Trade Barriers and Sovereign Default Risk*

George Alessandria
University of Rochester and NBER

Yan Bai
University of Rochester and NBER

Minjie Deng
Simon Fraser University

Chang Liu
Stony Brook University

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Abstract

Trade barriers are rising worldwide, yet their consequences for sovereign risk remain underexplored. We show that what matters is whether barriers fall on a country's exports or on its imports. Export cost shocks raise sovereign spreads, whereas import cost shocks leave spreads largely unchanged. Under balanced trade, this asymmetry would not arise because the two shocks are equivalent by Lerner symmetry. We prove that unbalanced trade and foreign currency debt break this equivalence in a general equilibrium model of sovereign default with trade. An export cost shock generates a larger depreciation, which raises both the incentive to borrow and the real burden of repayment, so spreads rise by more. We measure export and import wedges in a panel of sixteen emerging economies. Spreads comove strongly with the export wedge but barely with the import wedge. In the calibrated model, an export cost shock that lowers real GDP by one percent raises the spread by four percentage points, while an import cost shock has essentially no effect. The interaction of productivity and export cost shocks accounts for the spread spike of the Great Recession. Local currency debt mutes the debt burden channel, so the asymmetry weakens but persists, in both the model and the data.

Keywords: Sovereign default, trade friction, financial friction, trade wedge, trade barrier

JEL classification: F12, F34, F41

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1 Introduction

What drives sovereign spread fluctuations in emerging markets? The question matters: spreads shape the cost of government borrowing, amplify business cycles, and determine how much insurance emerging economies can access in bad times. The popular mechanism in the literature centers on emerging economies' own endowment fluctuations, terms-of-trade movements, or global factors. Yet trade disruptions especially the distinction between export-side and import-side disruptions have received little attention. When global trade fell sharply during the 2008–2009 Great Recession, sovereign spreads spiked alongside the trade collapse. A natural question arises: does it matter whether the trade disruption takes the form of export cost shocks that compress foreign revenues, or import cost shocks that raise the cost of production inputs?

Both types of disruption are well-documented in practice. Export cost shocks arise from trade sanctions and market access restrictions imposed by trading partners, such as the broad US tariff increases of 2025, EU anti-dumping duties on Indonesian palm oil, and sanctions on Russian commodity exports, as well as from the loss of preferential trade access and deteriorating shipping and logistics. Import cost shocks, by contrast, primarily operate through the production cost channel: Iran's loss of access to key imported intermediates under successive rounds of US sanctions, tariffs on intermediate inputs, and supply chain disruptions during the 2008–2009 trade collapse and the COVID-19 pandemic all raise production costs sharply.

This paper asks whether these two forms of trade disruption have different implications for sovereign spreads, and finds that they do: export cost shocks increase sovereign spread, whereas import cost shocks largely do not. To study this, we develop a quantitative general equilibrium model of sovereign default with international trade, derive analytical results that clarify the mechanism, and document and quantify the asymmetry in a panel of sixteen emerging and developing economies.

Our model is a small open economy with households, final-goods producers, intermediate-goods producers, and a government. Final-goods producers combine domestically produced intermediate inputs with imported intermediate inputs, and their output is consumed at home and sold abroad as exports. Imports are subject to an import cost shock and exports to an export cost shock, and part of the imported inputs must be paid for in advance with working-capital loans. The government borrows from foreign lenders by issuing one-period, non-state-contingent foreign currency debt, and it can default at the cost of temporary exclusion from international financial markets. Financial frictions therefore arise on two fronts: the sovereign's default risk raises its spread, and that spread passes through to the rate firms pay on working capital.

We show theoretically that, compared with import cost shocks, export cost shocks generate a larger depreciation and a greater drop in consumption, which pushes up the government's incentive to borrow and leads to higher sovereign spreads. The intuition is as follows. In a standard trade model with balanced trade, import and export cost shocks are equivalent by Lerner symmetry: they move allocations identically, even though the exchange rate responds differently to the two shocks. An export cost shock always generates a larger depreciation. In particular, when import demand is elastic, an import cost shock reduces domestic import demand for foreign goods and leads to an appreciation, whereas an export cost shock reduces foreign demand for domestic goods and generates a depreciation.

With international borrowing and lending, this exchange rate asymmetry starts to matter through two mechanisms. First, the larger depreciation under an export cost shock raises borrowing incentives since borrowing converts into more domestic goods when the currency is weak. This channel operates regardless of debt denomination. Second, foreign currency debt repayment widening the depreciation gap arising from export versus import cost shock: when the sovereign has large foreign-currency debt to repay, an export cost shock generates an even larger depreciation since the country has to repay debt independent of the depreciation. When domestic goods become cheaper, the country has to export more to pay foreign-currency debt, which leading to an extra depreciation. Larger depreciation also implies a larger debt burden with foreign currency debt. Thus consumption falls by more under export cost shock. This also increases incentives to borrow to smooth consumption. As a result, export cost shock leads to larger depreciation and larger drop in consumption when there is larger foreign currency debt. These generates larger increase in sovereign spread in facing a higher an export cost shock.

To test the model mechanism that export cost shocks generates larger sovereign spreads than import cost shocks, we compile a quarterly panel of 16 economies spanning 2000Q4–2020Q2. We cannot directly observe the export or import cost shocks, but follow the literature to measure these two shocks using export wedge and import wedge. In particular, we follow Alessandria et al. (2013); Levchenko et al. (2010) and measure the export and import wedges as the variation in trade that cannot be explained by domestic and foreign demand, the terms of trade, the share of intermediate goods in production, and the real exchange rate. Both wedges track trade costs well, but they relate very differently to sovereign risk. The results are striking: the export wedge is strongly and robustly positively correlated with spreads, while the import wedge shows little systematic relationship with spreads. A one-standard-deviation increase in the export wedge raises the spread by roughly 1.6 percentage points, and the export wedge is the key driver of the overall comovement between trade wedges and financial frictions.

To quantify the aggregate impact of the two shocks, we calibrate the model to the sixteen-economy

sample and use it to quantify the asymmetry directly. The model reproduces the key targeted and untargeted moments, and we use it to trace how the productivity shock, import cost shock, and export cost shock propagate through impulse responses. To compare them on an equal footing, we calibrate each to deliver the same 1% decline in real GDP on impact. The responses differ sharply. The negative productivity shock only increases spread a little bit and the economy recovers within about twenty quarters. An import cost shock increases import wedge, but has almost no effect on spread. An export cost shock, by contrast, produces the strongest financial amplification: the sovereign spread rises sharply from about 1.3% to 5.7% in annualized terms, an increase of more than 4 percentage points, and debt falls by about 8%.

We further bring the model to the 2008-2009 Great Recession. Centering an eight-quarter window on the trough of the trade-to-GDP ratio across the ten events in our sample, the model reproduces the sharp output contraction, the rise in both trade wedges, the surge in sovereign spreads, and the collapse in import and export shares. A shock-by-shock decomposition shows that the productivity shock accounts for the bulk of the output decline, while the spread spike is a nonlinear interaction effect: no single shock reproduces it, and only the combination of productivity and export cost shocks, amplified through endogenous default risk, generates the observed surge. Import cost shocks add little to the spike on their own.

Finally, our benchmark model assumes foreign-currency debt. We examine whether the asymmetry impact between export cost and import cost shocks depend on the currency denomination of debt. With local-currency debt, the asymmetry survives but becomes smaller. Export cost shocks remain more depreciationary, but they no longer generate the additional depreciation that operates through the debt channel, because the repayment value of local-currency debt is not directly affected by the exchange rate. Absent this channel, there is no extra depreciation and no extra fall in consumption following an export cost shock, thus the asymmetric response of borrowing incentives and spreads is smaller. We confirm this prediction empirically by exploiting variation in the currency composition of debt across countries and over time. European Union members issue a larger share of euro-denominated bonds, and thus a larger share of debt in their own currency, than non-members. The local currency share has also risen over time within countries. Consistent with the theory, countries and episodes with a higher local-currency share exhibit weaker spread responses to export wedges. Our quantitative results confirm the same mechanism in a more general setup.

Literature review Our paper contributes to three strands of literature. The first strand is the quantitative sovereign default literature. Building on Eaton and Gersovitz (1981), a large body of work models

sovereign borrowing and default in small open economies (Aguiar and Gopinath, 2006; Arellano, 2008; Cuadra et al., 2010; Yue, 2010; Hatchondo et al., 2016; Hamann et al., 2018; Sosa-Padilla, 2018; Espino et al., 2020; Arellano et al., 2020; Alessandria et al., 2020; Deng and Liu, 2024; see Aguiar and Amador, 2014 and Aguiar et al., 2016 for surveys). These models typically abstract from international trade, and in particular from the possibility that trade conditions and sovereign risk are jointly determined. This omission matters because the two interact in equilibrium: adverse trade conditions reduce economic activity and repayment capacity, raising default incentives, while higher default risk tightens external financing and can further compress trade. Our paper fills this gap by embedding international trade with both import and export margins into a sovereign default framework, allowing trade frictions and sovereign risk to be jointly determined and to amplify each other. In doing so, we also contribute to the literature on the determinants of sovereign spreads (Uribe and Yue, 2006; Longstaff et al., 2011; Gilchrist et al., 2022; Du and Schreger, 2022; Deng, 2024; Deng and Khederlarian, 2025, among others), which has not explored trade frictions as a driver of sovereign spread dynamics.

The second strand examines how sovereign defaults affect international trade. Empirical studies document that trade declines significantly during and after default episodes and attribute the decline to direct sanctions, impaired trade finance, or both (Rose, 2005; Borensztein and Panizza, 2010; Martinez and Sandleris, 2011; Zymek, 2012). Hébert and Schreger (2017) provides causal evidence that increases in default probability depress Argentine equity values and the exchange rate, consistent with broad real costs from sovereign risk that extend to trade. Gopinath and Neiman (2014) documents how Argentine firms adjusted their imported input mix during the crisis, demonstrating that disruptions to imported intermediates can generate sizable productivity losses, a channel that is central to our model. On the theoretical side, Serfaty (2021) emphasizes that trade can serve as a commitment device for sovereign borrowing, as defaults are more costly for countries that trade more; in that framework, the key assumption is that default leads to an exogenous increase in trade costs. Andreasen et al. (2024) provides firm-level evidence that industries more reliant on imported inputs and working capital are more negatively affected by sovereign risk, lending support to the transmission channel we model. Our model is most closely related to Mendoza and Yue (2012), who build a general equilibrium sovereign default model with importing intermediate goods. The key difference is that we include both export and import costs that endogenously interact with sovereign spreads, whereas in Mendoza and Yue (2012) there is no trade cost. This allows us to quantify how sovereign default risk and trade costs amplify each other, and to decompose the distinct roles of import and export cost shocks in driving this amplification.

The third strand of literature we contribute to is the measurement of trade wedges and the analysis of trade collapses. Levchenko et al. (2010) and Alessandria et al. (2013) define the trade wedge as the

component of trade variation not explained by movements in domestic and foreign demand, relative prices, and production shares, and use it to study the Great Trade Collapse of 2008–2009. Related work has examined the sources of this collapse from multiple angles, including trade prices (Gopinath et al., 2011), vertical linkages (Bems et al., 2011, 2013), inventory dynamics (Alessandria et al., 2010, 2011), intertemporal substitution (Leibovici and Waugh, 2019), and credit conditions (Chor and Manova, 2012; Ahn et al., 2011; Amiti and Weinstein, 2011). A common finding is that standard models driven only by aggregate shocks underpredict the magnitude of trade declines, suggesting that additional frictions are needed. More broadly, Leibovici (2021) and Kohn et al. (2020) show that financial frictions can generate sizable effects on trade volumes and export dynamics, particularly during large devaluations, yet this work does not connect trade frictions to sovereign risk. Our contribution to this strand is threefold. First, we show that the measured trade wedge is not solely a reflection of conventional trade costs; it also embeds an endogenous financial component that varies with sovereign risk through the working capital channel. Second, we decompose the trade wedge into import and export margins and demonstrate that these margins play distinct roles: the export wedge exhibits the strongest comovement with sovereign spreads, while the import wedge is more closely tied to trade flow volatility. Third, we extend the analysis from advanced economies, which have been the primary focus of the trade collapse literature, to a panel of 16 emerging and developing economies where sovereign risk is a first-order concern.

Roadmap The rest of the paper is organized as follows. Section 2 describes the general equilibrium sovereign default model. Section 3 derives analytically the asymmetric effects of import and export cost shocks. Section 4 analyzes the trade wedge in the data, quantifies the model, decomposes the roles of productivity, import, and export cost shocks, and studies how various shocks can explain the trade collapse episodes around the 2008-2009 Great Recession. Section 5 discusses how the currency denomination of sovereign debt affects the relationship between export and import wedges and sovereign spread. Section 6 concludes and discusses several extensions. The online Appendix provides data details, sample selection, robustness, data moments used in the model, trade collapse events, model details, proofs, and the computation algorithm.

2 Model

Our model builds on the general equilibrium framework of Mendoza and Yue (2012) in a small open economy populated by households, final-good firms, intermediate-good firms, and a central government. Production takes place in two sectors: a final-good sector f and an intermediate-good sector m. Final

goods are produced using a combination of domestically produced intermediate inputs and imported intermediate inputs, and are consumed by both domestic and foreign households.

The model incorporates firm-level financial frictions as well as international financial frictions: firms require working capital to finance part of their imported inputs, while the government issues state-uncontingent foreign currency debt. Following a sovereign default, the economy is excluded from international financial markets (financial autarky) and faces trade sanctions that restrict access to a subset of imports. Finally, we model trade frictions on both margins. Imports are subject to an iceberg cost τ_M, so that acquiring one unit of foreign intermediate inputs requires shipping $\tau_M \geq 1$ units from abroad, and exports face an analogous iceberg cost $\tau_X \geq 1$, implying that only a fraction $1/\tau_X$ of shipped output is delivered to foreign markets. Both τ_M and τ_X follow exogenous stochastic processes.

2.1 Households

A representative household supplies labor to domestic firms and consumes the domestic final good. Preferences are time-separable and given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \, u(c_t - g(L_t)) \,, \tag{1}$$

where $0 < \beta < 1$ is the discount factor, c_t denotes consumption, and L_t denotes hours worked. The function $u(\cdot)$ is increasing and concave, while $g(\cdot)$ is increasing and convex, so that disutility from labor is increasing at the margin.

Each period, households receive labor income at wage w_t, dividends (profits) from firms operating in the final-good and intermediate-good sectors, (π_t^f, π_t^m), and lump-sum transfers from the government, T_t. Let P_{ft} denote the domestic price of the final good. The household's period budget constraint is

$$P_{ft} c_t = w_t L_t + \pi_t^f + \pi_t^m + P_{ft} T_t, \tag{2}$$

where transfers are denominated in units of the final good. The household takes $(w_t, \pi_t^f, \pi_t^m, T_t, P_{ft})$ as given and chooses $\{c_t, L_t\}_{t \geq 0}$ to maximize lifetime utility subject to the sequence of budget constraints.The optimality condition for labor supply is:

$$g'(L_t) = w_t / P_{ft}. \tag{3}$$

The household supplies labor up to the point where the marginal disutility of working equals the marginal

benefit, w_t/P_{ft}. Hence, an increase in the real wage w_t/P_{ft} raises the incentive to work (higher labor supply).

2.2 Final Goods Producers

The production function for the final goods producers is given as:

$$y_t = z_t \left(M \left(m_t^d, m_t^* \right) \right)^{\alpha_M} \left(L_t^f \right)^{\alpha_L} k^{\alpha_k}, \tag{4}$$

with $0 < \alpha_L, \alpha_M, \alpha_k < 1$ and $\alpha_L + \alpha_M + \alpha_k = 1$, where z_t is stochastic TFP shock; M_t is intermediate goods; L_t^f is labor and k is a time-invariant capital stock.

The intermediate goods M_t combine domestic inputs m_t^d and foreign imported inputs m_t^* and is determined by a standard CES Armington aggregator. The imported inputs m_t^* is a Dixit-Stiglitz aggregator that combines a continuum of differentiated imported inputs m_{jt}^* for $j \in [0,1]$ with the elasticity of demand $\mu > 1$:

$$M_t = \left[\left(m_t^d \right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(m_t^* \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad m_t^* \equiv \left[\int_{j\in[0,1]} \left(m_{jt}^* \right)^{\frac{\mu-1}{\mu}} dj \right]^{\frac{\mu}{\mu-1}},$$

where σ is the elasticity of substitution between domestic intermediate goods m_t^d and foreign imported intermediate goods m_t^*, and ω denotes the weight on imported goods. Imported inputs are imported with prices $\tau_t^M p_{jt}^*$ for $j \in [0,1]$, where τ_t^M is the iceberg trade cost for imports and p_{jt}^* are prices for m_{jt}^*. Denote the price for domestic inputs m_t^d as p_t^d.

A subset Ω of the imported input varieties defined by the interval $[0,\theta]$, for $0 < \theta < 1$, needs to be paid in advance using working capital financing:

$$\kappa_t \geq (1 + r_t) \int_0^\theta \tau_t^M p_{jt}^* m_{jt}^* dj,$$

where κ_t is the working capital loans and r_t is the firm borrowing interest rate. Profit-maximizing producers of final goods choose κ_t so that this condition holds with equality. We model the transmission of sovereign risk to firms in reduced form by allowing the firm borrowing rate to comove with the sovereign spread. In particular, the interest rate faced by firms satisfies $r_t = r_f^* + \chi \, \text{spread}_t$, where r_f^* denotes the firm benchmark interest rate and χ governs the pass-through from sovereign risk to firm financing costs.[1] The final goods producers choose factor demands in order to maximize date-t profits

[1] For more structural approaches to the transmission of sovereign risk to firm borrowing costs, see Sosa-Padilla, 2018, Arellano et al., 2020, and Deng and Liu, 2024, among others.

taking $P_{ft}, w_t, r_t, \tau_t^M, p_{jt}^*$, and p_t^d as given. Date-t profits for the final goods producers are:

$$\pi_t^f = P_{ft}\, y_t - \int_0^\theta \left[(1+r_t)\,\tau_t^M\, p_{jt}^*\, m_{jt}^*\right] dj - \int_\theta^1 \left[\tau_t^M\, p_{jt}^*\, m_{jt}^*\right] dj - p_t^d\, m_t^d - w_t\, L_t^f. \tag{5}$$

The first integral captures the fact that a subset of imported purchases need to be paid in advance using working capital financing and therefore carries an additional interest rate term; the second integral corresponds to imported purchases that are paid without working-capital financing. Both are multiplied by τ_t^M to reflect trade costs.

