:

$$d_1 \leq \kappa \left(y^M + p^X y^X + \frac{1-a}{a} \cdot \left(\frac{(1-b)\, b \cdot \left(y^M + p^X y^X + \frac{d_1}{1+r} - d_0 \right)}{y^N p^X} \right)^{\frac{1}{\xi_{TN}}} y^N \right) \tag{14}$$

This constraint can become binding if agents, for reasons not fundamental to the model, decide to cut consumption (by selling more exportables and importing less importables) and deleverage. This contraction in importable and exportable consumption reduces the price of nontradables, and through this mechanism the collateral constraint can become binding when the representative household reduces their level of borrowing in period-0 (which determines d_1). The crisis is called self-fulfilling in this case, since the negative sentiments of the households which caused them to deleverage are validated by the collateral constraint becoming binding.

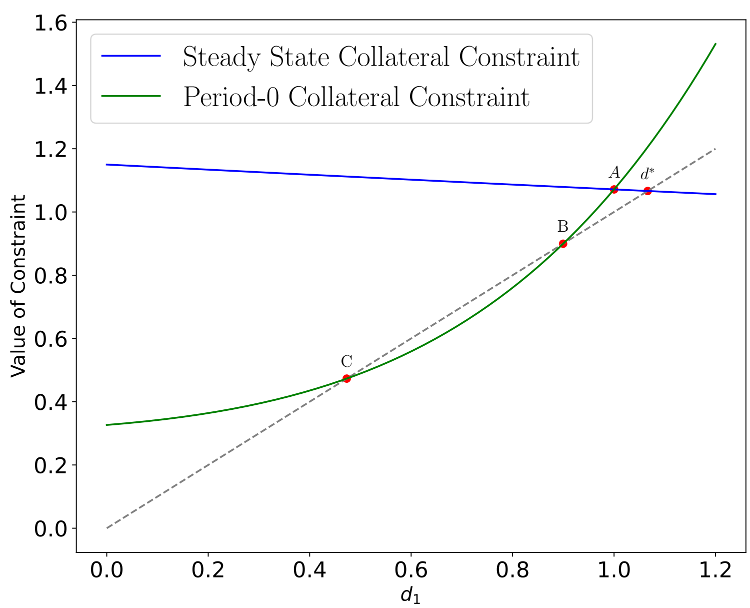
The slope with respect to the period-1 level of debt for the right hand side of the period-0 constraint in this case is then given by:

$$S = \kappa \frac{1-a}{a} \frac{(1-b)b}{(1+r)} \frac{1}{\xi_{TN}} \frac{1}{y^N p^X} \cdot \left(\frac{(1-b)b \cdot (y^M + p_t^X y^X + \frac{d_1}{(1+r)} - d_0)}{p^X y^N} \right)^{\frac{1-\xi_{TN}}{\xi_{TN}}} \tag{15}$$

From this, we have that the right hand side of the period-0 collateral constraint is increasing with respect to d_1 for any given value of d_0. This gives rise to the possibility of self-fulfilling crisis equilbria if, for a given level of debt d_0 below d^*, the slope of the period-0 collateral constraint is greater than 1. This phenomenon is best visualized in Figure 3.

In Figure 3 the x-axis represents the level of debt in the next period, while the y-axis represents the associated value taken on by the right-hand-side of either the collateral constraint in the initial period or in the steady-state. As before, the blue downward sloping line represents the right hand side of the steady state collateral constraint, which is decreasing in debt. The 45 degree line represents the left hand side of both the steady state and the period-0 constraint. The upward sloping green line represents the right hand side of the period-0 constraint, which as shown before is increasing in period-1 debt levels.