The unit price p_t^* of the composite imported input m_t^* is the CES price index implied by the cost-minimization problem of final-good producers. Because importing is subject to an iceberg trade cost $\tau_t^M \geq 1$, and a fraction $\theta \in [0,1]$ of imported purchases must be financed in advance through working-capital loans at gross rate $(1+r_t)$. As a result, the effective delivered unit cost equals $\tau_t^M p_{jt}^*(1+r_t)$ for $j \in [0,\theta]$ and $\tau_t^M p_{jt}^*$ for $j \in (\theta,1]$. The corresponding CES price index faced by the home economy is therefore

$$p_t^* = \left[\int_0^\theta \left(\tau_t^M p_{jt}^*(1+r_t)\right)^{1-\mu} dj + \int_\theta^1 \left(\tau_t^M p_{jt}^*\right)^{1-\mu} dj\right]^{\frac{1}{1-\mu}}. \tag{6}$$

Upon sovereign default, the economy is subject to a trade sanction that eliminates access to the subset $[0,\theta]$ of imported varieties. Equivalently, one can represent this restriction as an infinite interest rate for these varieties (i.e., $r_t \to \infty$ for $j \in [0,\theta]$), which drives their optimal demand to zero. Consequently, the set of varieties available for cost minimization shrinks to $j \in (\theta,1]$, and the CES price index for the composite imported input in autarky becomes

$$p_{t,\text{aut}}^* = \left[\int_\theta^1 \left(\tau_t^M p_{jt}^*\right)^{1-\mu} dj\right]^{\frac{1}{1-\mu}}. \tag{7}$$

We use a standard two-stage budgeting approach to characterize the solution of the final goods producers' optimization problem. In the first stage, the final-good producer chooses labor L_t^f, domestic intermediate inputs m_t^d, and the composite imported intermediate input m_t^* to maximize date-t profits, taking factor prices $(P_{ft}, w_t, p_t^d, p_t^*)$ as given:

$$\pi_t^f = P_{ft}\, z_t \Big(M(m_t^d, m_t^*)\Big)^{\alpha_M} (L_t^f)^{\alpha_L} k^{\alpha_k} - p_t^* m_t^* - p_t^d m_t^d - w_t L_t^f, \tag{8}$$

where the intermediate bundle is

$$M_t \equiv M(m_t^d, m_t^*) = \left[\left(m_t^d\right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(m_t^*\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{9}$$

with $\sigma > 1$ governing the elasticity of substitution between domestic and imported intermediate inputs and $\omega > 0$ shifting the relative weight on imported inputs.

In the second stage, taking the optimal composite quantity m_t^* as given, the firm chooses the continuum of imported varieties $\{m_{jt}^*\}_{j\in[0,1]}$ to minimize the total cost of obtaining m_t^* under the CES aggregator for imports. With elasticity $\mu > 1$, the standard CES cost-minimization problem implies a demand system with constant price elasticities. Because a fraction θ of varieties must be financed with working capital, the relevant delivered unit cost differs across j. The delivered unit cost is $\tau_t^M p_{jt}^*(1 + r_t)$ if $j \in [0, \theta]$ and $\tau_t^M p_{jt}^*$ if $j \in (\theta, 1]$. Accordingly, the demand for each imported variety is

$$m_{jt}^* = \left(\frac{\tau_t^M p_{jt}^*(1 + r_t)}{p_t^*}\right)^{-\mu} m_t^*, \qquad j \in [0, \theta], \tag{10}$$

$$m_{jt}^* = \left(\frac{\tau_t^M p_{jt}^*}{p_t^*}\right)^{-\mu} m_t^*, \qquad j \in (\theta, 1]. \tag{11}$$

When the sovereign defaults, the economy loses access to varieties in $[0, \theta]$. The cost-minimization problem is then restricted to $j \in (\theta, 1]$, implying the autarky import price index $p_{t,\text{aut}}^*$. The demand for $j \in [\theta, 1]$ follows equation (11) with p_t^* replaced by $p_{t,aut}^*$, while $m_{jt}^* = 0$ for $j \in [0, \theta]$.

Since imported varieties in $[0, \theta]$ enter the CES aggregator for imported inputs, their removal raises the unit cost of the imported composite and reduces the effective quantity of imported intermediates that the firm can profitably employ. Through the production function, the contraction in imported inputs lowers the intermediate bundle M_t and therefore generates an endogenous decline in output and profits following sovereign default.

2.3 Domestic Intermediate Goods Producers

Producers in the m^d sector use labor L_t^m and operate with a production function given by $A\,(L_t^m)^\alpha$, with $0 \leq \alpha \leq 1$ and $A > 0$. A represents both the role of a fixed factor and an invariant state of TFP in the m^d sector. Given p_t^d and w_t, the profit maximization problem of intermediate goods firms is:

$$\max_{L_t^m} \pi_t^m = p_t^d A\,(L_t^m)^\alpha - w_t L_t^m.$$

Their labor demand satisfies this standard optimality condition: $\alpha p_t^d A\,(L_t^m)^{\alpha-1} = w_t$.

2.4 Foreign Demand for Domestic Final Goods

We assume the foreign demand for domestic final goods is given by

$$X_t = \left(\frac{\tau_t^X P_{ft}}{P_{ft}^*}\right)^{-\rho} D^* = \left(\frac{e_t}{\tau_t^X}\right)^{\rho} D^*$$

where τ_t^X is the iceberg cost for exports, P_{ft} is the price of the domestic final goods and P_{ft}^* is the price of the foreign final goods. ρ is the elasticity of substitution between exported domestic final goods and foreign final goods. D^* is the level of overall foreign demand. $e_t \equiv \frac{P_{ft}^*}{P_{ft}}$ refers to the exchange rate. An increase in e_t represents a depreciation of the home currency. The foreign demand for domestic final goods is positively correlated with the exchange rate and overall demand, and negatively correlated with trade cost.

2.5 Equilibrium in Factor Markets and Production

Take as given TFP z_t, import trade cost τ_t^M, export trade cost τ_t^X, and the firm borrowing interest rate r_t, a static competitive equilibrium in production and factor markets is a collection of quantities $\left(m_t^*, m_t^d, L_t^f, L_t^m, L_t\right)$ and prices $\left(P_{ft}, p_t^d, w_t\right)$ such that: (i) final-good firms in sector f choose input demands to maximize profits given $(P_{ft}, w_t, p_t^d, p_t^*)$; (ii) domestic intermediate-good firms in sector m choose labor to maximize profits given (p_t^d, w_t); (iii) households choose consumption and labor optimally given (P_{ft}, w_t); and (iv) labor and intermediate-good markets clear. We denote the *private equilibrium* in production and factor markets by

$$PE(z_t, \tau_t^M, \tau_t^X, r_t, D_t),$$

where $D_t = 1$ indicates sovereign default. When $D_t = 0$, the relevant imported-input price index is p_t^*, while under default ($D_t = 1$) access to the subset $[0, \theta]$ of imported varieties is lost and the relevant price index is $p_{t,\text{aut}}^*$.

2.6 The Sovereign Government

The sovereign issues one-period, non-state-contingent bonds to competitive foreign lenders. Let b_t denote the stock of outstanding debt. The government chooses whether to default by maximizing the payoff:

$$V\left(b_t, z_t, \tau_t^M, \tau_t^X\right) = \max\left\{v^c\left(b_t, z_t, \tau_t^M, \tau_t^X\right), v^d\left(z_t, \tau_t^M, \tau_t^X\right)\right\} \tag{12}$$

where $v^{\mathrm{c}}\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$ is the value of repaying its bonds and $v^d\left(z_t, \tau_t^M, \tau_t^X\right)$ is the value of default.

If the government repays, it maximizes by choosing the next period bond b_{t+1}, subject to its budget constraint, household budget constraint, and the equilibrium in factor markets:

$$v^c\left(b_t, z_t, \tau_t^M, \tau_t^X\right) = \max_{b_{t+1}} \left\{ u\left(c_t - g\left(L_t\right)\right) + \beta \mathbb{E}\left[V\left(b_{t+1}, z_{t+1}, \tau_{t+1}^M, \tau_{t+1}^X\right)\right]\right\}$$

subject to

$$P_{ft} T_t = q_t b_{t+1} - b_t$$
$$P_{ft} c_t = w_t L_t + \pi_t^f + \pi_t^m + P_{ft} T_t$$
$$PE\left(z, \tau_t^M, \tau_t^X, r_t(q_t), D_t = 0\right) \in \mathcal{P},$$

where $\mathcal{P}$ denotes the set of equilibria in factor markets and production. $PE\left(z, \tau_t^M, \tau_t^X, r_t(q_t), D_t = 0\right) \in \mathcal{P}$ says that the allocation and prices $(c_t, m_t^d, m_t^*, L_t^f, L_t^m, L_t; P_{ft}, p_t^d, w_t)$ are consistent with a competitive equilibrium in production and factor markets when $D_t = 0$. Here, $r_t(q_t)$ indicates that the firm borrowing rate is linked to sovereign risk in reduced form through the bond price schedule, as specified above. Appendix A presents the details of the consolidated problem.

If the government defaults, it is excluded from international borrowing and enters financial autarky. In addition, the economy faces a trade sanction that restricts access to imported varieties in $[0, \theta]$, so the relevant imported-input unit cost becomes $p_{t,\text{aut}}^*$. Let $\phi \in (0,1)$ denote the exogenous probability of regaining access to international credit markets in the subsequent period. The value of default under consolidated problem is:

$$v^d\left(z_t, \tau_t^M, \tau_t^X\right) = \max_{c_t, m_t^d, m_t^*, L_t^f, L_t^m, L_t} \left\{ \begin{array}{l} u\left(c_t - g(L)\right) \\ +\beta(1-\phi)\mathbb{E} v^d\left(z_{t+1}, \tau_{t+1}^M, \tau_{t+1}^X\right) + \beta\phi \mathbb{E} V\left(0, z_{t+1}, \tau_{t+1}^M, \tau_{t+1}^X\right) \end{array} \right\}$$

subject to:

$$P_{ft} c_t = w_t L_t + \pi_t^f + \pi_t^m$$
$$PE\left(z, \tau_t^M, \tau_t^X, r_t(q_t), D_t = 1\right) \in \mathcal{P},$$

where $\mathcal{P}$ denotes the set of equilibria in factor markets and production. $PE\left(z, \tau_t^M, \tau_t^X, r_t(q_t), D_t = 1\right) \in \mathcal{P}$ says that the allocation and prices $(c_t, m_t^d, m_t^*, L_t^f, L_t^m, L_t; P_{ft}, p_t^d, w_t)$ are consistent with a competitive equilibrium in production and factor markets when $D_t = 1$. See Appendix A for details.

When the default value $v^d\left(z_t, \tau_t^M, \tau_t^X\right)$ is larger than the repayment value $v^c\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$, the government defaults, $D_t = 1$. The lenders are competitive and risk neutral. They face a constant world interest rate r^* and are willing to lend to the government as long as they break even in expected value.

The lenders are aware of the government's incentives to default on its bonds. Thus, in equilibrium, the break-even condition implies that the bond price schedule $q_t(b_{t+1}, z_t, \tau_t^M, \tau_t^X)$ satisfies:

$$q_t(b_{t+1}, z_t, \tau_t^M, \tau_t^X) = \frac{1}{1+r^*}\mathbb{E}_t(1 - D(b_{t+1}, z_{t+1}, \tau_{t+1}^M, \tau_{t+1}^X)).$$

2.7 Recursive Equilibrium

A recursive equilibrium consists of: (i) a government debt policy function $b_{t+1}(b_t, z_t, \tau_t^M, \tau_t^X)$, an associated value function $V(b_t, z_t, \tau_t^M, \tau_t^X)$, a default rule $D(b_t, z_t, \tau_t^M, \tau_t^X)$, consumption and transfers rules $c\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$ and $T\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$; (ii) allocation and price functions summarized by the within-period production equilibrium $PE(z_t, \tau_t^M, \tau_t^X, r_t, D_t)$; and (iii) a bond price schedule $q_t(b_{t+1}, z_t, \tau_t^M, \tau_t^X)$ such that:

1. Given the bond price schedule $q_t\left(b_{t+1}, z_t, \tau_t^M, \tau_t^X\right)$, the decision rule $b_{t+1}\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$ and the default rule $D\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$ solve the government's recursive maximization problem (12).
2. The consumption plan $c\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$ satisfies the resource constraint of the economy. Factor allocations are consistent with a competitive equilibrium in factor markets.
3. The transfers policy $T\left(b_t, z_t, \tau_t^M, \tau_t^X\right)$ satisfies the government budget constraint. They satisfy $P_{ft}\, T_t = q_t\, b_{t+1} - b_t$.
4. The bond pricing function $q_t\left(b_{t+1}, z_t, \tau_t^M, \tau_t^X\right)$ satisfies the arbitrage condition of foreign lenders.

This definition implies that the equilibrium jointly determines sovereign borrowing and default, the within-period allocation of labor and intermediate inputs across sectors (with and without credit market access), and the associated prices, including wages, intermediate-good prices, and firm profits.

Accounting. The equilibrium embeds the economy's national accounts. With the foreign final good as the numeraire, P_{ft} is the price of the home final good in units of foreign goods and $e_t = 1/P_{ft}$. Nominal GDP is the value of final-good output net of spending on imported inputs, $GDP_t \equiv P_{ft}y_t - p_t^* m_t^*$. The economy's resource constraint then reads $GDP_t = P_{ft}c_t + (b_t - q_t b_{t+1})$: domestic value added is absorbed by consumption and by the net transfer to foreign lenders, the repayment of maturing debt net of the revenue raised from new issuance. The balance of payments requires export earnings to finance imports plus this same transfer, $P_{ft}X_t = p_t^* m_t^* + (b_t - q_t b_{t+1})$, so the trade balance equals net debt service, $NX_t \equiv P_{ft}X_t - p_t^* m_t^* = b_t - q_t b_{t+1}$, and the economy runs a trade surplus exactly when repayment exceeds new borrowing. Combining the two identities recovers market clearing for the home final good, $y_t = c_t + X_t$.

3 Theoretical Characterization: Asymmetric Effects of Import and Export Cost Shocks

This section establishes the central result of the paper analytically: an export cost shock τ_t^X generates a larger fall in consumption, a larger depreciation of the exchange rate, and a stronger incentive to borrow, and hence higher sovereign spreads, than an import cost shock τ_t^M of equal size.

Both shocks raise the cost of intermediate imports: τ_t^M raises it directly, while τ_t^X reduces export demand, which generates a depreciation and makes imports more costly. Under balanced trade, the symmetry of Lerner (1936) holds and the two forces are equivalent for all allocations. With imbalanced trade, the two have distinct effects on borrowing. The depreciation caused by τ_t^X raises the incentive to borrow, whereas τ_t^M leads to an appreciation when import demand is elastic and therefore reduces it. Sovereign spreads thus increase by more under τ_t^X. Furthermore, when debt repayment is positive, τ_t^X generates an even larger depreciation, which raises the real burden of repayment, deepens the consumption contraction, and further raises the domestic value of new foreign borrowing. In contrast, τ_t^M raises only the import portion of external payments, so debt repayment dilutes its effect.

We develop this argument in three steps. Section 3.1 considers the private equilibrium and establishes symmetry under financial autarky. Section 3.2 takes the debt choice as given and ranks the exchange rate and consumption responses. Section 3.3 endogenizes borrowing and ranks the effect of the two shocks on sovereign spreads. To obtain closed forms we impose the following assumption, which is relaxed in the quantitative section. All proofs are in Appendix B.

Assumption 1. *(i) Foreign demand $D^* = 1$; (ii) firms face no working capital financing requirement; (iii) the government imposes a constant import tariff $t^m = 1/(\rho - 1)$; (iv) total labor is fixed at $\bar{L}$.*

Part (iii) deserves comment. The economy has monopoly power over its export good, and individual exporters do not internalize it, so exports are too high from the perspective of a domestic planner. The tariff $t^m = 1/(\rho - 1)$ corrects exactly this externality, so that the government does not use its debt choice as a second instrument to address it. Because the economies in our sample are party to trade agreements and levy small tariffs, we abstract from the tariff in the quantitative analysis. The results there are unaffected.

3.1 Private equilibrium

Combining the household and government budget constraints with firm optimality, the private economy collapses to a compact static block. Let

$$Y(m_t^*) \equiv \max_{L_t^m} z_t \left[(A(L_t^m)^\alpha)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} (m_t^*)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}\alpha_M} (\bar{L} - L_t^m)^{\alpha_L} \tag{13}$$

denote gross output when imported intermediates are m_t and the fixed labor endowment is allocated optimally between intermediate and final production. Define $\tilde{e}_t$ the *export-cost-adjusted* exchange rate and net debt repayment $\mathcal{R}_t$:

$$\tilde{e}_t \equiv e_t / \tau_t^X, \quad \mathcal{R}_t \equiv b_t - q_t b_{t+1}.$$

Under Assumption 1, and for a given government choice of b_{t+1}, the private equilibrium consists of allocations and exchange rate, $\{c_t, m_t^*, \tilde{e}_t\}$, that solve

$$c_t = Y(m_t^*) - \tilde{e}_t^\rho, \tag{14}$$

$$\tilde{e}_t^{\rho-1} = \tau_t^X \left[\tau_t^M m_t^* + \mathcal{R}_t \right], \tag{15}$$

$$Y'(m_t^*) = \tfrac{\rho}{\rho-1} \tilde{e}_t \tau_t^X \tau_t^M. \tag{16}$$

Equation (14) is the resource constraint: consumption equals gross output net of the resources absorbed by exporting. Equation (15) is the condition for the balance of payments: export revenue must cover the import bill *and* net debt repayment. Both are subject to the export cost τ_t^X. Equation (16) is import optimality: the marginal product of imported inputs equals their price in domestic currency, adjusted for the markup. Given (τ_t^X, τ_t^M) and $\mathcal{R}_t$, equations (15) and (16) jointly determine $(\tilde{e}_t, m_t^*)$, and (14) then delivers c_t.

The block (14) to (16) is static only in the sense that it describes the private equilibrium *within* a period, conditional on the debt issued by the government. The predetermined stock b_t and the issuance b_{t+1} enter through $\mathcal{R}_t$, so the entire dynamic problem of the sovereign is summarized, from the perspective of private agents, by the single number $\mathcal{R}_t$.