Figure 3: Period-0 Constraint and Multiplicity of Equilibria

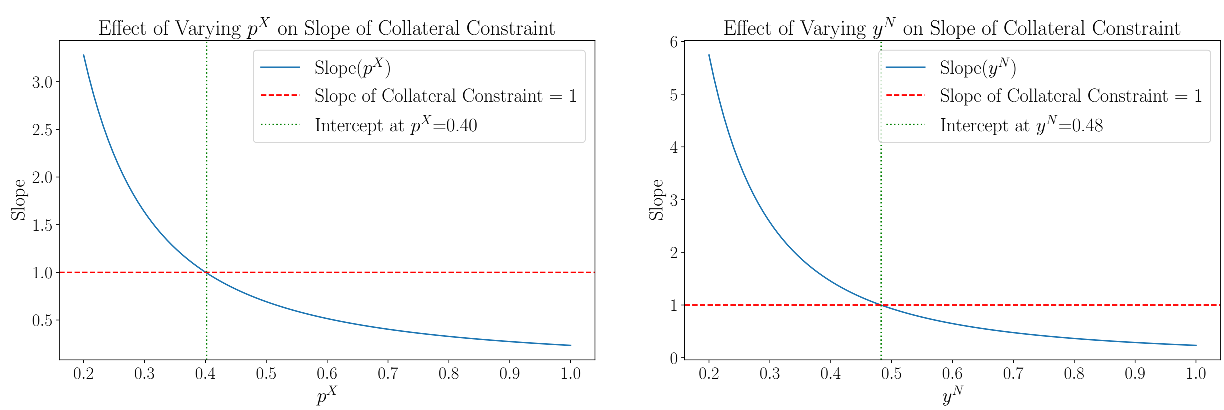


Note: This figure depicts combinations of values of debt and associated constraints for which the self-fulfilling crisis equilibria emerges. The green upward curve is the right-hand-side of the period-0 constraint, the blue downward line is the right-hand-side of the collateral constraint.

If the slope of the green line for a given level of debt d_0 is greater than 1 for a level of debt sufficiently close to d^* there will be a point of intersection between the 45-degree line and the period-0 constraint, representing a self-fulfilling crisis equilibrium in which the collateral constraint is binding at a lower level of debt. In fact, there can be multiple self-fulfilling crisis equilibria due to the convexity of the period-0 constraint.[4] Points of type C occur when the slope of the period-0 constraint decreases below 1 and intersects the 45-degree line again at a lower level of debt than points of type B.

More specifically, a sufficient condition for self-fulfilling crisis equilibria to exist is that the slope of the collateral constraint with respect to d_1 is greater than 1 when the initial debt level d_0 is equal to d^*. To understand this, consider a value of debt $d^* - d'$ slightly lower than d^* for which the collateral constraint is not binding. By continuity, the period-0 constraint must cross the 45-degree representing the left hand side of the constraint for levels of d' small enough. These intersection points have lower levels of debt and feature a binding constraint for one period making them imply an extent of deleveraging, thus rendering them invalid as steady state equilibria. These are denoted as self-fulfilling crisis equilibria.

Figure 4: Slope of the collateral constraint when $d = d^*$ for ranges of p^X (left) and y^N (right).



Note: These figures show the slope of the collateral constraints as a function of a changing parameter, leaving the rest constant. On the left panel we allow p^X to change, on the right panel y^N is changing. The left panel shows how a strong deterioration of the terms-of-trade facilitates a self-fulfilling crisis —the slope of the period-0 constraint becomes greater than 1.

With this in mind, for any given parameterization and values for state variables, we can calculate the slope of the collateral constraint at the value of d^*, first by solving implicitly for the value of

[4]This convexity is a result of the assumption that $\xi_{TN} \in (0, 1)$

d^* for the given parameters, then using this value along with the parameter values to calculate the slope of the period-0 constraint. For the baseline parameterization mentioned before, the value of the slope with respect to d_1 is 0.236. This result differs significantly from the result obtained in Schmitt-Grohé and Uribe (2021), where the slope of the baseline parameterization where $\xi_{TN} = 0.5$ was 1.37.

To explore this further, we compare the impact of changes in the terms of trade trade (p^X) and the endowments of non-tradable goods (y^N) on the slope of the collateral constraint. These variables have been the focus of significant debate in the literature, with many arguing for their importance to emerging economies such as Kose (2002) and Broda and Tille (2003) and inspecting the former is helpful in understanding the role of the TOT in emerging economies for the eventual transition to multiple equilibria outcomes —which as we indicate in Section 6 can be indicative of sudden stops episodes. On the other hand, in the following section we also explore stochastic changes in these variables in a setup where they can be correlated. The results of the comparative static changes (one variable at a time) are shown in the figure 4, where we display the slope for different variables a selected variable, and show the value of the slope at the baseline variable value (red, dashed line) as a comparison. We can see that the slope decreases in both p^X and p^N, and is greater than one for $p^X < 0.4$ and values of $y^N < 0.48$. This echoes the result of Schmitt-Grohé and Uribe (2021), that self-fulfilling crises emerge in the context of poor economic fundamentals, and importantly, given this study includes p^X as a fundamental, that strong TOT (or improvements in them) can have a role in avoiding dynamics leading to multiple equilibria.[5]

6 Multiple Equilibria in the Presence of Uncertainty

So far the analysis of the model has focused on terms of trade and endowments that remain constant. In this section we relax these assumptions and allow for stochastic changes in the terms of trade p_t^X and the endowment of nontradable goods y_t^N. Furthermore we consider the case that these two variables are potentially correlated. For simplicity, the other features of the model are left unchanged.

The following AR(1) process, derived from terms of trade data from the World Bank World

[5]The relationship between the slope and its other components are shown in the Figure 7 in Appendix B where we can see that the slope of the period-0 constraint with respect to d_1 is increasing in y^M, y^X, and κ, decreasing in a, and for b and ξ_{TN} the slope value reaches its peak at 0.5 and 0.7 respectively for the baseline parameterization.

Development Indicators database (WDI) and sectoral level data from Eurostat, is used to determine the values of the two state variable exogenous to household behavior.[6]

$$\begin{bmatrix} \ln p_t^X \\ \ln y_t^N \end{bmatrix} = \begin{bmatrix} 0.871 & 0.052 \\ 0.038 & 0.314 \end{bmatrix} \begin{bmatrix} \ln p_{t-1}^X \\ \ln y_{t-1}^N \end{bmatrix} + \varepsilon_t, \tag{16}$$

where $\varepsilon_t \sim N(0, \Sigma)$ with

$$\Sigma = \begin{bmatrix} 0.00082 & -0.00015 \\ -0.00015 & 0.00157 \end{bmatrix}$$

With this auto-regressive process a multiplicity of equilibria can emerge if the fundamentals of the economy (terms of trade and non-traded output) decrease substantially. This occurs for the parameterization shown in Table 2, that largely resembles the baseline one used in Schmitt-Grohé and Uribe (2021).