Proposition 1 (Autarky Lerner symmetry)**.** *In financial autarky, $\mathcal{R}_t = 0$, the export cost shock τ_t^X and the import cost shock τ_t^M have identical effects on all real allocations.*

With $\mathcal{R}_t = 0$, we can replace $\tilde{e}_t$ using the balanced payment condition (15), and the private equilibrium

conditions (14) and (16) become

$$c_t = Y(m_t^*) - \left(\tau_t^X \tau_t^M m_t^*\right)^{\frac{\rho}{\rho-1}}, \qquad Y'(m_t^*) = \tfrac{\rho}{\rho-1} \left(\tau_t^X \tau_t^M\right)^{\frac{\rho}{\rho-1}} {m_t^*}^{\frac{1}{\rho-1}}, \tag{17}$$

so the two costs enter only through their product $\tau_t^X \tau_t^M$. Holding m_t^* fixed, a one percent rise in either cost raises the cost of imports by exactly $\rho/(\rho-1)$ percent. This is the logic of the symmetry theorem of Lerner (1936): with balanced trade, the exchange rate adjusts to equate import spending to export revenue, so a cost that raises the foreign currency price of imports and a cost that reduces foreign currency revenue per unit exported are two sides of the same deterioration in the terms of trade. Although the symmetry is usually stated for tariffs and export taxes, what matters is not the instrument but the restriction that trade be balanced (see also Costinot and Werning 2019; Bai et al. 2025).

As we show next, the symmetry breaks with international borrowing and lending: the two costs are no longer interchangeable, and they alter borrowing incentives in different directions. Sections 3.2 hold b_{t+1}, and therefore $\mathcal{R}_t$, fixed and characterize how the two shocks move the private equilibrium; Section 3.3 lets the government choose b_{t+1} optimally and shows that the same elasticities govern its borrowing incentive and hence the sovereign spread.

3.2 Asymmetric effects with debt repayment

We now take b_{t+1}, and hence $\mathcal{R}_t$, as given and ask how the effects of the two shocks differ. The asymmetry arises through two channels: even absent debt, the two shocks move the exchange rate differently when import demand is elastic; and for $\mathcal{R}_t \geq 0$, net external payments amplify this differential. The case $\mathcal{R}_t \geq 0$ is the empirically relevant one: an indebted country must service its outstanding debt, so net payments are positive even when it continues to borrow. Both the exchange rate and consumption responses reflect these asymmetries.

Two objects summarize all of the comparative statics that follow. The first is the *import share of external payments*,

$$\chi_t \equiv \frac{\tau_t^M m_t^*}{\tau_t^M m_t^* + \mathcal{R}_t} \geq 0, \tag{18}$$

the fraction of export revenue spent on imports rather than on debt service. The share χ_t is always positive and $\chi_t \leq 1$ if the country chooses to have a net debt repayment, $\mathcal{R}_t \geq 0$. Financial autarky is the case $\mathcal{R}_t = 0$, $\chi_t = 1$. The second is the *(inverse) import demand elasticity*,

$$\eta_t \equiv -\frac{d \ln Y'(m_t^*)}{d \ln m_t^*} > 0, \tag{19}$$

which is well defined because (16) makes $Y'(m_t^*)$ the inverse import demand curve, so $1/\eta_t$ is the price elasticity of import demand. Import demand is elastic when $\eta_t < 1$. The following lemma, proved in Appendix B, guarantees that η_t is positive and characterizes when import demand is elastic.

Lemma 1 (Properties of η_t)**.** *Under decreasing returns to scale, $\alpha_M + \alpha_L \leq 1$, (i) $\eta_t > 0$; and (ii) if $\sigma \geq 1$, then $\eta_t < 1$, so import demand is strictly elastic whenever domestic and imported intermediates are substitutes.*

Lemma 1 is intuitive. When the price of imported inputs rises they are partly replaced by domestic intermediates, and output contracts as well, so imports fall more than one for one with their price and the import bill falls. This is the empirically relevant case, as we set the Armington elasticity to $\sigma = 3$ in the quantitative analysis. Substitutability is sufficient but not necessary: $\eta_t < 1$ continues to hold for σ somewhat below one, and fails only under strong enough complementarity.

Proposition 2 (Exchange rate elasticities)**.** *Holding $\mathcal{R}_t$ fixed, the equilibrium elasticities of the exchange rate with respect to the two wedges are*

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} = \frac{\rho\, \eta_t}{(\rho - 1)\eta_t + \chi_t}, \qquad \frac{\partial \ln e_t}{\partial \ln \tau_t^M} = \frac{\chi_t\, (\eta_t - 1)}{(\rho - 1)\eta_t + \chi_t}, \tag{20}$$

and, for $\rho > 1$, $\chi_t \in (0, 1]$ and $\eta_t > 0$, the ranking is unambiguous:

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} > \frac{\partial \ln e_t}{\partial \ln \tau_t^M}. \tag{21}$$

We highlight three implications of Proposition 2. First, an export cost shock unambiguously *depreciates* the exchange rate, and outstanding debt amplifies the response. Th reason is that a higher τ_t^X lowers foreign demand for domestic goods, so the exchange rate depreciates. With foreign currency debt, the depreciation must be larger. External payment consists of import spending and debt service, and depreciation restores balance by adjusting the former; debt service is fixed in foreign currency. Only the trade portion χ_t of external payments responds to the exchange rate, and a smaller responsive margin requires a larger price movement to close the same shortfall.

Second, the sign of the elasticity with respect to the import wedge depends on η_t. When $\eta_t < 1$, which by Lemma 1 holds when $\sigma \geq 1$, a higher import cost lowers import spending, reduces the foreign currency the economy must generate, and *appreciates* the exchange rate. The two shocks then move the exchange rate in opposite directions. Third, and regardless of that sign, the export wedge always moves the exchange rate by strictly more when $\chi_t \leq 1$.

It is worth recording two special cases. When imported intermediates are fixed at $\bar{m}$, the quantity

margin is shut down, $\eta_t \to \infty$, and (20) collapses to $\partial \ln e_t / \partial \ln \tau_t^X = \rho/(\rho-1)$ and $\partial \ln e_t / \partial \ln \tau_t^M = \chi_t/(\rho-1) > 0$: absent any quantity response, both shocks depreciate, and the import shock does so only in proportion to the share of external payments accounted for by imports. When production uses imported intermediates only, $\eta_t = 1 - \alpha_M < 1$, so import demand is necessarily elastic and a higher import cost always appreciates.

The same asymmetry appears in consumption. By the envelope theorem applied to the static block, the consumption elasticities take a simple form.

Proposition 3 (Consumption elasticities)**.** *Holding $\mathcal{R}_t$ fixed,*

$$\frac{\partial \ln c_t}{\partial \ln \tau_t^X} = -\frac{\alpha_M (1-s_t)}{\chi_t}\frac{Y_t}{c_t}, \qquad \frac{\partial \ln c_t}{\partial \ln \tau_t^M} = -\alpha_M (1-s_t)\frac{Y_t}{c_t}, \tag{22}$$

where $s_t \equiv A^\zeta (L_t^m)^{\alpha\zeta} / \left[A^\zeta (L_t^m)^{\alpha\zeta} + \omega^{1/\sigma}(m_t^*)^\zeta\right] \in (0,1]$ is the CES value share of the domestically produced intermediate in the composite and $\zeta = (\sigma-1)/\sigma$. Hence the export wedge is more costly for consumption whenever $\mathcal{R}_t > 0$ and so $\chi_t < 1$.

Two features stand out. First, both elasticities are unambiguously negative: whatever the sign of the exchange rate response, either shock lowers consumption. Second, the two elasticities differ by the factor $1/\chi_t$, so the export shock reduces consumption by more whenever $\mathcal{R}_t \geq 0$. To see why, we can rewrite the resource constraint so that consumption equals output minus import costs and debt payment,

$$c_t = Y(m_t^*) - e_t \tau_t^M m_t^* - e_t \mathcal{R}_t. \tag{23}$$

The export shock depreciates the exchange rate by more than the import shock (Proposition 2), and the larger depreciation reduces consumption through two channels: it raises the domestic cost of imported inputs, $e_t \tau_t^M m_t^*$, and it raises the domestic cost of servicing foreign currency debt, $e_t \mathcal{R}_t$. The second channel exists only with outstanding foreign currency debt, which is why the gap between the two elasticities is governed by import share of external payment χ_t: as the debt burden grows, χ_t falls and the gap widens.

3.3 Endogenous borrowing and sovereign spreads

The asymmetry in consumption costs translates directly into borrowing incentives. We now let the debt choice respond. The government enters the period with b_t and chooses b_{t+1} facing the bond price schedule $q(b_{t+1})$, which embeds default risk and satisfies $q' < 0$. Writing $C(\tau_t^X, \tau_t^M, \mathcal{R}_t)$ for the consumption level

delivered by the static block (14) to (16), the government solves

$$V\left(b_t, \tau_t^X, \tau_t^M\right) = \max_{b_{t+1}} \; u\Big(C\left(\tau_t^X, \tau_t^M, \, b_t - q(b_{t+1})b_{t+1}\right)\Big) + \beta \, \mathbb{E} \, V\left(b_{t+1}, \tau_{t+1}^X, \tau_{t+1}^M\right), \tag{24}$$

where the expectation takes into consideration the future default probability.

Assumption 2. *The trade cost shocks τ_t^X and τ_t^M are i.i.d. over time; and $q(b_{t+1})$ is continuous and differentiable with $q'(b_{t+1}) < 0$.*

The assumption that shocks are i.i.d. isolates the mechanism operating within the period. Because current realizations carry no information about future ones, neither the continuation value nor the bond price schedule varies with today's trade costs. The future enters the borrowing problem only through b_{t+1}, and $q(\cdot)$ does not vary with current realizations of the shocks, so the feedback from trade costs to borrowing costs through default risk is switched off contemporaneously. Any ranking we obtain therefore comes from the exchange rate and consumption channels alone. The quantitative model in Section 4 restores the feedback.

Taking first-order condition over b_{t+1}, we obtain the Euler equation:

$$u'(c_t)\, e_t \left[q(b_{t+1}) + q'(b_{t+1})\, b_{t+1}\right] \;=\; \beta \, \mathbb{E}\left[u'(c_{t+1})\, e_{t+1}\right]. \tag{25}$$

The left side is the marginal revenue from issuing one more unit of debt, namely $q + q'b_{t+1}$ units of foreign currency, where $q'b_{t+1} < 0$ is the price impact of additional borrowing, valued at the shadow price of foreign currency today, $u'(c_t)e_t$. The right side is the expected shadow cost of repayment tomorrow. Both sides are scaled by the exchange rate because the debt is denominated in foreign currency. Because the shocks are i.i.d., the right side depends on b_{t+1} only. Current trade cost shocks therefore move desired borrowing through a single channel: the shadow value today, $u'(c_t)e_t$. That channel has two components,

$$\frac{\partial \ln \left[u'(c_t)e_t\right]}{\partial \ln \tau} = \underbrace{\frac{\partial \ln e_t}{\partial \ln \tau}}_{\text{depreciation gain}} - \underbrace{\gamma_t \frac{\partial \ln c_t}{\partial \ln \tau}}_{\text{consumption smoothing}}, \qquad \tau \in \{\tau_t^X, \tau_t^M\}, \tag{26}$$

where $\gamma_t \equiv -u''(c_t)c_t/u'(c_t) \geq 0$ is relative risk aversion. Propositions 2 and 3 rank both components in the same direction, which yields the main result of this section.

Proposition 4 (Borrowing incentives and spreads)**.** *For any concave u, $\rho > 1$ and $\chi_t \in (0, 1]$,*

$$\frac{\partial \ln \left[u'(c_t)e_t\right]}{\partial \ln \tau_t^X} - \frac{\partial \ln \left[u'(c_t)e_t\right]}{\partial \ln \tau_t^M} = \frac{\eta_t \left(\rho - \chi_t\right) + \chi_t}{\eta_t(\rho - 1) + \chi_t} + \gamma_t \, \frac{1 - \chi_t}{\chi_t} \, \alpha_M \left(1 - s_t\right) \frac{Y_t}{c_t} \;>\; 0. \tag{27}$$

Thus, if the marginal revenue of issuance $q(b_{t+1}) + q'(b_{t+1})b_{t+1}$ is positive and strictly decreasing at the optimum, optimal issuance b_{t+1} rises by strictly more after an export cost shock than after an import cost shock of equal size.

The two terms in (27) are the direct counterparts of the two propositions above. The first is positive because τ_t^X depreciates the exchange rate by more (Proposition 2), raising the domestic value of each unit of new foreign borrowing. The second is positive because τ_t^X lowers consumption by more (Proposition 3), raising marginal utility and the desire to smooth. The second term disappears at $\chi_t = 1$ and grows with the repayment burden. The export shock therefore induces strictly more borrowing, and since the bond price schedule is decreasing in issurance, the larger increase in b_{t+1} generates a decline in q_t and a larger rise in sovereign spread. Section 4 shows that this asymmetry presents in our general quantitative model and in the data.

Discussion. Our benchmark model assumes that the debt is denominated in foreign currency. It is natural to ask how much of the asymmetry survives when the sovereign borrows in its own currency. The ranking survives, but in weaker form. The export shock still depreciates the exchange rate by more and thus leads to larger incentive to borrow. But local currency debt service no longer appear in the foreign currency bill that the exchange rate must cover, so the exchange rate adjusts to balance trade alone and the export shock no longer forces the additional depreciation. And because repayment is domestic currency, depreciation no longer raises its domestic cost, so the consumption channel behind the factor $1/\chi_t$ in (22) is absent. Section 5 formalize this claim and take it to the data, showing that the empirical comovement between the export wedge and the spread is weaker for the issuers that rely least on borrowing in foreign currency.

Our finding of asymmetric effect of import and export cost is consistent with Razin and Svensson (1983), where an export tax shifts consumption toward the present and raises borrowing while an import tariff lowers it through intertemporal substitution; we obtain the analogous ranking with iceberg costs rather than taxes, and we add a second mechanism to theirs: with net debt repayment in foreign currency, the export shock depreciates the exchange rate by more and further raises the domestic cost of servicing foreign currency debt.

Itskhoki and Mukhin (2025) study the effects of import tariffs and export taxes imposed by the United States on the U.S. economy itself, and find that the import tariff is the more recessionary instrument. Our question is the mirror image: we study import and export costs faces by a small open economy, whether arising from trade policy in the rest of the world or from iceberg frictions, and we find that the export cost is more recessionary. Two differences in the environment drive the reversal. First, because the cost

we study are imposed from abroad or are pure resource losses, they generate no domestic revenue and no rebate, and they enter the balance of payments directly. Second, our economy borrows in an infinite horizon model with default risk and endogenous borrowing limits, so the exchange rate must also cover foreign debt service, which is the source of the amplification we emphasize.

In contemporaneous work, Aguiar et al. (2026) study how tariff wars revalue existing net foreign asset positions through international relative prices in a two-country setting. Their result that a sufficiently high tariff can raise the real burden of liabilities payable in the other country's goods, forcing the debtor to export more, is consistent with our depreciation channel. They characterize equilibria in which claims are honored without default, whereas in our framework borrowing and default risk are endogenous, so the same valuation channel moves sovereign spreads.

Finally, our results are robust to the assumption that imports are consumption goods rather than intermediate inputs. Appendix C repeats the analysis of this section in a variant where the household consumes a CES bundle of the home and imported goods with elasticity σ and production uses only domestic factors. Every result survives, with the inverse import demand elasticity η_t replaced by its consumption counterpart $1/\sigma$. The ranking of borrowing incentives and spreads requires only the mild condition $\gamma_t \sigma \geq 1$. The asymmetry is a property of the balance of payments rather than the assumption of importing intermediate goods or consumption goods.

4 Quantitative Analysis

This section evaluates the quantitative properties of the model. We start by bringing our model-implied export and import wedges to the data and studies how sovereign spreads relate to the trade wedges in the data. We then follow with parameterization of the model and study the dynamic responses of these variables and show that regressions on model-simulated data closely replicate the empirical findings.

4.1 Trade Wedge in the Data

As TFP shocks, trade cost shocks cannot be directly observed. We therefore construct the empirical counterparts of the model-implied export and import wedges. We then plot the population-weighted averages of these wedges. At the aggregate level, these wedges are negatively correlated with sovereign spreads, with the relationship being particularly strong for the export wedge. To quantify this relationship, we estimate a panel regression and show that the correlation with sovereign spreads is largely driven by the export wedge, after controlling for country-level characteristics.

Measured Trade Wedge in the Model Following Alessandria et al. (2013); Levchenko et al. (2010), we measure the trade wedge as the variation in trade that cannot be explained by domestic and foreign demand, the terms of trade, the share of intermediate goods in production, and the real exchange rate. Specifically, we define export wedge and import wedge as follows.

Definition 1. *From the export demand function,* $\ln(X_t) = \ln\left(\left(\tau_t^X P_{ft}/P_{ft}^*\right)^{-\rho} D^*\right)$*, we derive the export wedge following*

$$\ln(X_t) = \ln \underbrace{(D^*)}_{\substack{\text{foreign}\\ \text{demand}}} + \rho \ln \underbrace{\left(\frac{P_{ft}^*}{P_{ft}}\right)}_{RER} - \textit{export wedge}. \tag{28}$$

The measured export wedge is given by

$$\textit{Export wedge} = \rho \ln\left(\tau_t^X\right), \tag{29}$$

where τ_t^X *denotes the iceberg costs for exports. Following the imported intermediate goods demand function,* $\ln(m_t^*) = \ln\left((\alpha_M y_t)^\sigma M_t^{1-\sigma} \omega (p_t^*)^{-\sigma} (P_{ft})^\sigma\right)$*, the corresponding import wedge is derived following*

$$\ln(m_t^*) = \ln \underbrace{(y_t)}_{\substack{\text{domestic}\\ \text{demand}}} - \sigma \ln \underbrace{\left(\frac{p_{jt}^*}{P_{ft}}\right)}_{TOT} + (1-\sigma) \ln \underbrace{\left(\frac{M_t}{Y_t}\right)}_{\substack{\text{share of}\\ \text{inter. goods}}} - \textit{import wedge}. \tag{30}$$

Then the import wedge is constructed as

$$\textit{Import wedge} = \underbrace{\ln\left(\omega^{-1} \alpha_M^{-\alpha} \left(\tau_t^M\right)^\sigma\right)}_{\textit{conventional import wedge}} + \underbrace{\sigma \ln\left(\left[\theta(1+r_t)^{1-\mu} + 1 - \theta\right]^{\frac{1}{1-\mu}}\right)}_{\textit{financial friction}}. \tag{31}$$

The export wedge is straightforward. Decomposing $\ln(X_t)$ as in (28), once foreign demand and the real exchange rate are accounted for, the residual captures the trade cost on exports. This residual defines the export wedge in (29), which is proportional to the log iceberg cost $\ln\left(\tau_t^X\right)$ and thus reflects the frictions that raise the effective cost of selling abroad.