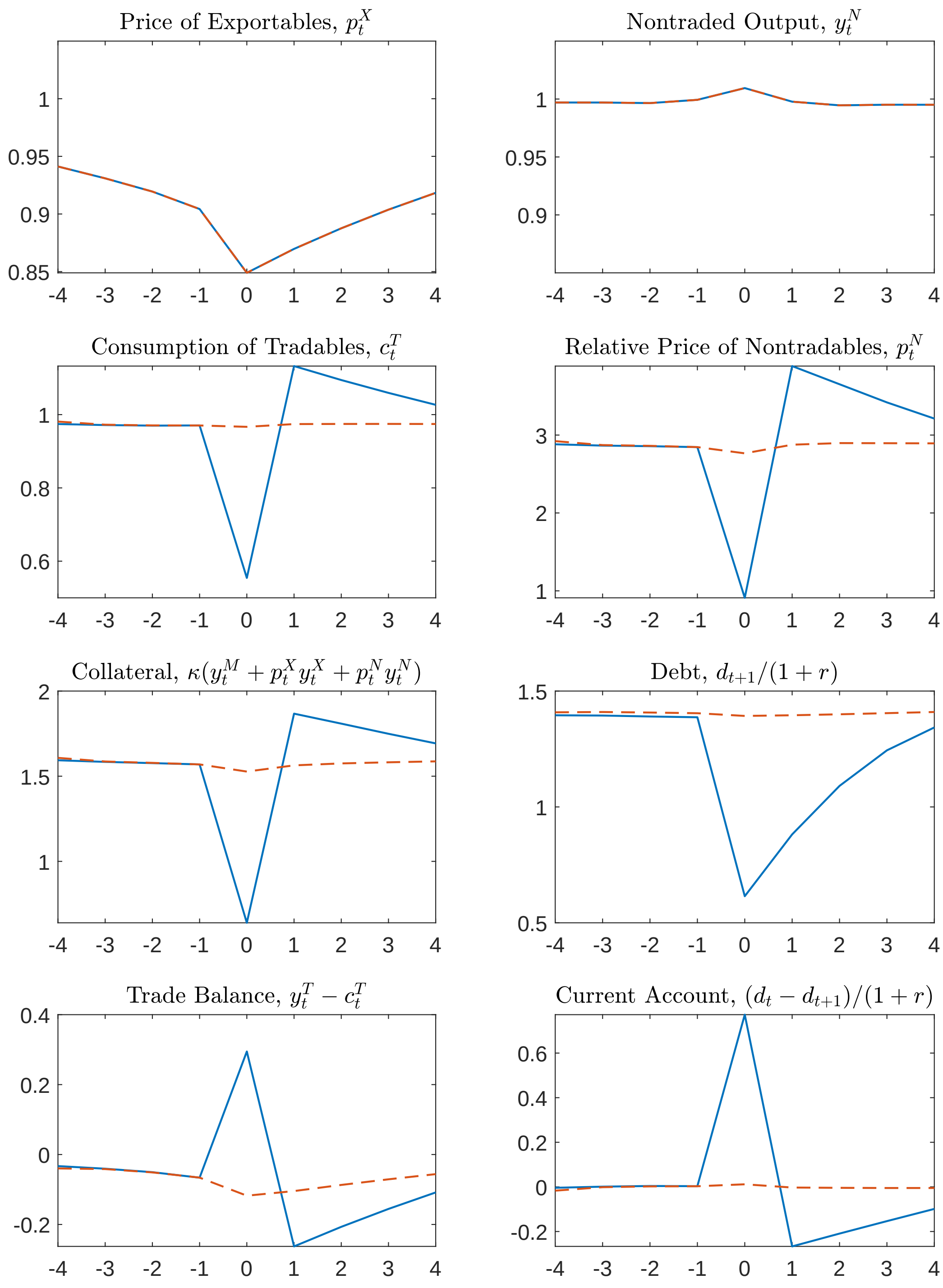
Table 2: Calibration

Parameter	**Value**	**Description**
Structural parameters		
κ	$0.32(1+r)$	Parameter of collateral constraint
σ	2	Inverse of intertemporal elasticity of consumption
β	0.91	Subjective discount factor
r	0.04	Annual interest rate
ξ_{TN}	0.5	Elasticity of substitution between composite tradables and non-tradables
ξ_{MX}	1	Elasticity of substitution between importables and exportables
a	0.25	Share Parameter of tradables in tradable-nontradable CES aggregator
b	0.5	Share Parameter of importables in importable-exportable CES aggregator
Discretization of state space		
n_{p^X}	13	Number of grid points for $\ln p_t^X$, equally spaced
n_{y^N}	13	Number of grid points for $\ln y_t^N$, equally spaced
n_d	800	Number of grid points for d_t, equally spaced
$[\ln \underline{p^X}, \ln \overline{p^X}]$ $[-0.1055, 0.1055]$ Range for logarithm for terms of trade		
$[\ln \underline{y^N}, \ln \overline{y^N}]$ $[-0.1211, 0.1211]$ Range for logarithm of non-tradable output		
$[\underline{d}, \overline{d}]$ $[0.2, 2(1+r)]$ Debt range		

Notes: The time unit is a year.

[6] From Eurostat we consider the Gross Value Added Contribution to GDP by Industry.

Figure 5: Comparison of Equilibria Selection Criteria A and C



Note: This figure shows the path of each variable around a self-fullfilling crisis equilibrium episode. The values are found as the average of the variables across all the crises episodes in the model simulation. The dashed line is the average value for a Criterion A equilibrium allocation, selecting a steady-state (non-crisis) equilibrium when available among the multiple equilibria solving the system. The continuous line is the average for the Criterion C equilibrium selecting the allocation with the lowest-debt "bad" self-fulfilling equilibrium.

Before analyzing the dynamics of the economy during periods of multiplicity of equilibria, we must lay out the criteria for determining which equilibria is selected, since by definition the self-fulfilling crisis equilibria coexist with the steady state —with non-binding financial constraints, occurring only if consumers choose to deleverage. Following Schmitt-Grohé and Uribe (2021), let selection criteria A be the criteria which always selects the steady state whenever possible, and let selection criteria C be the criteria which selects the lowest debt level self-fulfilling crisis equilibrium when possible, and when self-fulfilling crisis equilibria do not coexist with the steady state, selects the steady state equilibria.[7]

We simulate the dynamics of the economy for one million periods. The representative household optimizes expected lifetime utility by choosing their consumption and future debt level for given values of the terms of trade, the endowment of nontradables, and the current debt level in each period taking into account the how the current values for p_t^X and y_t^N affect the future values of themselves and each other according to the aforementioned autoregressive process. Most of the time, the steady state equilibria exists uniquely for the economy, and the two selection criteria are equivalent.[8] However, when the current debt level is sufficiently high and, at the same time, the economic fundamentals (terms of trade and nontradable endowment) deteriorate sufficiently, then the multiplicity of equilibria emerges, and the economy takes very different paths based on which selection criteria is being used. The average dynamics of the economy for 9 periods centered on the period in which the multiplicity emerges are shown in Figure 5.

Shown in Figure 5 are average dynamics of the economy centered around a point where a self-fulfilling crisis equilibria is possible. The dynamics under equilibrium selection criteria A are depicted by the red dashed line and the dynamics under equilibrium selection criteria C are depicted by the solid blue line. For both criteria, the terms of trade and the endowment of nontradables decrease by the same amounts, but for the economy under selection criteria C, a sharp increase in the current account and a sharp fall in the price of nontradables, the value of collateral, and consumption all occur compared to the economy under selection criteria A which does not see these changes. This is because in period-0 the economy under criteria C moves to the self-fulfilling crisis equilibrium with a lower level of debt, while the economy under selection

[7]Selection criteria B would select the higher self-fulfilling crisis equilibria when two are present, i.e. the middle equilibria when three exist counting the steady state, and otherwise would be identical to selection criteria C.

[8]Multiplicity of equilibria is dependent on the slope of the collateral constraint being greater than 1. The values of p_t^X and y_t^N affect this condition and debt levels far from d^* need not intersect that 45 degree line even if at d^* the slope is greater than 1.

criteria A remains at the steady state equilibrium. The sharp increase in the current account and sizable fall in consumption under criteria C also resemble the dynamics of a sudden stop, which highlights the relevance, for policymakers, of avoiding these type of economic outcomes whenever possible, a core concern in international finance.

7 Conclusions

This paper shows that terms-of-trade fluctuations can play a role in shaping the macro-financial landscape of emerging economies, particularly during episodes in which financial constraints bind and sudden stops threaten to push the economy into a bad equilibrium. By extending a standard small open economy model to include importable, exportable, and nontradable goods (an MXN setup) and allowing the borrowing capacity to depend on the relative price of these goods, we highlight a channel through which terms-of-trade changes affect external financing conditions and equilibrium multiplicity.

While terms-of-trade shocks may not necessarily be a dominant driver of business-cycle dynamics, we find they become consequential under stressed conditions. Favorable terms-of-trade can serve as a stabilizing force —by enhancing the value of the collateral, thereby limiting the scope for self-fulfilling crises and mitigating the risk of severe downturns characterized by current account reversals and collapsing domestic absorption. Conversely, when fundamentals erode sufficiently—embodied here in deteriorating terms-of-trade and low nontradable output—the model admits multiple equilibria, including crisis outcomes driven by shifts in expectations rather than traditional fundamentals alone. In highlighting the non-trivial influence of the terms-of-trade on these destabilizing scenarios, our findings resonate with the broader literature's efforts to uncover alternative mechanisms that enhance the relevance of the terms-of-trade (e.g. Feenstra, Mandel, Reinsdorf, and Slaughter, 2013).

Taken together, our results suggest that monitoring the terms-of-trade and managing its volatility may help policymakers and investors better anticipate and avert large-scale financial disruptions. Rather than viewing these relative prices solely as a modest contributor to day-to-day fluctuations, recognizing their power to shape and even prevent adverse equilibria can guide more effective policy responses and strengthen external resilience in emerging economies.

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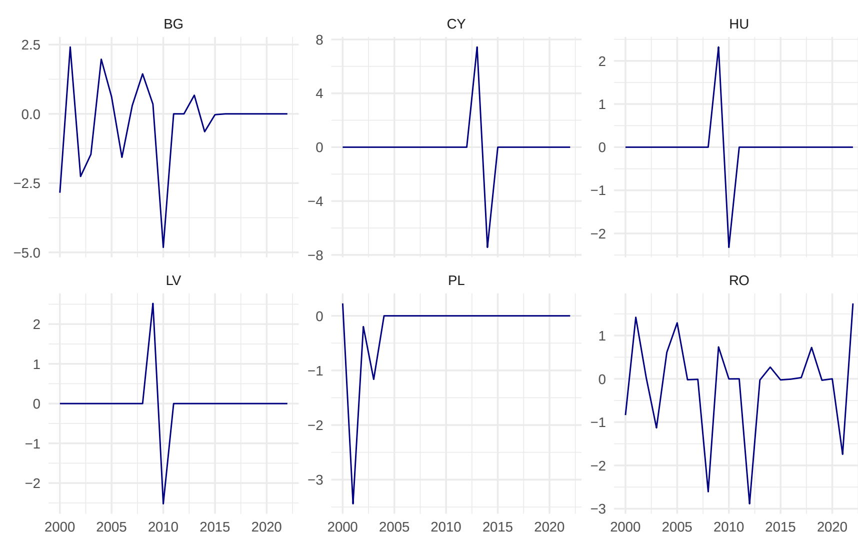
A Estimations with defaulted debt