Imports in the model are governed by the demand for imported intermediate goods, $\ln(m_t^*) = \ln\left((\alpha_M y_t)^\sigma M_t^{1-\sigma}\, \omega\, (p_t^*)^{-\sigma} (P_{ft})^\sigma\right)$. As in (30), the import demand entirely depends on prices and expenditures, including domestic demand y_t, the terms of trade p_{jt}^*/P_{ft}, and the share of imported intermediate goods M_t/Y_t. The import wedge is then defined as the gap between observed import flows and those predicted by these relative expenditures and prices, and is constructed as in (31). The import wedge

depends not only on the exogenous import iceberg costs but also on the endogenous sovereign default risk. Sovereign default risk raises domestic input costs through working capital requirements, effectively acting as a trade cost that reduces imports even when foreign prices remain unchanged. According to equation (31), when $\theta = 0$ (no working capital requirements), the import wedge reduces to the conventional measure, depending solely on import trade costs. Similarly, when sovereign default risk is absent ($r_t = 0$), the import wedge also reduces to the conventional measure. Hence, any shock that affects sovereign spreads will be reflected in the import wedge. Our theory thus provides an endogenous source of variation in trade wedges.

Data We compile a quarterly unbalanced panel of 16 economies spanning 2000Q4–2020Q2. See Appendix I.1 for details on variable construction and data source. Our baseline sample includes countries whose average sovereign spreads exceed one percentage point. The economies in the baseline sample are Argentina, Brazil, Bulgaria, Colombia, Greece, Hungary, Indonesia, Ireland, Italy, Lithuania, Mexico, Peru, the Philippines, South Africa, Spain, and Turkey.

The construction of empirical trade wedges in (28) and (30) requires: (i) real national accounts data on GDP, exports, and imports; (ii) measures of sovereign default risk; and (iii) price data, including the real exchange rate, terms of trade, and intermediate goods prices. National accounts data is mainly from IMF's International Financial Statistics (IFS). We primarily use real, seasonally adjusted national accounts data denominated in domestic currency from the IMF IFS. The domestic demand is measured as domestic real GDP, while the foreign demand is proxied by U.S. GDP as U.S. is one of the main trading partners of economies in the sample. We measure country-level financial frictions using quarterly sovereign CDS spreads obtained from Bloomberg. Specifically, we use the 5-year maturity CDS spread, quoted in U.S. dollars, and take the end-of-quarter last price as our measure.

All price data (real exchange rate and terms of trade) are mainly from the Global Economic Monitor (GEM). To get the real exchange rate, we average the monthly nominal exchange rate data into quarterly frequency, and then deflate the quarterly nominal exchange rate using the consumer price index (CPI) data. We do not directly observe the quarterly intermediate goods price. Nevertheless, using the OECD Inter-Country Input-Output (ICIO) Tables, we can obtain M_t/Y_t from the ratio of total intermediate goods used relative to total output from the input-output tables. Table I.3 in Appendix I.1 summarizes the statistics of key variables used in deriving trade wedges.

Trade Wedge and Sovereign Default Risk in the Data We estimate trade wedges following the theoretical decomposition in Definition 1.[2] Independent of the specific calibration, we adopt conventional parameter values commonly used in the literature ($\sigma = \rho = 3$) to construct the model-implied wedges, following (28) and (30). Considering the cross-country variations, we demean each series before deriving the trade wedge measures.[3]

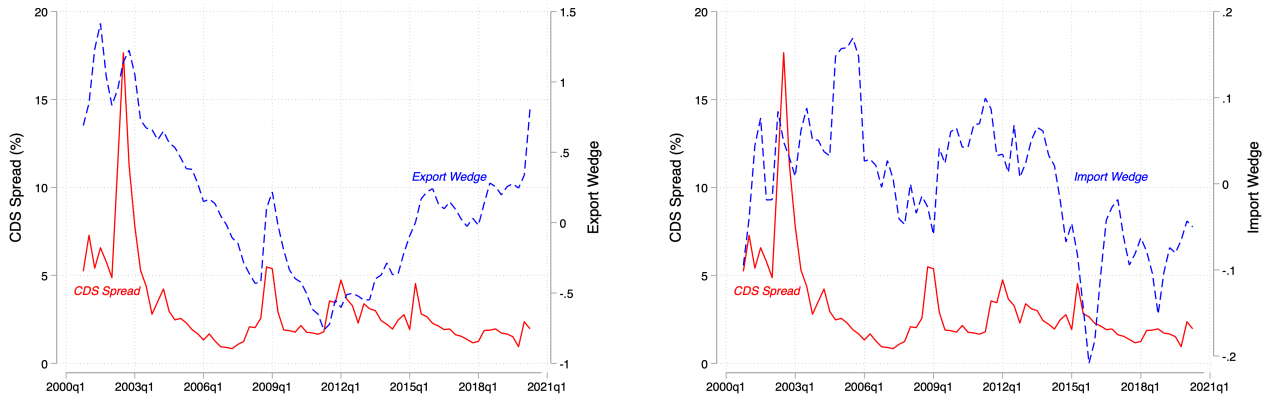
We first construct population-weighted averages of the export and import wedges across countries and then compare these series with our measure of sovereign default risk, the CDS spread. In Figure 1, the blue dashed lines plot the export and import wedges.[4] The movements in the export and import wedges are consistent with major trade events. The period of trade liberalization starting in 2002 coincides with a pronounced decline in the measured export wedge and a relatively mild change in the import wedge. During the 2008–09 Great Recession, a period marked by a collapse in trade, as widely documented in the literature (Alessandria et al. (2010, 2011), Gopinath et al. (2011), Bems et al. (2011, 2013), Chor and Manova (2012), among others), the export wedge peaked and the import wedge increased, reflecting a surge in trade barriers. Following the 2008-2009 Great Recession, trade barriers remained elevated, especially on the export side, indicating a shift toward geoeconomic fragmentation. This trend can be attributed to the rise of protectionism, as governments prioritized domestic industries and employment over free trade in the post-crisis period.

Figure 1 further compares the export and import wedges with the sovereign spread, showing that both are positively correlated with the CDS spread. As indicated in Panel (a) of Figure 1, the export wedge and CDS spread have an overall correlation of 0.56. The model-implied import wedge is weakly correlated with the CDS spread, at 0.15. From 2002 to 2007, both the export wedge and the CDS spread declined. The export wedge peaks during periods of elevated sovereign spreads, such as the period of emerging-market crises before 2002 and the 2008-2009 Great Recession. However, the export wedge also peaks during periods of stable CDS spreads, suggesting that non-financial factors such as geoeconomic fragmentation may also drive its dynamics. The country-specific figures for export and import wedges are provided in Appendix I.4, which demonstrates that the weighted-average series are not driven by any individual economy in the sample. We further demonstrate in Appendix I.5 that our main findings are robust to alternative aggregation methods. In particular, using median values or GDP-weighted averages across the 16 economies, rather than population weights, yields similar results.

[2]The intermediate goods price data is available at an annual frequency and is not available for all countries. Therefore, we exclude it from our baseline analysis and will discuss in our robustness check that this exclusion does not bias our baseline conclusions by applying a subsample with available intermediate goods price data.

[3]The baseline measure of the trade wedge removes time-invariant country-specific factors. The baseline results remain robust even after removing a linear country-specific trend from each variable for each country.

[4]In Appendix I.3, we compare the constructed export and import wedges with the corresponding export-to-GDP and import-to-GDP ratios, and show that the wedges are good proxies for export- and import-side barriers.



(a) Export wedge

(b) Import wedge

Figure 1: Export & import wedge and CDS spread

Notes: The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

To further establish the relationship between CDS spread and trade wedges, we consider the following panel regression:

$$\text{Spread}_{it} = \alpha + \beta_X \text{Export wedge}_{it} + \beta_M \text{Import wedge}_{it} + \gamma X_{it} + \eta_i + \lambda_t + \varepsilon_{it}, \tag{32}$$

where the dependent variable is CDS spread for country i at time t. The key regressors are the standardized export and import wedges. X_{it} includes a set of macroeconomic controls to account for business-cycle conditions and fiscal fundamentals, including output growth, CPI inflation, and the debt-to-GDP ratio. Output growth is the four-quarter log change in real GDP, inflation is the four-quarter log change in the consumer price index, and the debt-to-GDP ratio is the ratio of external debt to GDP. We also control for country and time fixed effects, which absorb time-invariant cross-country heterogeneity and common global shocks, respectively.

Table 1 reports the estimation results of Equation (32). Column (1) and (2) reveal a strong and robust positive relationship between the export wedge and spreads, with or without additional aggregate controls. A one–standard-deviation increase in the export wedge raises the spread by roughly 1.5–2.1 percentage points. In contrast, Columns (3) and (4) show that the import wedge is not positively related to spreads and turns weakly negative when controls are included. Columns (5) and (6) include both wedges jointly, confirming that the positive association with spreads is driven primarily by the export wedge. All specifications include country and time fixed effects.

Our baseline findings are robust to a range of sample and methodological choices. Both the time-

Table 1: Correlations between spreads and model-implied wedges

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	2.059***	1.508***			2.059***	1.552***
	(0.371)	(0.311)			(0.371)	(0.316)
Import wedge			0.028	-0.143*	0.026	-0.224***
			(0.119)	(0.076)	(0.117)	(0.087)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.253	0.565	0.237	0.530	0.253	0.568

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

series patterns shown in Figure 1 and the regressions testing the correlation between the wedges and sovereign spreads are robust to expanding the sample from 16 to 37 economies, adopting alternative elasticities of substitution, removing within-country linear trends rather than country means, excluding crisis episodes with extreme sovereign spreads, and incorporating intermediate goods price data into the wedge construction. Appendix I.5 reports the details.

Trade Wedge and Real Exchange Rate In Section 3, we show that τ_t^X depreciates more strongly than τ_t^M. We empirically validate this theoretical prediction by estimating Equation (32), using the real exchange rate as the dependent variable. We construct the real exchange rate from the nominal exchange rate, defined as the local currency per U.S. dollar, adjusted by relative prices, measured as the ratio of the U.S. CPI to the domestic CPI. The estimation results are reported in Table 2. We find that an increase in the export wedge is associated with a significant domestic currency depreciation, whereas the import wedge has only a mild depreciating effect on the exchange rate. We also examine the relationship between the terms of trade and the wedges in Appendix I.6 to further test the model's prediction regarding how trade cost shocks affect relative prices.

4.2 Parameterization

We parameterize the model to our 16-economy sample. For the households preference, we define $g(L) = \frac{L^\eta}{\eta}$ with $\eta > 1$, where $\frac{1}{\eta - 1}$ is the Frisch elasticity of labor supply. The period utility function takes the standard CRRA form $u(c, L) = \frac{(c - L^\eta/\eta)^{1-\gamma} - 1}{1-\gamma}$ with $\gamma > 0$.

Table 2: Correlations between RER and model-implied wedges

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	0.149***	0.159***			0.149***	0.159***
	(0.002)	(0.002)			(0.002)	(0.002)
Import wedge			-0.000	0.009***	-0.000	0.001
			(0.002)	(0.003)	(0.001)	(0.001)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	1.000	1.000	0.999	0.999	1.000	1.000

Notes: The dependent variable is the real exchange rate against the U.S. dollar. The real exchange rate is measured as the CPI-adjusted nominal exchange rate, expressed in units of local currency per U.S. dollar. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

We assume that the productivity shock z follows a first-order autoregressive process:

$$\log(z_t) = \rho_z \log(z_{t-1}) + \sigma_z \varepsilon_t, \quad \varepsilon_t \sim N(0,1), \tag{33}$$

where ρ_z captures the persistence of the productivity shock and σ_z governs the volatility of the productivity shock. ε_t follows a standard normal random process. After default, productivity takes a form in the fashion of Chatterjee and Eyigungor (2012), $z_d(z) = z - \max\left\{d_1 z + d_2 z^2, 0\right\}$ with $d_1 < 0 < d_2$. Under this form, the productivity loss, $\max\left\{d_1 z + d_2 z^2, 0\right\}$, is higher for countries that default under a higher level of productivity.

We assume the import cost shock τ^M and export cost shock τ^X follow first-order autoregressive processes:

$$\log(\tau_t^i) = \rho_\tau \log(\tau_{t-1}^i) + \sigma_{\tau_i} \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1), \tag{34}$$

where $i = \{M, X\}$. We assume that both shocks have the same persistence ρ_τ, but the two can have different volatilities σ_{τ_M} and σ_{τ_X}.

The model is at a quarterly frequency. There are two groups of parameters. The parameters in the first group are taken directly from the literature or from our empirical exercise, and those in the second group are jointly chosen to match a set of moments. The moments are the median values across the baseline sample. Table 3 lists all the parameter values.

The fixed parameters are $\{\alpha_M, \alpha_L, \alpha_k, \omega, A, \alpha, \rho, \mu, \sigma, \eta, \gamma, r^*, r_f^*, \chi, \phi, \rho_z, \rho_\tau, k\}$. We normalize the intermediate goods TFP and capital to 1. We set the parameters $\{\alpha_M, \alpha_L, \alpha_k\}$ in the final goods production function as in Mendoza and Yue (2012). Following Mendoza and Yue (2012), we set weight on imported goods ω to 0.23.[5] The labor share in GDP of intermediate goods α is 0.7, which is the standard labor share in GDP. We set the trade elasticity in foreign demand ρ to 3, following Eaton et al. (2016). We set the elasticity of demand in the Dixit-Stiglitz aggregator to 5, a corresponding value in Alessandria and Choi (2021). The Argmington elasticity is set to be 3, following Eaton et al. (2016). The curvature of labor disutility in the utility function is set to $\eta = 1.5$, which implies a Frisch elasticity of 2. This is the value typically used in RBC models of the small open economy. The coefficient of relative risk aversion γ is set to 2 and the quarterly risk-free interest rate r^* is set to 0.5%.

The firm benchmark interest rate r_f^* is 1.32% as the central bank policy rate. The parameter that governs the passthrough of sovereign risk is 0.6 following Arellano et al. (2020). The probability of reentry after default is 0.083, which implies that the country stays in exclusion for three years after default on average. We set autocorrelation of TFP shocks to 0.9, which is conventional value in the literature. We estimate the autocorrelation of iceberg cost shocks ρ_τ using a panel AR(1) specification for the export and import wedges recovered in Section 4.1. We assume both export and import wedges follow a AR(1) process:

$$\text{export wedge}_{it} = \rho_\tau^w \, \text{export wedge}_{i,t-1} + \alpha_i^x + \varepsilon_{x,it}, \tag{35}$$

$$\text{import wedge}_{it} = \rho_\tau^w \, \text{import wedge}_{i,t-1} + \alpha_i^m + \varepsilon_{m,it}, \tag{36}$$

where i indexes countries and t indexes time. We include country fixed effects, α_i^x and α_i^m, in both equations and estimate the two equations jointly. We impose a common autoregressive coefficient ρ_τ^w across export and import wedges by restricting the coefficients. The estimated ρ_τ is 0.936.

We calibrate the remaining parameters $\{D^*, \sigma_z, \sigma_{\tau_M}, \sigma_{\tau_X}, \theta, \beta, d_1, d_2\}$ jointly by minimizing the sum of distances between model-implied moments and their empirical counterparts. While the parameters are chosen simultaneously, it is useful to describe which moments primarily discipline each one. The export-demand shifter D^* is pinned down by the trade-to-GDP ratio. The standard deviation of TFP innovations, σ_z, mainly governs GDP volatility. The volatilities of import and export trade-cost shocks, σ_{τ_M} and σ_{τ_X}, primarily affect the standard deviations of the import-to-GDP and export-to-GDP ratios. The parameter θ, the share of imported inputs requiring working-capital financing, is tightly linked to the working-capital-to-GDP ratio. Finally, the mean and volatility of sovereign spreads, together with the average level of debt-to-GDP, are most informative about the discount factor β and the default punishment

[5] ω in this paper and λ in Mendoza and Yue (2012) are linked by $\omega = (\frac{1-\lambda}{\lambda})^\sigma$.

parameters $\{d_1, d_2\}$.

Table 4 reports the moments in the data and in the model. The model captures the targeted moments reasonably well (top panel, "Targeted moments"). It generates an average spread of 1.3%, compared with 1.8% in the data, with dispersion of a similar order of magnitude (1.1% in the model versus 1.3% in the data). The model aligns well with most of the remaining targets: it produces a mean working-capital-to-GDP ratio of roughly 7%, GDP volatility just above 4%, and a mean trade-to-GDP ratio near 55%, all close to their data counterparts. The mean debt-to-GDP ratio is somewhat lower in the model than in the data, at about 26% versus 33%. Finally, the model captures the volatility of gross trade flows: the standard deviation of exports to GDP is close to 3% in both the data and the model, while the standard deviation of imports to GDP is a bit higher in the model than in the data (3.9% versus 3.0%).

The bottom panel of Table 4 compares the model with a broad set of non-targeted trade and macro moments. The model delivers import and export shares close to those in the data: the import-to-GDP ratio is 30.5% in the model versus 27.5% in the data, and the export-to-GDP ratio is 25.8% versus 27.6% (reported in Appendix Table D.1). The model captures the order of magnitude of trade-wedge volatility, with the standard deviation of the export wedge at 0.19 in the model versus 0.41 in the data, and that of the import wedge at 0.15 in the model versus 0.29 in the data. The standard deviation of trade-to-GDP is 6.0% in the model and 4.4% in the data, and the standard deviation of the trade balance-to-GDP ratio is slightly lower in the model than in the data (2.8% versus 3.7%). The model generates about half of the volatilities of relative prices and absorption: the standard deviations of the terms of trade and the real exchange rate are both about 0.05 in the model versus 0.11 and 0.13 in the data, and the standard deviation of consumption is 0.03 versus 0.05. Despite these gaps, the discrepancies are mostly quantitative rather than qualitative, and the model still reproduces the approximate magnitudes of these moments.

The cyclical patterns are broadly in line with the data: the correlation between spreads and GDP is negative, trade is procyclical, and the import and export wedges are weakly correlated. Finally, using data generated from the calibrated model, we estimate the counterparts of the regressions in Table 1.[6] The model produces magnitudes quantitatively comparable to those in the data. A one-standard-deviation increase in the export wedge raises the spread by roughly 1.6 percentage points both in the data and in the model. As for the import wedge, the data shows a negative or insignificantly positive correlation between the import wedge and spreads, and the model shows a weak correlation between them. This result shows that the model successfully captures the dominant role of the export wedge in determining sovereign spreads. We further illustrate this mechanism through additional exercises, including impulse

[6]For the model counterparts, see Appendix E for details.

response functions and event analyses.