As an alternative approach to gauge the relevance of terms-of-trade fluctuations for financial conditions, we consider a second empirical exploration in which the dependent variable is the (log) change in the amount of defaulted debt, taken from the Beers et al. (2024) database. While capital flows serve as a broad indicator of financial conditions, defaulted debt provides a more direct, albeit rarer, measure of severe financial distress.

In these estimations, we follow the specification of equation (1), but replace the dependent variable with the log-change in defaulted debt. We also include capital flows as an additional control. A key limitation of this exercise is the scarcity of information about defaulted debt. This information is naturally limited relative to other time series as default episodes are infrequent, which restricts the time variation and reduces the precision of our estimates. Figure 6 shows the (log) changes in defaulted debt over time for the subset of countries and years for which data are available in our sample.

Figure 6: Log-Change in Defaulted Debt



Note: This figure shows the annual log-change in defaulted debt in our sample. Defaulted debt data are taken from the Beers et al. (2024) database. The sparse and episodic nature of defaults presents additional challenges for our empirical estimations.

Table 3: Selected Regression Results: Significant TOT Effects on Defaulted Debt

TOT Measure	Flows used as controls	Coefficient of TOT	p-value
TOT OECD	Banking equity inflows	-5.545**	0.033
	Banking equity outflows	-4.07*	0.073
	Banking equity net inflows	-5.756**	0.024
Penn Tables 1: p_x/p_m	—		
Penn Tables 2: p/p^*	Total inflows	-2.631**	0.034
	FDI inflows	-2.632**	0.03
	FDI debt inflows	-2.62**	0.029
	FDI equity inflows	-2.637**	0.03
	Portfolio inflows	-2.643**	0.032
	Portfolio debt inflows	-2.638**	0.031
	Portfolio equity inflows	-2.66**	0.032
	Banking inflows	-2.633**	0.035
	Banking debt inflows	-2.633**	0.035
	Derivatives inflows	-3.129**	0.039
	Total outflows	-2.652**	0.038
	FDI outflows	-2.666**	0.048
	FDI debt outflows	-2.656**	0.026
	FDI equity outflows	-2.813**	0.051
	Portfolio outflows	-2.678**	0.035
	Portfolio debt outflows	-2.683**	0.036
	Portfolio equity outflows	-2.666**	0.034
	Banking outflows	-2.634**	0.032
	Banking debt outflows	-2.634**	0.032
	Derivatives outflows	-3.297**	0.017
	Total Net inflows	-2.708**	0.023
	FDI net inflows	-2.707**	0.024
	FDI debt net inflows	-2.83**	0.021
	FDI equity net inflows	-2.736**	0.023
	Portfolio net inflows	-2.683**	0.038
	Portfolio debt net inflows	-2.696**	0.041
	Portfolio equity net inflows	-2.665**	0.034
	Banking net inflows	-2.635**	0.038
	Banking debt inflows	-2.635**	0.038
	Derivatives net inflows	-3.41**	0.017
TOT WDI	Derivatives outflows	-1.564*	0.075
	Derivatives net inflows	-2.002***	0.003

Notes: The table shows the significant coefficients of the terms-of-trade in panel regressions where the dependent variable is the change in the defaulted debt reported in Beers et al. (2024). Each row corresponds to a different panel using different measures of capital flows as additional controls (relative to the model in equation (1). * p<0.10, ** p<0.05, *** p<0.01. Standard errors and p-values are calculated using a correction method as in Beck and Katz (1995).

Table 3 summarizes the significant results from regressions using each terms-of-trade measure. Consistent with our earlier findings (on capital flows), terms-of-trade improvements reduce the amount—and thus incidence—of defaulted debt, especially when we employ the terms-of-trade measure constructed from Penn Tables price of output data as Berka et al. (2018). Although these results are even more preliminary than those obtained using capital flows—due to the limited availability and variability of the defaulted debt data, they support the notion that favorable terms-of-trade conditions can mitigate financial stress in emerging economies.

B Other analytical results of the model

Here we provide further comparative statics for the baseline model under the baseline calibration.

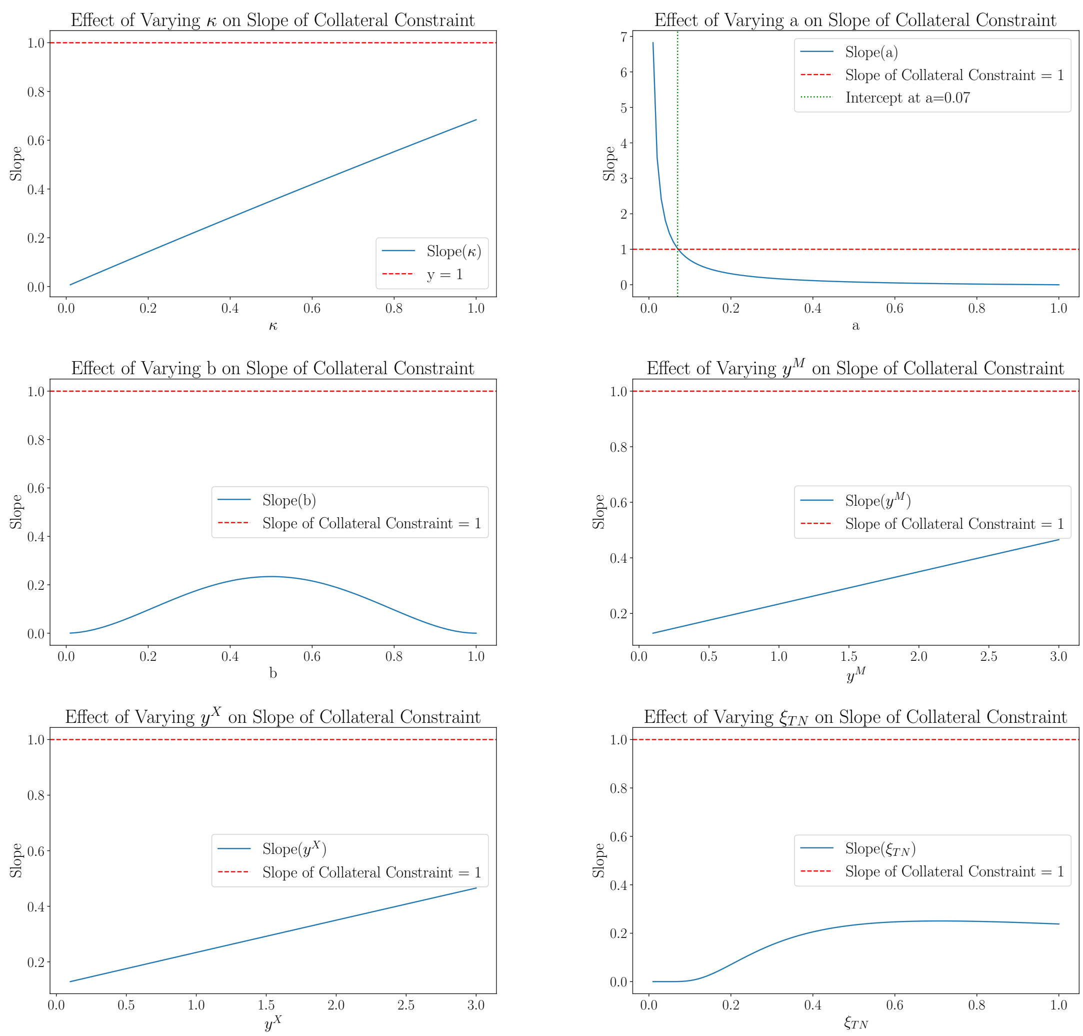


Figure 7: Values of the slope of the collateral constraint for different ranges of a set of variables

C Data sources (for online appendix)

We list here the detailed data sources for the variables used in the Panel estimations in Section 2, and in the auxiliary estimations to obtain some parameters in Section 6.

Terms-of-trade We consider four terms-of-trade indicators. Two are obtained directly from the sources below, and two are constructed based on the Penn Tables 10.0:

Terms-of-trade 1

Source: OECD

Name of database: Data Live dataset - `DP_LIVE`

Indicator: TERMTRADE, Terms of trade.