Table 3: Parameter Values

Parameter	Description	Value	Target/Source
Fixed Parameters			
α_M	Int. goods share in gross output of final goods	0.43	Mendoza and Yue (2012)
α_L	Labor share in gross output of final goods	0.4	Mendoza and Yue (2012)
α_k	Capital share in gross output of final goods	0.17	Mendoza and Yue (2012)
ω	Weight on imported goods	0.23	Mendoza and Yue (2012)
A	Intermediate goods TFP coefficient	1	Normalization
α	Labor share in GDP of int. goods	0.7	Standard labor share in GDP
ρ	Trade elasticity in foreign demand	3	Eaton et al. (2016)
μ	Elasticity of demand	5	Alessandria and Choi (2021)
σ	Armington elasticity	3	Eaton et al. (2016)
η	Frisch elasticity of labor supply ($\frac{1}{\eta-1}$)	1.5	Frisch elasticity=2
γ	Coefficient of relative risk aversion	2	Standard value
r^*	Risk-free interest rate	0.5%	Standard value
r_f^*	Firm benchmark interest rate	1.32%	Central bank policy rate
χ	Pass through of sovereign risk	0.6	Arellano et al. (2020)
ϕ	Reentry probability	0.083	Mendoza and Yue (2012)
ρ_z	Autocorrelation of TFP shocks	0.9	Standard value
ρ_τ	Autocorrelation of iceberg cost shocks	0.936	Our estimation
k	Capital	1	Normalization
Parameters from Moment Matching			
D^*	Export demand level	10	Trade to GDP ratio
σ_z	Standard deviation of TFP innovations	0.008	SD of GDP
σ_{τ_M}	Standard deviation of import cost shock	0.015	SD of import to GDP ratio
σ_{τ_X}	Standard deviation of export cost shock	0.02	SD of export to GDP ratio
θ	Imported inputs with working capital	0.25	Working capital to GDP ratio
β	Discount factor	0.87	Average debt to GDP ratio
d_1	Punishment parameter	-0.8	Average spread
d_2	Punishment parameter	0.81	SD of spread

4.3 Dynamic Responses to Productivity and Trade Cost Shocks

To analyze the roles of productivity shock, import cost shock, and export cost shock, and investigate the propagation mechanism, we compute impulse responses to each of the three shocks. The economy is initialized at its ergodic mean, the shock is introduced in period 1, and the corresponding driving process follows its underlying Markov chain thereafter. The plotted impulse responses are averages across 50,000 simulated paths. To facilitate comparison across shocks, we calibrate the size of each shock so that real GDP, measured at base-period prices, falls by 1% on impact. Achieving this 1% decline requires a roughly 0.47% fall in productivity z_t, a 6% rise in the import cost τ_t^M, or a 7% rise in the export cost τ_t^X. Figure 2

Table 4: Moments

Targeted moments					
Mean(%)	**Data**	**Model**	**Std(%)**	**Data**	**Model**
Mean(Spread)	1.8	1.3	Std(Spread)	1.3	1.1
Mean(Debt/GDP)	33.4	26.4	Std(GDP)	4.3	4.4
Mean(Trade/GDP)	55.4	56.3	Std(Import/GDP)	3.0	3.9
Mean(Working capital/GDP)	7.1	7.2	Std(Export/GDP)	2.8	2.7
Untargeted moments					
Mean(%) & Std(%)	**Data**	**Model**	**Comovement(%)**	**Data**	**Model**
Std(Export wedge)	40.6	19.3	Corr(spread, GDP)	-21.0	-4.2
Std(Import wedge)	29.3	14.8	Corr(Import wedge, Export wedge)	4.8	2.0
Std(Trade/GDP)	4.4	6.0	Corr(Trade/GDP, GDP)	38.6	18.7
Std(Trade balance/GDP)	3.7	2.8	Corr(Trade/GDP, spread)	-22.7	-7.2
Std(ln(TOT))	10.7	4.6	**Regression Coef**		
Std(ln(RER))	13.2	4.6	Coef(export wedge)	1.6	1.6
Std(Consumption)	4.9	2.8	Coef(import wedge)	-0.2	0.5

Notes: This table reports data and model. The top panel reports the targeted moments used for calibration; the bottom panel reports the untargeted moments. For the construction of moments in the data, see Appendix I.7 for the details. The model moments are given by the averages across 5,000 simulations. All in percentage, except the regression coefficients.

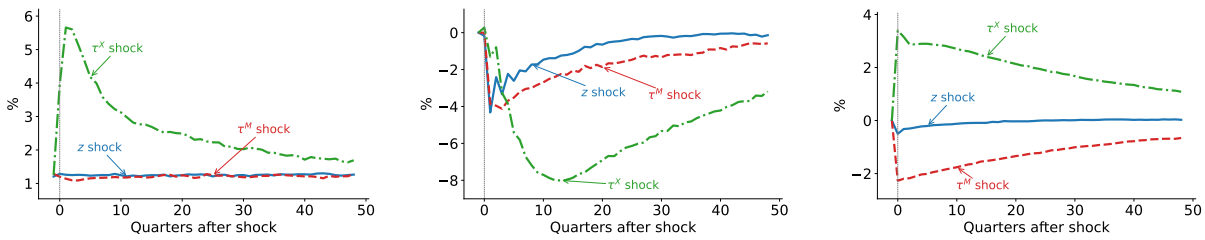
reports the responses to the three shocks side by side. The figure delivers the paper's central asymmetry in one picture: holding the size of the decline in output fixed, the export cost shock depreciates the exchange rate and raises the sovereign spread sharply, whereas the productivity and import cost shocks, with the same output cost, leave the spread essentially unchanged.

Panel (a) plots the sovereign spreads. The sovereign spread barely moves under the productivity shock and is flat under the import cost shock, but under the export cost shock, it jumps to 5.7%, an increase of more than 4 percentage points. Panel (b) plots debt. It falls by about 4% under z_t and τ_t^M and then recovers steadily, whereas under τ_t^X it falls by about 8%, reaching its trough roughly three years after the shock and recovering slowly.

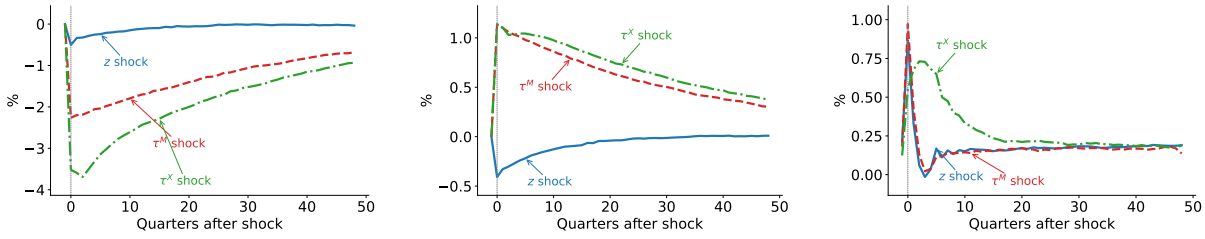
Panel (c) plots the exchange rate. The import cost shock appreciates the exchange rate by about 2%, and the export cost shock depreciates the exchange rate by about 3.5%. The productivity shock moves the exchange rate by only 0.5%. The depreciation under τ_t^X raises the domestic value of new foreign borrowing while the appreciation under τ_t^M lowers it, which is the borrowing incentive channel of Proposition 4. Panel (d) plots $\tilde{e} = e/\tau^X$, which falls by about 3.7% under the export cost shock, because τ_t^X rises by more than the currency depreciates.

Panels (e) plots domestic inputs. Both trade cost shocks trigger substitution toward home inputs, with domestic intermediate input use m^d rising by about 1.1%. Under the productivity shock, m^d dips briefly by about 0.4%. Finally, panels (h) and (i) plots import and export wedge which confirms that each trade cost shock loads on its own wedge on impact.

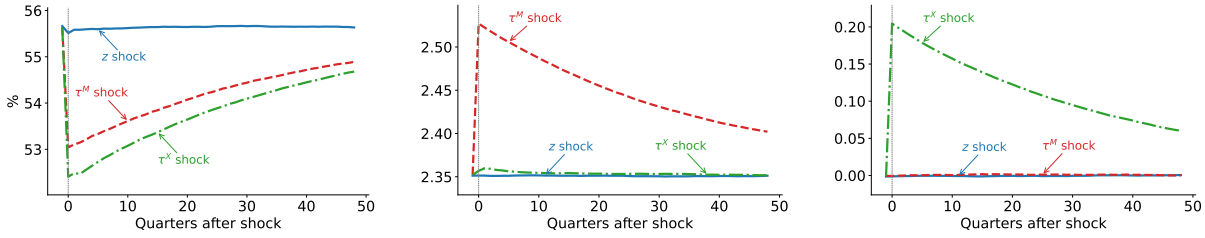
To understand why τ_t^X has such a big effect on sovereign risk, Figure 3 examines repayment capacity under different shocks. Export revenue in foreign-good units, $P^f \cdot EX$, falls by about 1% under the z_t shock, by about 4.5% under τ_t^M, and by about 12% under τ_t^X. Since external debt is serviced out of these foreign currency revenues, the debt-to-export-revenue ratio $b/(P^f \cdot EX)$ spikes to nearly one on impact under τ_t^X, well above the responses under the other two shocks. The default frequency follows the same ranking, rising from about 4.7% to about 12% following a τ_t^X shock, against about 6.6% under τ_t^M and essentially no movement under z_t. With debt service fixed in foreign currency, τ_t^X shocks compress the foreign currency revenue stream available to service external debt more than the other two shocks of comparable real GDP impact, and this compression of repayment capacity is what makes τ_t^X the dominant driver of spread dynamics in the model.



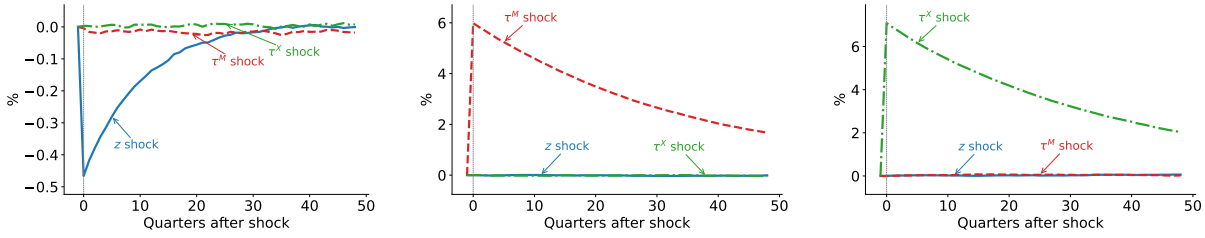
(a) Spread (b) Debt (c) Exchange rate e



(d) $\tilde{e} = e/\tau_X$ (e) Domestic inputs m^d (f) Trade balance/GDP



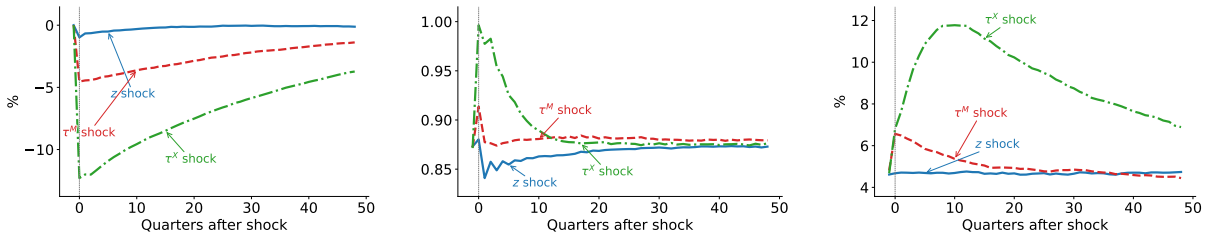
(g) Trade/GDP (h) Import wedge (i) Export wedge



(j) z shock (k) τ^M shock (l) τ^X shock

Figure 2: Impulse responses to productivity, import-cost, and export-cost shocks

Notes: Impulse responses are averages across 50,000 simulated paths. The economy is initialized at its ergodic mean. The size of each shock is chosen so that real GDP at base-period prices falls by 1% on impact. All variables are reported in percentage deviation from their pre-shock value, except for the sovereign spread, which is reported in annualized percentage points, the trade balance to GDP and trade-to-GDP ratios, which are reported in percentage points of GDP, and the import and export wedges, which are reported in levels.



(a) Export revenue $P^f \cdot EX$ (% dev.) (b) Debt / export revenue $b/(P^f \cdot EX)$ (c) Default frequency

Figure 3: Repayment-capacity channel: export revenue, debt-to-revenue ratio, and default frequency

Notes: For each shock, calibrated to deliver the same 1% on-impact decline in real GDP, the figure plots: (i) the percentage deviation of export revenue $P^f \cdot EX$ from its pre-shock value, (ii) the ratio of debt to export revenue $b/(P^f \cdot EX)$ in levels, and (iii) the average default frequency in percentage, computed as the share of simulated paths in default at each horizon. The export-cost shock produces the largest compression of foreign currency revenue and the largest increase in default risk.

4.4 Event Analysis

While the countries in our sample experienced sustained increases in trade openness over the preceding decades, they also underwent several sharp episodes during the Great Recession of 2008–2009, when the trade-to-GDP ratio declined temporarily but substantially. As Levchenko et al. (2010) document, a significant "trade wedge" emerges between the observed collapse in trade and what would be expected given the path of economic activity and relative prices. This wedge motivates our event-study approach: we focus on the trade collapse episodes around the Great Recession, document the dynamics of key variables during these episodes and use these empirical patterns to discipline the quantitative analysis of our model.

A trade collapse event is defined as an episode in which a country's linearly detrended trade-to-GDP ratio drops more than one standard deviation below its country-specific mean during the Great Recession of 2008-2009. Each event is centered on the trough of the trade-to-GDP ratio, and we trace the behavior of key variables over a symmetric window of eight quarters around the event. Figure 4 presents the average paths across the ten events identified in our dataset for output growth, import wedge, export wedge, sovereign spreads, import-to-GDP ratio, and export-to-GDP ratio.[7] All series are standardized at the country level, so values are expressed in units of standard deviations from the mean, with zero corresponding to the country-specific average.

Panel (a) shows that output growth declines by about 2.4 standard deviations at the trough. Panels (b) and (c) reveal that the import wedge and the export wedge both rise sharply around the trough, peaking

[7]The ten events trough at Argentina 2009Q3, Colombia 2009Q3, Greece 2009Q4, Hungary 2009Q2, Indonesia 2009Q1, Italy 2009Q2, Mexico 2009Q2, Philippines 2009Q1, South Africa 2009Q2, and Spain 2009Q1.

at about 0.8 and 0.3 standard deviations, respectively, consistent with a tightening of trade conditions during the crisis. Panel (d) shows that sovereign spreads spike at the time of the trade collapse, peaking at about 1.6 standard deviations above their mean at $t = -1$ and declining as the crisis subsides. Panels (e) and (f) document the collapse in import-to-GDP and export-to-GDP, which fall by about 1.3 and 1.2 standard deviations at the trough, respectively, before recovering.[8]

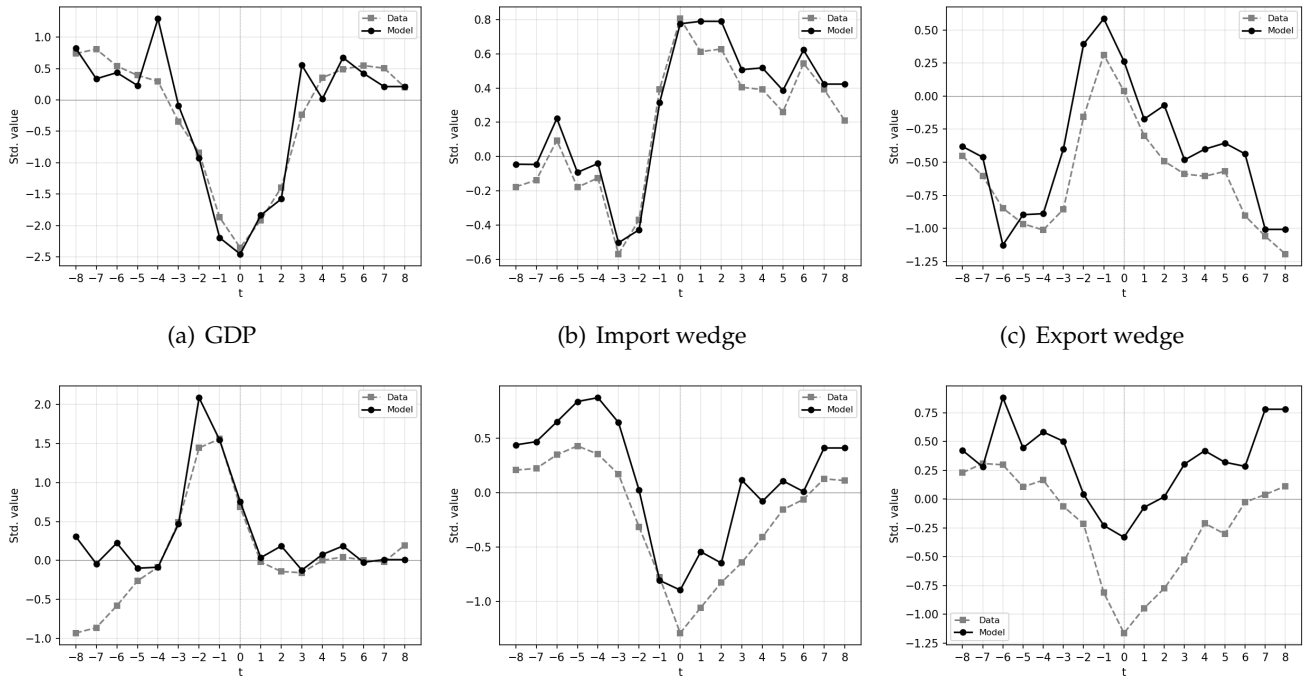
We use the benchmark model to assess its quantitative ability to match the observed event dynamics. We initialize the economy at the mean of its stationary distribution and simulate the event by feeding in sequences of productivity, import cost, and export cost shocks. We select these shock sequences to minimize the distance between the model-implied paths of GDP, the import wedge, and the export wedge and their empirical counterparts. All series are standardized.

As shown in Figure 4, the model reproduces the dynamics of the targeted series reasonably well (Panels (a), (b), and (c)). GDP bottoms out at about -2.4 standard deviations in the data and -2.5 in the model, both at $t = 0$; the model runs slightly deeper going into the trough (-2.2 versus -1.9 at $t = -1$), and the rebound thereafter is well matched. The model also captures the trade-wedge dynamics: the import wedge peaks at about 0.8 in both the data (at $t = 0$) and the model, and although the export wedge peaks a little higher in the model (0.6 versus 0.3 in the data), its peak-to-trough swing is comparable across the two (about 1.5 in the data and 1.7 in the model). Both wedges drift down through the post-event window.

The untargeted moments (Panels (d), (e), and (f)) match the same qualitative patterns. Spreads spike sharply into the event, peaking at 1.6 standard deviations in the data at $t = -1$ and 2.1 in the model at $t = -2$, and then revert toward normal within a few quarters. Trade shares collapse and recover, with the model reproducing both the timing and, broadly, the magnitude: the peak-to-trough decline of the import-to-GDP ratio is 1.8 standard deviations in the model versus 1.7 in the data, and the peak-to-trough decline of the export-to-GDP ratio is 1.2 in the model versus 1.5 in the data. The model matches the depth of the import-share collapse and modestly understates that of the export share.