Link: https://www.oecd.org/en/data/indicators/terms-of-trade.html

Terms-of-trade 2

Source: World Bank

Name of database: World Development Indicators - `WDI`

Indicator: TT.PRI.MRCH.XD.WD, Net Barter Terms of Trade index.

Link: databank.worldbank.org/source/world-development-indicators/Series/TT.PRI.MRCH.XD.WD

Terms-of-trade 3 and 4

Source: Groningen Growth and Development Centre, University of Groningen

Name of database: Penn World Tables 10.0

Indicator: pl_x, Price level of exports.

Indicator: pl_m, Price level of imports.

Indicator: pl_gdpo, Price level of output.

Indicator: pop, Population (in millions).

Link: https://www.rug.nl/ggdc/productivity/pwt/pwt-releases/pwt100

A first measure from this source takes the ratio of the price level of exports over that of imports. A second takes the ratio of the domestic price level of output over the population-weighted average of the same variable for the EU25 country group.

Capital Flows For capital flows, we consider inflows, outflows, and a net inflows measure (inflows minus outflows).

Capital flows (different types) as a percentage to GDP

Source: IMF-International Finance Statistics

Name of database: IMF-International Finance Statistics - `IMF-IFS`,

Indicators (of inflows):

BFDLXF_BP6_USD: Direct investment (net incurrence of liabilities)

BFDLDXF_BP6_USD: Direct investment - Debt

BFDLEXF_BP6_USD: Direct investment - Equity

BFPLXF_BP6_USD: Portfolio investment (net incurrence of liabilities)

BFPLDXF_BP6_USD: Portfolio investment - Debt

BFPLEXF_BP6_USD: Portfolio investment - Equity

BFOLXF_BP6_USD: Other investment (banking)

BFOLDXF_BP6_USD: Other investment - Debt

BFOLEXF_BP6_USD: Other investment - Equity

BFFL_BP6_USD: Financial Derivatives (liabilities — inflows)

Indicators (of outflows):

BFDA_BP6_USD: Direct investment (net acquisition of assets)

BFDAD_BP6_USD: Direct investment - Debt

BFDAE_BP6_USD: Direct investment - Equity

BFPA_BP6_USD: Portfolio investment (net acquisition of assets)

BFPAD_BP6_USD: Portfolio investment - Debt

BFPAE_BP6_USD: Portfolio investment - Equity

BFOA_BP6_USD: Other investment (banking)

BFOAD_BP6_USD: Other investment (banking) - Debt

BFOAE_BP6_USD: Other investment (banking) - Equity

BFFA_BP6_USD: Financial Derivatives (Assets - outflows)

Indicator: NGDP_XDC, GDP in domestic currency.

Indicator: EDNA_USD_XDC_RATE, Exchange rate US Dollars per domestic currency.

Link: https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b

With these indicators, the total flows are computed as the sum of direct investment (FDI), portfolio, other (banking), and derivatives. Net inflows are computed for each category in this list of indicators as inflows minus outflows. The measures are obtained as a ratio to GDP which requires to use a GDP and exchange rate series.

Other indicators

Long-run Interest Rates Spread

Source: European Central Bank (ECB)
Name of database: Interest Rates Statistics (IRS).
Indicator: Long-term interest rate for convergence purposes - Debt security issued (10 years)
Link: https://data.ecb.europa.eu/data/datasets/IRS

GDP of Non-tradable sectors:

Source: Eurostat
Name of database: namq_10_a10, Government deficit/surplus, debt and associated data
Indicator: TE, Total General Government Expenditure
Link: https://doi.org/10.2908/namq_10_a10

To compute the GDP of the non-tradable sector we obtain the sector level real GDP (in 2005 chained dollars) and aggregate the sectoral indicators —using the Statistical classification of economic activities in the European Community (NACE Rev. 2)— into traded and non-traded categories following the classification in Berka, Devereux, and Engel (2018). This classification considers traded the output of sectors coded under: A (agriculture), B (industry), C (manufacturing), and G (transportation). The non-traded GDP is computed as the remainder.

Real GDP growth:

With this information we also compute the total GDP (by aggregating all sectors) and compute the real GDP growth.

Defaulted Debt (sovereign default debt):

Source: Beers et al. (2024).
Name of database: BoC-BoE Sovereign Default Database.

Indicator: DEBT_TOTAL_2023

Measure: Amount of defaulted debt by year in nominal US millions

Link: https://www.bankofcanada.ca/2023/07/staff-analytical-note-2023-10/