Figure 5 decomposes the event dynamics by allowing one shock to move at a time. The black line reports the benchmark fit with all shocks; the colored lines show counterfactual paths in which only one shock is active (only z, only τ_M, or only τ_X). Several observations stand out. First, the GDP contraction is overwhelmingly accounted for by productivity. With all shocks, GDP falls to about -2.5 standard deviations at $t = 0$; with only z, the trough is about -2.2 at $t = 0$, capturing the bulk of the benchmark decline. The trade-cost shocks alone generate very mild GDP movement: under only τ_M, GDP stays near zero throughout, and under only τ_X, GDP barely dips, to about -0.2. The depth of the GDP contraction is

[8] Please see Appendix I.8 for more details.



(a) GDP (b) Import wedge (c) Export wedge

(d) Spread (e) Import/GDP (f) Export/GDP

Figure 4: Event Analysis

Notes: The figure plots average event paths around trade-collapse episodes during the Great Recession of 2008–2009. An event is an episode in which a country's linearly detrended trade-to-GDP ratio falls more than one standard deviation below its country-specific mean; each event is centered on the trough of that ratio ($t = 0$), and paths are averaged across the ten identified events over a symmetric window of eight quarters on either side. Gray dashed lines with square markers denote the data and black solid lines with circle markers the benchmark model. All series are standardized at the country level, so values are expressed in standard deviations from the country-specific mean, with zero corresponding to that mean. GDP and the import and export wedges (Panels (a)–(c)) are targeted: starting from the mean of the model's stationary distribution, the shock sequences for z_t, τ_t^M, and τ_t^X are chosen to minimize the distance between the model and data paths of these three series. The sovereign spread and the import- and export-to-GDP ratios (Panels (d)–(f)) are untargeted.

therefore driven by z_t, with little incremental role for τ_t^M or τ_t^X in isolation.

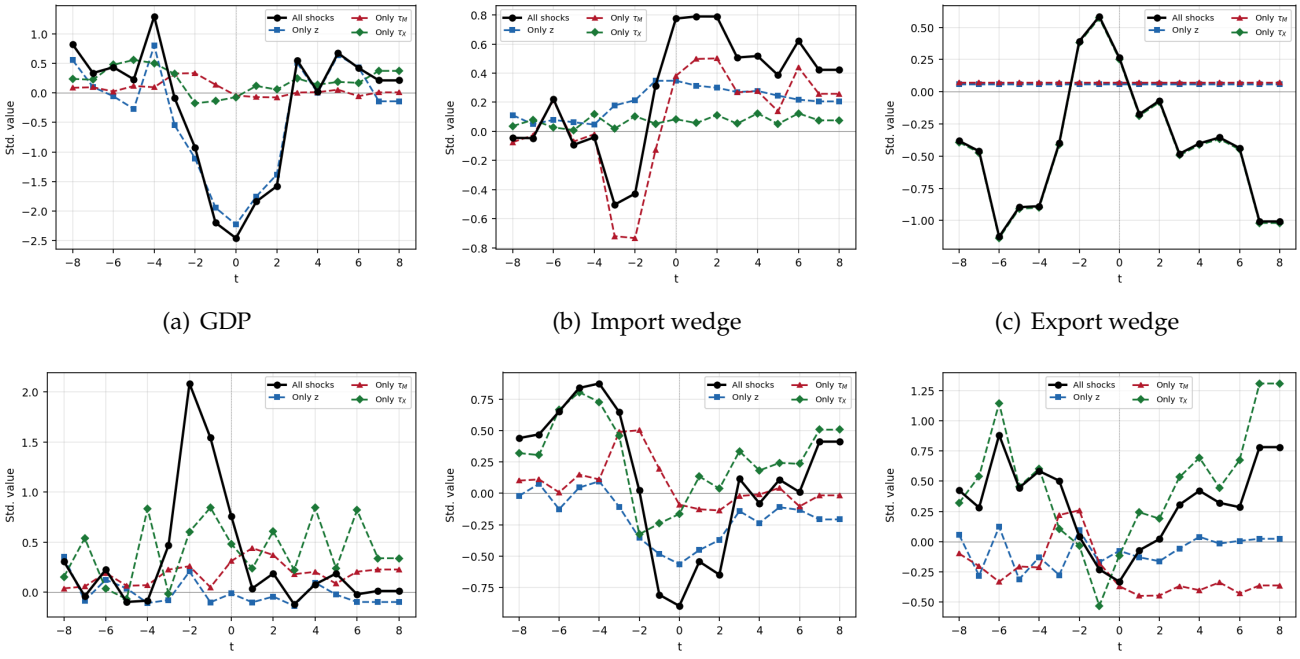
Second, the wedges load on different shocks. The import wedge is driven by the import-cost shock and indirectly by productivity. With all shocks it peaks at 0.8; under only τ_M the peak is 0.5, and under only z the peak is 0.4. Both shocks contribute substantively: z_t raises the spread, which feeds into the working-capital component of the import wedge, while τ_t^M raises the wedge directly. The export wedge, by contrast, is entirely pinned down by the export-cost shock, as expected from its definition $\rho \log \tau_t^X$: under only τ_X the peak is 0.6, indistinguishable from the all-shock benchmark.

Third, the spread spike is a nonlinear interaction effect. The benchmark spread peaks at 2.1 standard deviations near $t = -2$, but none of the single-shock counterfactuals comes close: only z produces a peak of 0.4, only τ_M a peak of 0.4, and only τ_X a peak of 0.8. The peak under all three shocks combined is therefore much larger than the sum of the individual contributions, indicating that the interaction of the shocks through endogenous default risk is what generates most of the spread response. Finally, the trade-share panels reveal that the import-cost and export-cost shocks each pull their respective trade margin in the same direction as the benchmark, but neither single shock matches the depth of the all-shock benchmark, and under only τ_X the export-to-GDP swing actually overshoots the benchmark.

5 Local Currency Debt

This section examines currency denomination of sovereign debt shape the asymmetric impact of export and import wedges on sovereign spreads. With local currency debt, it is still the case that export cost shock depreciates the exchange rate more than the import cost shock. However, the elasticity of consumption to the two shocks are the same. Thus, our baseline results that the borrowing incentives are higher under the export cost shock still present, but the differential responses of spread to the two shocks become smaller.

We first present the results theoretically. We then test this idea along two margins. First, we exploit cross-country variation by splitting issuers into EU and non-European economies, taking the latter as more reliant on foreign currency borrowing, and ask whether their spreads comove more strongly with export wedges. Second, we exploit variation over time: as more emerging markets escaped "original sin" and shifted toward local currency debt after 2004, we ask whether the comovement correspondingly weakened. Lastly, we present the impulse response functions and show that quantitatively the results survive.



(a) GDP (b) Import wedge (c) Export wedge

(d) Spread (e) Import/GDP (f) Export/GDP

Figure 5: Event Analysis: Decomposition

Notes: The figure decomposes the event paths of Figure 4 by activating one shock at a time. The black solid line with circle markers is the benchmark fit with all three shocks; the dashed lines are counterfactual paths in which only a single shock is active: only z_t (blue, squares), only τ_t^M (red, triangles), and only τ_t^X (green, diamonds). The event construction, the panels, the symmetric eight-quarter window, and the country-level standardization are identical to Figure 4; values are expressed in standard deviations from the country-specific mean.

5.1 Theory: Asymmetric Response

With local currency debt, the face value b_t is denominated in units of the home final good. Repayment is then worth $P_{ft}b_t$ in foreign-good units, so the resource constraint of the repayment problem becomes

$$P_{ft}c_t + P_{ft}\left(b_t - q_t^{LC}b_{t+1}\right) = P_{ft}z_t M\left(m_t^d, m_t^*\right)^{\alpha_M}\left(L_t^f\right)^{\alpha_L}k^{\alpha_k} - p_t^* m_t^*, \tag{37}$$

with the same replacement of the net debt flows in the balance of payments condition. The bond price q_t^{LC}, now expressed in units of the home final good, satisfies the foreign lenders' break-even condition and carries the expected exchange rate conversion:

$$q_t^{LC} = \frac{1}{1+r^*}\,\mathbb{E}_t\left[\left(1 - D(b_{t+1}, z_{t+1}, \tau_{t+1}^M, \tau_{t+1}^X)\right)\frac{e_t}{e_{t+1}}\right], \tag{38}$$

where $e_t = 1/P_{ft}$. Besides default risk, q_t^{LC} thus prices the expected change in the value of the home good between t and $t+1$. A real depreciation, that is a fall in P_{ft} or equivalently a rise in e_t, deflates the foreign currency value of outstanding debt. The rest of the model is unchanged. Let $\mathcal{R}_t^{LC} = b_t - q_t^{LC}b_{t+1}$ be the net debt repayment in local currency.

Proposition 5. *With local currency debt, export cost shock depreciates the exchange rate by more than the import cost shock, while the two shocks reduce consumption equally:*

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} - \frac{\partial \ln e_t}{\partial \ln \tau_t^M} = 1, \qquad \frac{\partial \ln c_t}{\partial \ln \tau_t^X} = \frac{\partial \ln c_t}{\partial \ln \tau_t^M} = -\alpha_M(1-s_t)\frac{Y_t}{c_t} \;<\; 0. \tag{39}$$

Outstanding debt no longer amplifies the differential depreciation, and the reason is who bears the valuation risk on the repayment. Written in units of home goods, the balance of payments conditions is $\tilde{e}_t^{\rho} = \tilde{e}_t\tau_t^X\tau_t^M m_t + \tilde{e}_t\tau_t^X\mathcal{R}_t$ under foreign currency debt and $\tilde{e}_t^{\rho} = \tilde{e}_t\tau_t^X\tau_t^M m_t + \mathcal{R}_t^{LC}$ under local currency debt. A foreign currency claim fixes the repayment in foreign goods, so when the export cost rises the country must ship over more home goods to deliver the same foreign value: the home cost of debt service, $\tilde{e}_t\tau_t^X\mathcal{R}_t$, rises with the shock, and the exchange rate must depreciate further to generate the additional export quantity. A local currency claim fixes the repayment in home goods: the country delivers $\mathcal{R}_t^{LC}$ regardless, and the deterioration in the terms of trade reduces what lenders receive rather than what the borrower must ship. The repayment term is therefore free of both shocks, the trade costs enter the condition only through their product. Thus, the shocks move $\tilde{e}_t$ equally, so the exchange rate elasticities differ only by the mechanical unit, and consumption falls equallsy, since the shock no longer raises the home resource cost of serving existing debt. Lenders anticipate bearing this valuation risk and price it in

to q_t^{LC} through the expected foreign value of repayment.

Rewrite the bond price schedule as

$$q_t^{LC} = e_t\, Q_t(b_{t+1}), \qquad Q_t(b_{t+1}) \equiv \frac{1}{1+r^*}\,\mathbb{E}_t\left[\left(1-D_{t+1}\right)/e_{t+1}\right], \tag{40}$$

where $Q_t(b_{t+1})$ is the value in foreign goods lenders pay per unit of face value. Under i.i.d. shocks, $Q_t(\cdot)$ depends on b_{t+1} only. The government's optimal choice of b_{t+1} is given by

$$\frac{u'(c_t)\,e_t}{\rho-\chi_t}\left[Q(b_{t+1}) + Q'(b_{t+1})\,b_{t+1}\right] = \beta\mathbb{E}\left[\frac{u'(c_{t+1})}{\rho-\chi_{t+1}}\right]. \tag{41}$$

where $\chi_t \equiv= \frac{\tau_t^M m_t}{\tau_t^M m_t + \mathcal{R}_t^{LC}/e_t}$. When $\mathcal{R}_t^{LC} \geq 0$, $\chi_t \leq 1$. In this case, export cost shock still generates the stronger borrowing incentive due to the larger depreciation it induces. The consumption response, which under foreign currency debt amplified the asymmetry, is now common to the two shocks. Thus the asymmetry becomes smaller relative to the foreign currency case. Export cost shocks therefore continue to push up sovereign spreads by more than import cost shocks, but by a smaller magnitude. Proposition 9 in the appendix provides the formal proof.

5.2 Empirical Analysis

We now test the model's prediction for local currency debt: the export cost shock should still raise sovereign spreads by more than the import cost shock, but the asymmetry shrinks. We examine two sample splits in which the prevalence of local currency debt differs. First, we compare European countires with countries outside Europe. European sovereigns issue predominantly in euros, which for euro area members is their own currency, so this group borrows disproportionately in local currency. Second, it is well documented that countries have shifted toward local currency debt over time (Ottonello and Perez, 2019), so we split the sample into the periods before and after 2004.

European versus non-European countries. The baseline specification in Equation (32) relates sovereign spreads to the export and import wedges. Here we augment it with interaction terms: each wedge is interacted with $\mathcal{I}_{\text{nonEU}}$, an indicator for non-EU members, which rely more on foreign currency borrowing. Table 5 reports the results.

In Column (6), the interaction between export wedge and $\mathcal{I}_{\text{nonEU}}$ is positive and significant, implying that with 1 standard deviation increase in export wedge, the sovereign spread increases roughly 1.69

Table 5: Spreads and trade wedges: European vs. non-European countries

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.941***	0.204			2.181***	0.070
	(0.690)	(0.377)			(0.738)	(0.381)
Export wedge $\times \mathcal{I}_{nonEU}$	0.128	1.529**			-0.001	1.688**
	(0.625)	(0.635)			(0.621)	(0.656)
Import wedge			0.029	-0.205**	0.112	-0.288***
			(0.133)	(0.084)	(0.135)	(0.107)
Import wedge $\times \mathcal{I}_{nonEU}$			-0.017	1.341***	-1.686*	0.696**
			(0.780)	(0.357)	(0.951)	(0.313)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.253	0.571	0.237	0.534	0.254	0.576

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. $\mathcal{I}_{\text{nonEU}}$ is an indicator that equals 1 if country i is not a member of the EU. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

percentage points more for non-EU issuers. The same pattern holds for the import wedge: the non-EU interaction is positive, indicating 0.70 percentage points higher for non-EU countries. This is consistent with our prediction that countries with more foreign currency borrowing show stronger correlation between wedges and sovereign spreads.

Before versus after 2004. Table 6 interacts the wedges with $\mathcal{I}_{<04}$, which equals one before 2004. As shown in Ottonello and Perez (2019), the average share of sovereign debt issuance denominated in local currency rose from 63 percent over 1990–2003 to 84 percent over 2004–2014, we adopt 2004 as the cutoff separating the low- and high-local-currency-issuance regimes. With more foreign currency debt of those sovereigns, the before-2004 interactions are expected to be positive. Column (6) confirms that an increase of one standard deviation of export-wedge on average is associated with 1.34 percentage points increase in sovereign spread after 2004. The estimated interaction term of 2.16 indicates that the average effects are 2.16 percentage points higher before 2004. The import wedge behaves similarly. As a robustness check, we re-estimate using the global financial crisis as the cutoff and find that the results are robust; details are reported in Appendix I.5.

Taken together, the two tables trace the same mechanism along two margins. Sovereigns that borrow more in foreign currency, which correspond to non-EU countries, exhibit a stronger correlation between export and import wedges and spreads. When sovereigns use more foreign currency debt before 2004, the correlations are also stronger. This is consistent with our theoretical prediction.

Table 6: Spreads and wedges: local currency debt before 2004

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.969***	1.251***			1.970***	1.339***
	(0.453)	(0.306)			(0.454)	(0.313)
Export wedge $\times \mathcal{I}_{<04}$	0.460	2.479***			0.456	2.162***
	(0.722)	(0.566)			(0.785)	(0.572)
Import wedge			0.005	-0.169**	0.022	-0.250***
			(0.118)	(0.079)	(0.117)	(0.090)
Import wedge $\times \mathcal{I}_{<04}$			4.524***	8.633***	0.021	5.194**
			(1.518)	(2.932)	(2.005)	(2.231)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.253	0.579	0.238	0.536	0.253	0.584

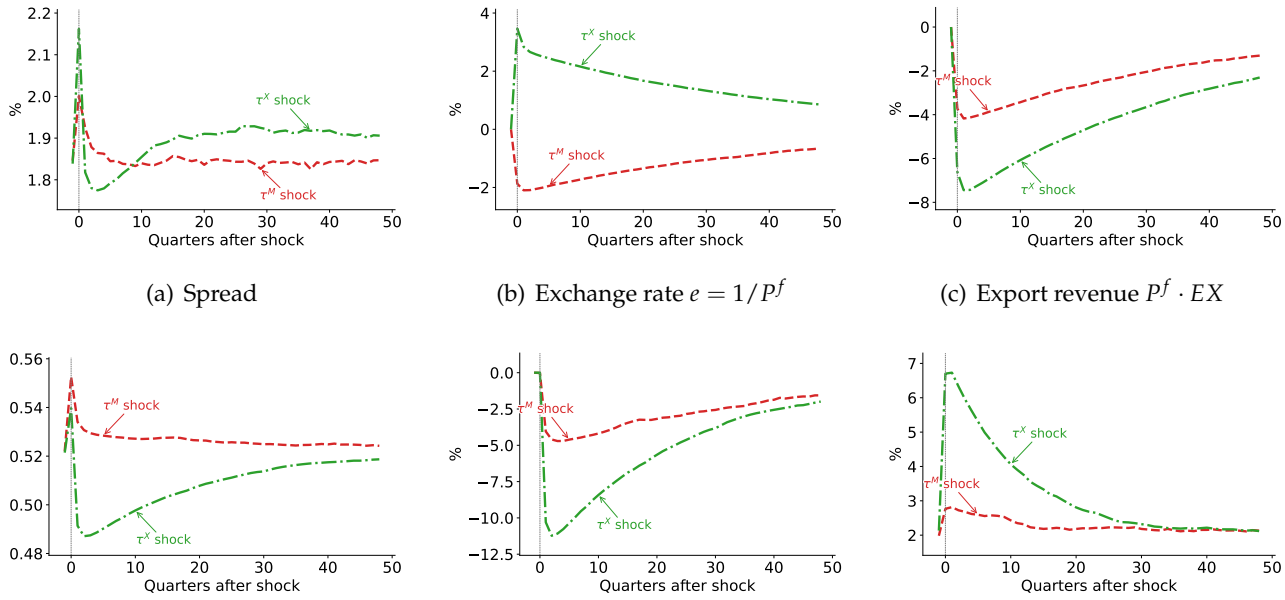
Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. $\mathcal{I}_{<04}$ is an indicator variable equal to 1 for years before 2004. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

5.3 Quantitative Analysis

We now show that the theoretical predictions carry over to our quantitative analysis, which relaxes Assumption 1 and allows for persistent shocks. The parameters are the same as in the benchmark. The impulse responses use the same normalization as in Section 4.3: the size of each trade cost shock is calibrated within the model so that real GDP falls by 1% on impact. For the import cost shock, this requires a rise in τ_t^M of about 6%, the same size as in the benchmark. For the export cost shock, a rise in τ_t^X of about 4.8% suffices, compared with 7% in the benchmark.

Figure 6 reports the impulse responses of the economy with the local currency debt. Panel (a) plots the sovereign spread, which we can compare with the benchmark responses of Figure 2. First, it is still the case that the rise in spread is smaller under τ^M shock than under τ^X shock. Second, in the benchmark, the export cost shock raises spread on impact by 2.7% (from about 1.3% to 4.0%) in annualized terms, with a peak near 5.7% one quarter later. Under local currency debt, the spread rises only 0.4% (from 1.8% to 2.2%), and the response dies out within one quarter. The spread is thus less sensitive to the export cost shock than under foreign currency debt, consistent with the theoretical prediction.

Panels (b) and (c) plot the exchange rate and export revenue. The export cost shock depreciates the real exchange rate: e_t rises by 3.5% on impact, close to the 3.3% depreciation in the benchmark. The depreciation compresses export revenue in foreign-good units, which falls by about 7% at its trough. In the benchmark, the revenue available for debt service collapses while the foreign currency value



(a) Spread (b) Exchange rate $e = 1/P^f$ (c) Export revenue $P^f \cdot EX$

(d) Debt / export revenue $P^f b/(P^f \cdot EX)$ (e) Debt (f) Default frequency

Figure 6: Impulse responses in the local currency debt economy

Notes: The figure plots impulse responses of the local currency debt economy to the import cost shock (dashed red) and the export cost shock (dash-dotted green). The size of each shock is calibrated so that real GDP falls by 1% on impact, the same normalization as in Figure 2: τ_t^M rises by about 6% and τ_t^X by about 4.8%. Responses are averages across 50,000 simulated paths whose pre-shock states are drawn from the ergodic distribution. As in Figure 2, the exchange rate $e = 1/P^f$ (the foreign final good price is normalized to one), export revenue $P^f \cdot EX$, and debt are reported in percentage deviations from their pre-shock values, while the sovereign spread is reported as an annualized percentage points and the default frequency as the share of simulated paths in default at each horizon in percentage. Panel (d) plots the ratio of the foreign currency value of debt to export revenue, $P^f b/(P^f \cdot EX)$, in levels; it is the local currency counterpart of the benchmark ratio $b/(P^f \cdot EX)$ in Panel (b) of Figure 3.

of the debt is fixed, so the debt-to-export-revenue ratio spikes, as documented in Figure 3. With local currency debt, the same depreciation also shrinks the debt itself: because the sovereign's obligations are denominated in home goods, a fall in P_{ft} lowers their foreign currency value in the same proportion. The debt burden therefore falls alongside the export revenue that services it, rather than staying fixed as under foreign currency debt. Panel (d) shows the result: under the same normalized shock, the ratio of the foreign currency value of debt to export revenue rises by only 3.5% on impact, compared with 14% in the benchmark (Panel (b) of Figure 3), and is back below its pre-shock level within a quarter. The import cost shock appreciates the real exchange rate, with e_t falling by about 2%, which raises the foreign currency value of local currency debt.

Panels (e) and (f) also show how the local currency debt economy absorbs the export cost shock. Debt falls by about 11% at its trough two quarters after the shock, a much more front-loaded deleveraging than the benchmark's 8% trough reached roughly three years after the shock: with the home good depreciated and expected to remain so, each unit of newly issued local currency debt raises fewer foreign-good resources, since the issuance value $P_{ft}q_t^{LC}$ in (37) falls as the exchange rate depreciates. On impact, the default frequency jumps from about 2% to 6.7% as the shock pushes the most indebted paths into immediate default, but the wave recedes steadily thereafter, in contrast to the benchmark, where the default frequency keeps building for ten quarters after the shock (Figure 3). In the local currency debt economy, the exchange rate and deleveraging absorb the export cost shock, thus having a smaller increase in sovereign spreads.

6 Conclusion

The key takeaway from this paper is that trade and sovereign default risk are jointly determined. Measured trade wedges do not only reflect movements in trade costs in the conventional sense emphasized in the trade wedge literature (Levchenko et al., 2010; Alessandria et al., 2013). Instead, they also embed an endogenous financial component that moves with sovereign risk. In turn, sovereign default risk can be influenced by trade costs, especially export cost. Empirically, we document that model-implied trade wedges comove with sovereign spreads, with the export wedge exhibiting the tightest relationship. The event analysis of the Great Recession highlights that interacting productivity and trade cost shocks, amplified by default risk, match the comovement in GDP, spreads, and trade.

This perspective has broader implications for how we interpret trade disruptions across countries, particularly for emerging and developing economies. International shocks that worsen export conditions

can trigger sharp increases in spreads by directly eroding export revenues and the stream of tradable resources available to service external debt. The resulting rise in spreads then tightens working-capital financing and further compresses trade, creating a reinforcing cycle. By contrast, import-side disturbances can generate large movements in gross trade flows yet have more muted implications for default incentives when firms substitute away from imported intermediates toward domestic production. More generally, the composition of trade shocks matters for sovereign risk dynamics: export cost shocks are particularly potent because they operate through external revenues and the trade balance, whereas productivity shocks primarily operate through fundamentals and import cost shocks are partly absorbed by endogenous input substitution.

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ONLINE APPENDIX TO "TRADE BARRIERS AND SOVEREIGN DEFAULT RISK"

A Model Details

A.1 Solving problem of final good producers

We use a standard two-stage budgeting approach to characterize the solution of the final goods producers' optimization problem. In the first stage, the final-good producer chooses labor L_t^f, domestic intermediate inputs m_t^d, and the composite imported intermediate input m_t^* to maximize date-t profits, taking factor prices $(P_{ft}, w_t, p_t^d, p_t^*)$ as given:

$$\pi_t^f = P_{ft} z_t \Big(M(m_t^d, m_t^*) \Big)^{\alpha_M} (L_t^f)^{\alpha_L} k^{\alpha_k} - p_t^* m_t^* - p_t^d m_t^d - w_t L_t^f, \tag{A.1}$$

where the intermediate bundle is

$$M_t \equiv M(m_t^d, m_t^*) = \left[\left(m_t^d \right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(m_t^* \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{A.2}$$

with $\sigma > 1$ governing the elasticity of substitution between domestic and imported intermediate inputs and $\omega > 0$ shifting the relative weight on imported inputs. The first-order conditions of the first stage are:

$$\begin{aligned}
[L_t^f]: \quad & P_{ft} \alpha_L z_t k^{\alpha_k} M_t^{\alpha_M} \left(L_t^f \right)^{\alpha_L - 1} = w_t, \\
[m_t^d]: \quad & P_{ft} \alpha_M z_t k^{\alpha_k} \left(M \left(m_t^d, m_t^* \right) \right)^{\alpha_M - 1 + \frac{1}{\sigma}} \left(L_t^f \right)^{\alpha_L} \left(m_t^d \right)^{-\frac{1}{\sigma}} = p_t^d, \\
[m_t^*]: \quad & P_{ft} \alpha_M z_t k^{\alpha_k} \left(M \left(m_t^d, m_t^* \right) \right)^{\alpha_M - 1 + \frac{1}{\sigma}} \left(L_t^f \right)^{\alpha_L} \omega^{\frac{1}{\sigma}} \left(m_t^* \right)^{-\frac{1}{\sigma}} = p_t^*.
\end{aligned}$$

In the second stage, taking the optimal composite quantity m_t^* as given, the firm chooses the continuum of imported varieties $\{m_{jt}^*\}_{j \in [0,1]}$ to minimize the total cost of obtaining m_t^* under the CES aggregator for imports. With elasticity $\mu > 1$, the standard CES cost-minimization problem implies a demand system with constant price elasticities. Because a fraction θ of varieties must be financed with working capital, the relevant delivered unit cost differs across j. The delivered unit cost is $\tau_t^M p_{jt}^* (1 + r_t)$ if $j \in [0, \theta]$ and

$\tau_t^M p_{jt}^*$ if $j \in (\theta, 1]$. Accordingly, the demand for each imported variety is

$$m_{jt}^* = \left(\frac{\tau_t^M p_{jt}^* (1 + r_t)}{p_t^*} \right)^{-\mu} m_t^*, \qquad j \in [0, \theta], \tag{A.3}$$

$$m_{jt}^* = \left(\frac{\tau_t^M p_{jt}^*}{p_t^*} \right)^{-\mu} m_t^*, \qquad j \in (\theta, 1]. \tag{A.4}$$

When the sovereign defaults, the economy loses access to varieties in $[0, \theta]$. The cost-minimization problem is then restricted to $j \in (\theta, 1]$, implying the autarky import price index $p_{t,\text{aut}}^*$. The demand for $j \in [\theta, 1]$ follows equation (A.4) with p_t^* replaced by $p_{t,aut}^*$, while $m_{jt}^* = 0$ for $j \in [0, \theta]$.

Since imported varieties in $[0, \theta]$ enter the CES aggregator for imported inputs, their removal raises the unit cost of the imported composite and reduces the effective quantity of imported intermediates that the firm can profitably employ. Through the production function, the contraction in imported inputs lowers the intermediate bundle M_t and therefore generates an endogenous decline in output and profits following sovereign default.

A.2 Equilibrium conditions in factor markets and production

The equilibrium conditions are summarized by the following system.

$$P_{ft} \alpha_M z_t k^{\alpha_k} \left(M \left(m_t^d, m_t^* \right) \right)^{\alpha_M - 1 + \frac{1}{\sigma}} \left(L_t^f \right)^{\alpha_L} \omega^{\frac{1}{\sigma}} \left(m_t^* \right)^{-\frac{1}{\sigma}} = p_t^* \tag{A.5}$$

$$P_{ft} \alpha_M z_t k^{\alpha_k} \left(M \left(m_t^d, m_t^* \right) \right)^{\alpha_M - 1 + \frac{1}{\sigma}} \left(L_t^f \right)^{\alpha_L} \left(m_t^d \right)^{-\frac{1}{\sigma}} = p_t^d \tag{A.6}$$

$$P_{ft} \alpha_L z_t k^{\alpha_k} \left(M \left(m_t^d, m_t^* \right) \right)^{\alpha_M} \left(L_t^f \right)^{\alpha_L - 1} = w_t \tag{A.7}$$

$$\alpha p_t^d A \left(L_t^m \right)^{\alpha - 1} = w_t \tag{A.8}$$

$$P_{ft} g' \left(L_t \right) = w_t \tag{A.9}$$

$$L_t^f + L_t^m = L_t \tag{A.10}$$

$$A \left(L_t^m \right)^{\alpha} = m_t^d. \tag{A.11}$$

A.3 Consolidated problem

We can write the repayment problem as a planner's problem that internalizes the competitive equilibrium conditions. The repaying value is given by the choice of $\left[c_t, m_t^d, m_t^*, L_t^f, L_t^m, L_t, b_{t+1} \right]$ that solves this

consolidated maximization problem:

$$v^c\left(b_t, z_t, \tau_t^M, \tau_t^X\right) = \max_{c_t, m_t^d, m_t^*, L_t^f, L_t^m, L_t, b_{t+1}} \left\{ \begin{array}{l} u\left(c_t - g\left(L_t\right)\right) \\ +\beta \mathbb{E}\left[V\left(b_{t+1}, z_{t+1}, \tau_{t+1}^M, \tau_{t+1}^X\right)\right] \end{array} \right\}, \tag{A.12}$$

subject to

$$P_{ft} c_t + b_t - q_t b_{t+1} = P_{ft} z_t M\left(m_t^d, m_t^*\right)^{\alpha_M} \left(L_t^f\right)^{\alpha_L} k^{\alpha_k} - p_t^* m_t^* \tag{A.13}$$

$$P_{ft}(\frac{e_t}{\tau_t^X})^\rho D^* = p_t^* m_t^* + b_t - q_t b_{t+1} \tag{A.14}$$

$$L_t^f + L_t^m = L_t \tag{A.15}$$

$$A\left(L_t^m\right)^\alpha = m_t^d. \tag{A.16}$$

The first constraint is the resource constraint of the economy, where the right-hand-side is the nominal GDP. The second constraint is the balanced payment condition, where $P_{ft} X_t = P_{ft}(\frac{e_t}{\tau_t^X})^\rho D^*$ is the export, and $p_t^* m_t^*$ is the import. The last two constraints are the resource constraints in the markets for labor and domestic inputs, respectively.

B Proofs of Propositions in Section 3

Throughout this appendix, Assumption 1 is maintained, hats denote log deviations, and the objects χ_t, η_t, and s_t are as defined in (18), (19), and Proposition 3. We first derive the static block (14)–(16); the proofs then follow in the order of the main text.

B.1 Derivation of the static block (14)–(16)

For a given government choice of b_{t+1}, combining the household and government budget constraints with firm optimality reduces the private economy to a consolidated problem: imports m_t^* and the export-cost-adjusted exchange rate $\tilde{e}_t$ are chosen to maximize period utility subject to the resource constraint and the balance of payments condition,

$$\max_{m_t^*, \tilde{e}_t} u(c_t) \qquad \text{s.t.} \qquad c_t = Y(m_t^*) - \tilde{e}_t^\rho, \qquad \tilde{e}_t^{\rho-1} = \tau_t^X \tau_t^M m_t^* + \tau_t^X \mathcal{R}_t, \tag{B.17}$$

where $Y(m_t^*)$ is gross output as defined in (13), with the fixed labor endowment $\bar{L}$ allocated optimally between intermediate production (L_t^m) and final production ($L_t^f = \bar{L} - L_t^m$), and $\mathcal{R}_t = b_t - q_t b_{t+1}$ is net

debt repayment. The two constraints are (14) and (15).

The first-order condition over m_t^* is

$$u'(c_t)\left[Y'(m_t^*) - \frac{\rho}{\rho-1}\left(\tau_t^X\tau_t^M\, m_t^* + \tau_t^X\mathcal{R}_t\right)^{\frac{1}{\rho-1}}\tau_t^X\tau_t^M\right] = 0. \tag{B.18}$$

Using the balance of payments condition to substitute $\left(\tau_t^X\tau_t^M m_t^* + \tau_t^X\mathcal{R}_t\right)^{\frac{1}{\rho-1}} = \tilde{e}_t$ delivers the import optimality condition (16). Given (τ_t^X, τ_t^M) and $\mathcal{R}_t$, equations (15) and (16) jointly determine $(\tilde{e}_t, m_t^*)$, the resource constraint (14) delivers c_t, and the exchange rate follows from $e_t = \tilde{e}_t\,\tau_t^X$.

B.2 Proof of Proposition 1

Proof. With $\mathcal{R}_t = 0$, the balance of payments condition (15) reads $\tilde{e}_t^{\rho-1} = \tau_t^X\tau_t^M m_t^*$. Substituting for $\tilde{e}_t$ in (14) and (16) yields the system (17), in which the two costs enter only through their product $\tau_t^X\tau_t^M$. The solution (m_t^*, c_t), and with it the labor allocation (L_t^m, L_t^f) inside (13), therefore depends on (τ_t^X, τ_t^M) only through $\tau_t^X\tau_t^M$: an increase in either cost by the same proportion induces identical real allocations. (The exchange rate $e_t = \tilde{e}_t\,\tau_t^X$ does respond differently to the two shocks, consistent with Proposition 2 at $\chi_t = 1$, but no real allocation depends on this difference.) □

B.3 Proof of Lemma 1

We first derive a closed form for η_t. The first-order condition of (13) over L_t^m is

$$\frac{\alpha_L}{L_t^f} \;=\; \frac{\alpha\,\alpha_M\,s_t}{\bar{L} - L_t^f}, \tag{B.19}$$

where $s_t \in (0,1]$ is the CES value share of the domestically produced intermediate defined in Proposition 3: the marginal value of labor in final production equals its marginal value in intermediate production, the latter discounted by the domestic input's share. Equivalently,

$$A^{\frac{\sigma-1}{\sigma}}\left(L_t^m\right)^{\frac{\alpha(\sigma-1)}{\sigma}-1}\left[\alpha\alpha_M\bar{L} - (\alpha_L + \alpha\alpha_M)\,L_t^m\right] \;=\; \alpha_L\,\omega^{1/\sigma}{m_t^*}^{\frac{\sigma-1}{\sigma}}. \tag{B.20}$$

By the envelope theorem applied to (13),

$$\frac{\partial \ln Y(m_t^*)}{\partial \ln m_t^*} \;=\; \alpha_M\left(1 - s_t\right), \tag{B.21}$$

with s_t evaluated at the optimum. Log-differentiating the definition of s_t together with the optimal allocation (B.19) (which implies $\frac{d\ln L_t^m}{d\ln s_t} = \frac{\alpha_L}{\alpha_L+\alpha\alpha_M s_t}$) gives the total elasticity of the share with respect to imports:

$$\varepsilon_s \;\equiv\; \frac{d\ln s_t}{d\ln m_t^*} \;=\; \frac{-\frac{\sigma-1}{\sigma}\,(1-s_t)\,\big(\alpha_L+\alpha\alpha_M s_t\big)}{\big(\alpha_L+\alpha\alpha_M s_t\big) \;-\; \frac{\alpha(\sigma-1)}{\sigma}\,\alpha_L\,(1-s_t)}. \tag{B.22}$$

Combining (B.21) with $Y'(m_t^*) = \alpha_M(1-s_t)\,Y_t/m_t^*$ and (B.22), the inverse import demand elasticity defined in (19) is

$$\begin{aligned}\eta_t \;&=\; 1-\alpha_M(1-s_t)+\frac{s_t}{1-s_t}\,\varepsilon_s \\ &=\; 1-\alpha_M(1-s_t)-\frac{\frac{\sigma-1}{\sigma}\,s_t\big(\alpha_L+\alpha\alpha_M s_t\big)}{\big(\alpha_L+\alpha\alpha_M s_t\big) \;-\; \frac{\alpha(\sigma-1)}{\sigma}\,\alpha_L\,(1-s_t)}.\end{aligned} \tag{B.23}$$

Proof. Throughout, let $H_t \equiv (\alpha_L+\alpha\alpha_M s_t) - \frac{\alpha(\sigma-1)}{\sigma}\,\alpha_L(1-s_t) > 0$ denote the denominator of (B.22), and write (B.23) as

$$\eta_t \;=\; \big[\,1-\alpha_M(1-s_t)\,\big] \;-\; f(s_t), \qquad f(s_t) \;\equiv\; -\frac{s_t}{1-s_t}\,\varepsilon_s \;=\; \frac{\sigma-1}{\sigma}\,\frac{s_t\big(\alpha_L+\alpha\alpha_M s_t\big)}{H_t}.$$

Part (i). For $\sigma \le 1$, $\varepsilon_s \ge 0$, so $f(s_t) \le 0$ and $\eta_t \ge 1-\alpha_M(1-s_t) > 0$, using $\alpha_M < 1$.

For $\sigma > 1$, $\varepsilon_s < 0$: imports and the domestic intermediate are substitutes, and a rise in m_t^* crowds out the domestic share and pulls labor out of intermediate production. Rearranging (B.23) yields the exact identity

$$\Big(\eta_t - \frac{1}{\sigma}\big[1-\alpha_M(1-s_t)\big]\Big)\,H_t \;=\; \frac{\sigma-1}{\sigma}\,(1-s_t)\,\Lambda,$$

where

$$\Lambda \;=\; (1-\alpha_M)^2\Big(1-\tfrac{\alpha(\sigma-1)}{\sigma}\Big) \;+\; \frac{\alpha\alpha_M s_t}{\sigma}\,(1-\alpha_M) \;+\; (1-\alpha_L-\alpha_M)\Big[\tfrac{\alpha(\sigma-1)}{\sigma}\,\alpha_M s_t - (1-\alpha_M)\Big(1-\tfrac{\alpha(\sigma-1)}{\sigma}\Big)\Big].$$

If the bracket multiplying $(1-\alpha_L-\alpha_M)$ is nonnegative, all three terms of Λ are nonnegative. If it is negative, then since $0 \le 1-\alpha_L-\alpha_M \le 1-\alpha_M$ under decreasing returns,

$$\begin{aligned}\Lambda \;&\ge\; (1-\alpha_M)^2\Big(1-\tfrac{\alpha(\sigma-1)}{\sigma}\Big) + \frac{\alpha\alpha_M s_t}{\sigma}(1-\alpha_M) + (1-\alpha_M)\Big[\tfrac{\alpha(\sigma-1)}{\sigma}\,\alpha_M s_t - (1-\alpha_M)\Big(1-\tfrac{\alpha(\sigma-1)}{\sigma}\Big)\Big] \\ &=\; \alpha\alpha_M s_t\,(1-\alpha_M) \;\ge\; 0.\end{aligned}$$

In either case $\Lambda \ge 0$, so $\eta_t \ge \frac{1}{\sigma}\big[1-\alpha_M(1-s_t)\big] > 0$, using $\alpha_M < 1$.

Part (ii). For $\sigma \ge 1$, $f(s_t) \ge 0$ (with equality only at $\sigma = 1$), while $\alpha_M(1-s_t) > 0$ since $m_t^* > 0$ implies

$s_t < 1$; hence $\eta_t < 1$. □

B.4 Proof of Proposition 2

Proof. Log-differentiating the balance of payments condition (15), the export wedge τ_t^X scales both the import bill and debt repayment and passes through one-for-one, while τ_t^M and m_t^* affect only the import portion:

$$(\rho - 1)\,\hat{\tilde{e}}_t \;=\; \hat{\tau}_t^X + \chi_t\big(\hat{\tau}_t^M + \hat{m}_t^*\big). \tag{B.24}$$

Log-differentiating the import optimality condition (16) and using the definition of η_t in (19),

$$-\,\eta_t\,\hat{m}_t^* \;=\; \hat{\tilde{e}}_t + \hat{\tau}_t^X + \hat{\tau}_t^M. \tag{B.25}$$

Substituting $\hat{m}_t^*$ from (B.25) into (B.24) and collecting terms,

$$\hat{\tilde{e}}_t\,\Big[(\rho - 1)\,\eta_t + \chi_t\Big] \;=\; \big(\eta_t - \chi_t\big)\,\hat{\tau}_t^X + \chi_t\big(\eta_t - 1\big)\,\hat{\tau}_t^M. \tag{B.26}$$

Since $\hat{e}_t = \hat{\tilde{e}}_t + \hat{\tau}_t^X$, the elasticities in (20) follow. Under $\rho > 1$, $\eta_t > 0$, and $\chi_t > 0$, the common denominator $(\rho-1)\eta_t + \chi_t$ is strictly positive. For the ranking (21),

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} - \frac{\partial \ln e_t}{\partial \ln \tau_t^M} \;=\; \frac{\rho\,\eta_t - \chi_t(\eta_t - 1)}{(\rho-1)\,\eta_t + \chi_t} \;=\; \frac{\eta_t(\rho - \chi_t) + \chi_t}{(\rho-1)\,\eta_t + \chi_t} \;>\; 0,$$

where the inequality uses $\rho > 1 \geq \chi_t > 0$ and $\eta_t > 0$. □

B.5 Proof of Proposition 3

Proof. Using the balance of payments condition (15) to substitute for $\tilde{e}_t$, the consolidated problem (B.17) becomes

$$c_t \;=\; \max_{m_t^*}\; \Upsilon(m_t^*) - \big(\tau_t^X \tau_t^M\, m_t^* + \tau_t^X \mathcal{R}_t\big)^{\rho/(\rho-1)}. \tag{B.27}$$

By the envelope theorem, and using $\tau_t^X\tau_t^M m_t^* + \tau_t^X\mathcal{R}_t = \tilde{e}_t^{\,\rho-1}$ together with $\tau_t^X\tau_t^M\,m_t^* = \chi_t \tilde{e}_t^{\,\rho-1}$,

$$\frac{\partial c_t}{\partial \ln \tau_t^X} \;=\; -\,\frac{\rho}{\rho-1}\,\tilde{e}_t^{\,\rho}, \qquad\qquad \frac{\partial c_t}{\partial \ln \tau_t^M} \;=\; -\,\frac{\rho}{\rho-1}\,\chi_t\,\tilde{e}_t^{\,\rho}. \tag{B.28}$$

It remains to express $\tilde{e}_t^{\,\rho}$ through the sufficient statistics. Multiplying (16) by m_t^* and using $\tau_t^X\tau_t^M\,m_t^* = \chi_t\tilde{e}_t^{\,\rho-1}$ gives $\Upsilon'(m_t^*)\,m_t^* \;=\; \frac{\rho}{\rho-1}\,\chi_t\,\tilde{e}_t^{\,\rho}$; combining this with the envelope elasticity (B.21), which states

$Y'(m_t^*)\, m_t^* = \alpha_M(1-s_t)\, Y_t$, yields

$$\tilde{e}_t^{\rho} \;=\; \frac{\rho-1}{\rho\,\chi_t}\,\alpha_M(1-s_t)\,Y_t. \tag{B.29}$$

Substituting (B.29) into (B.28) and dividing by c_t delivers (22). Both elasticities are strictly negative: $\alpha_M(1-s_t) > 0$ since $m_t^* > 0$ implies $s_t < 1$; $Y_t > c_t > 0$ by the resource constraint (14); and $\chi_t \in (0,1]$. Finally, the two elasticities differ exactly by the factor $1/\chi_t \geq 1$, with strict inequality whenever $\mathcal{R}_t > 0$ (so $\chi_t < 1$), which establishes the last claim of the proposition. □

B.6 Proof of Proposition 4

Proof. We first derive the Euler equation (25). Differentiating the static program (B.27) with respect to $\mathcal{R}_t$ and using $e_t = \tilde{e}_t\,\tau_t^X$,

$$\frac{\partial C}{\partial \mathcal{R}_t} \;=\; -\,\frac{\rho}{\rho-1}\,\tilde{e}_t\,\tau_t^X \;=\; -\,\frac{\rho}{\rho-1}\,e_t. \tag{B.30}$$

In the government problem (24), $\mathcal{R}_t = b_t - q(b_{t+1})\,b_{t+1}$, so $\partial\mathcal{R}_t/\partial b_{t+1} = -\big[q(b_{t+1}) + q'(b_{t+1})\,b_{t+1}\big]$ and the envelope condition is $V_b = u'(c_t)\,\partial C/\partial\mathcal{R}_t = -\frac{\rho}{\rho-1}\,u'(c_t)\,e_t$. The first-order condition for b_{t+1}, after the common factor $\rho/(\rho-1)$ cancels from both sides, is the Euler equation (25). Because the shocks are i.i.d. (Assumption 2), the right-hand side of (25) depends on b_{t+1} only, so the current wedges move desired borrowing only through today's shadow value $u'(c_t)\,e_t$, whose log response to a wedge is decomposed in (26).

Substituting the exchange rate elasticities of Proposition 2 and the consumption elasticities of Proposition 3 into (26) and differencing,

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} - \frac{\partial \ln e_t}{\partial \ln \tau_t^M} = \frac{\eta_t(\rho-\chi_t)+\chi_t}{(\rho-1)\,\eta_t+\chi_t}, \qquad -\frac{\partial \ln c_t}{\partial \ln \tau_t^X} + \frac{\partial \ln c_t}{\partial \ln \tau_t^M} = \Big(\frac{1}{\chi_t}-1\Big)\alpha_M(1-s_t)\,\frac{Y_t}{c_t},$$

which gives (27). The first term is strictly positive since $\eta_t > 0$ (Lemma 1), $\rho > 1 \geq \chi_t$, and $\chi_t > 0$; the second is nonnegative since $\gamma_t \geq 0$ and $\chi_t \leq 1$.

For the consequence, write the Euler equation (25) as $u'(c_t)e_t\,R(b_{t+1}) = \beta\,\Lambda(b_{t+1})$ with $R \equiv q + q'b_{t+1}$ and $\Lambda(b_{t+1}) \equiv \mathbb{E}[u'(c_{t+1})e_{t+1}]$, which is independent of the current shock by the i.i.d. assumption. Implicit differentiation at an optimum satisfying the second-order condition ($u'(c_t)e_tR' - \beta\Lambda' < 0$) gives

$$\frac{\partial b_{t+1}}{\partial \ln \tau} \;=\; \frac{u'(c_t)\,e_t\,R(b_{t+1})}{\beta\Lambda'(b_{t+1}) - u'(c_t)e_tR'(b_{t+1})}\,\frac{\partial \ln\big[u'(c_t)e_t\big]}{\partial \ln \tau}, \qquad \tau \in \{\tau_t^X, \tau_t^M\},$$

whose leading fraction is positive and common to both wedges; the ranking of $\partial b_{t+1}/\partial \ln\tau$ therefore coincides with (27). □

C Imports in Consumption

The benchmark model assumes that imports are intermediate inputs. This appendix shows that the theoretical results of Section 3 are robust to the alternative assumption that imports are consumption goods.

C.1 Environment and the static block

Assumption 1 is maintained. Production uses only domestic factors, so gross output of the home final good is exogenous within the period, $\bar{y}_t = z_t \bar{L}^{\alpha_L} k^{\alpha_k}$. The household consumes a CES bundle of the home good c_h and the imported good c_f,

$$C(c_h, c_f) \;=\; \left[c_h^{\zeta} + \omega^{1/\sigma}\, c_f^{\zeta}\right]^{1/\zeta}, \qquad \zeta = \frac{\sigma - 1}{\sigma}, \tag{C.31}$$

which mirrors the intermediate-input aggregator $M(m^d, m^*)$, with σ now the elasticity of substitution in consumption. Period utility is $u(C_t)$ with $u' > 0 > u''$ and $\gamma_t \equiv -u''(C_t)C_t/u'(C_t)$.

With $\tilde{e}_t \equiv e_t/\tau_t^X$ and $\mathcal{R}_t \equiv b_t - q_t b_{t+1}$ as in the main text, foreign demand is $X_t = \tilde{e}_t^{\rho}$, export revenue in foreign goods is $\tilde{e}_t^{\rho-1}/\tau_t^X$, and the import bill is $\tau_t^M c_{f,t}$. For a given $\mathcal{R}_t$, the consolidated private equilibrium chooses $\{c_{h,t}, c_{f,t}, \tilde{e}_t\}$ subject to

$$c_{h,t} = \bar{y}_t - \tilde{e}_t^{\rho}, \tag{C.32}$$

$$\tilde{e}_t^{\rho-1} = \tau_t^X\left[\tau_t^M c_{f,t} + \mathcal{R}_t\right]. \tag{C.33}$$

Substituting the constraints and maximizing C over $\tilde{e}_t$ yields the import optimality condition

$$\frac{C_f(c_{h,t}, c_{f,t})}{C_h(c_{h,t}, c_{f,t})} \;=\; \frac{\rho}{\rho - 1}\,\tilde{e}_t\,\tau_t^X\tau_t^M. \tag{C.34}$$

The block (C.32) to (C.34) replicates (14) to (16) line by line: the balance of payments (C.33) is identical to (15) with m_t^* replaced by $c_{f,t}$, and the only substantive change is that import optimality (C.34) equates the marginal rate of substitution in consumption, rather than the marginal product $Y'(m_t^*)$, to the markup-adjusted domestic price of imports. In the decentralized economy, the corrective tariff $t^m = 1/(\rho - 1)$ of Assumption 1, rebated lump sum, delivers (C.34) exactly as in the benchmark.

Two of the summary objects carry over unchanged, and one is new:

$$\chi_t \equiv \frac{\tau_t^M c_{f,t}}{\tau_t^M c_{f,t} + \mathcal{R}_t} \in (0,1], \qquad s_{f,t} \equiv \frac{C_f\, c_{f,t}}{C_t} \in (0,1), \qquad \psi_t \equiv \frac{\tilde{e}_t^{\rho}}{c_{h,t}} > 0. \tag{C.35}$$

Here χ_t is the import share of external payments, exactly as in (18); $s_{f,t}$ is the import value share of consumption, the counterpart of $\alpha_M(1-s_t)Y_t/c_t$ in Proposition 3; and ψ_t, the ratio of exports to home consumption of the home good, is new. It appears because the marginal rate of substitution in (C.34) depends on $c_{h,t}$, which is linked to $\tilde{e}_t$ through (C.32); in the benchmark this feedback is absent because $Y'(m_t^*)$ depends on m_t^* alone.

Remark 1 (Import demand elasticity). *For the CES aggregator, $C_f/C_h = \omega^{1/\sigma}(c_f/c_h)^{-1/\sigma}$, so the inverse import demand curve defined by (C.34) has slope $1/\sigma$. The counterpart of η_t (Lemma 1) is therefore the constant $1/\sigma$, and the condition $\eta_t < 1$ becomes $\sigma > 1$: import demand is elastic if and only if home and imported consumption are substitutes.*

Remark 2 (Lerner symmetry). *In financial autarky, $\mathcal{R}_t = 0$, substituting $\tilde{e}_t = (\tau_t^X \tau_t^M c_{f,t})^{1/(\rho-1)}$ from (C.33) into (C.32) and (C.34) makes the two costs enter only through the product $\tau_t^X \tau_t^M$, so they have identical effects on all real allocations, exactly as in (17).*

C.2 Exchange rate elasticities

Let hats denote log deviations, holding $\mathcal{R}_t$ fixed. From (C.32), $\hat{c}_h = -\rho\psi_t\,\hat{\tilde{e}}_t$. Log-differentiating (C.34) using the CES form,

$$-\tfrac{1}{\sigma}\big(\hat{c}_f - \hat{c}_h\big) = \hat{\tilde{e}}_t + \hat{\tau}_t^X + \hat{\tau}_t^M \quad\Longrightarrow\quad \hat{c}_f = -\rho\psi_t\,\hat{\tilde{e}}_t - \sigma\big(\hat{\tilde{e}}_t + \hat{\tau}_t^X + \hat{\tau}_t^M\big), \tag{C.36}$$

and from (C.33), $(\rho-1)\hat{\tilde{e}}_t = \hat{\tau}_t^X + \chi_t\big(\hat{\tau}_t^M + \hat{c}_f\big)$. Substituting (C.36),

$$\underbrace{\big[(\rho-1) + \chi_t(\sigma+\rho\psi_t)\big]}_{\equiv\, D_t\, >\, 0}\ \hat{\tilde{e}}_t \;=\; (1-\chi_t\sigma)\,\hat{\tau}_t^X \;+\; \chi_t(1-\sigma)\,\hat{\tau}_t^M, \qquad \hat{e}_t = \hat{\tilde{e}}_t + \hat{\tau}_t^X. \tag{C.37}$$

Proposition 6 (Exchange rate elasticities with consumption imports). *Holding $\mathcal{R}_t$ fixed,*

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} = \frac{\rho\,(1+\chi_t\psi_t)}{D_t} > 0, \qquad \frac{\partial \ln e_t}{\partial \ln \tau_t^M} = -\,\frac{\chi_t(\sigma-1)}{D_t}, \tag{C.38}$$

and for $\rho > 1$, $\chi_t \in (0,1]$, the ranking is unambiguous:

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} - \frac{\partial \ln e_t}{\partial \ln \tau_t^M} = \frac{\rho + \chi_t(\rho\psi_t + \sigma - 1)}{D_t} \; > \; 0.$$

Proof. The first elasticity follows from (C.37): $\partial \ln e_t / \partial \ln \tau_t^X = [D_t + 1 - \chi_t\sigma]/D_t = [\rho + \chi_t\rho\psi_t]/D_t$. The second is immediate. For the difference, if $\sigma \geq 1$ every term in the numerator is positive; if $\sigma < 1$, then $\rho + \chi_t(\sigma - 1) + \chi_t\rho\psi_t > \rho - \chi_t \geq \rho - 1 > 0$. □

The implications of Proposition 2 carry over: the export cost shock always depreciates, and outstanding debt amplifies the response (the derivative of $\rho(1 + \chi\psi)/D$ with respect to χ is proportional to $-(\psi + \sigma) < 0$, so the depreciation grows as χ_t falls); the import cost shock appreciates if and only if $\sigma > 1$; and setting $\psi_t \to 0$, $\eta_t = 1/\sigma$ in (C.38) recovers (20) exactly, the new term $\rho\psi_t$ only strengthening the export-shock depreciation.

C.3 Consumption elasticities

Proposition 7 (Consumption elasticities with consumption imports)**.** *Holding $\mathcal{R}_t$ fixed,*

$$\frac{\partial \ln C_t}{\partial \ln \tau_t^X} = -\frac{s_{f,t}}{\chi_t}, \qquad \frac{\partial \ln C_t}{\partial \ln \tau_t^M} = -s_{f,t}. \tag{C.39}$$

Both are negative, and their ratio is exactly $1/\chi_t$: the export cost shock is more costly for consumption whenever $\mathcal{R}_t > 0$.

Proof. Write the maximized aggregate as $C^*(\tau^X, \tau^M, \mathcal{R}) = \max_{\tilde{e}} C\big(\bar{y} - \tilde{e}^\rho,\ [\tilde{e}^{\rho-1}/\tau^X - \mathcal{R}]/\tau^M\big)$ and apply the envelope theorem. For the export cost, only c_f is directly affected:

$$\frac{\partial C^*}{\partial \tau^X} = C_f \cdot \Big(-\frac{\tilde{e}^{\rho-1}}{(\tau^X)^2\,\tau^M} \Big) = -\frac{C_f\,(\tau^M c_f + \mathcal{R})}{\tau^X\,\tau^M},$$

using (C.33) in the second step. In elasticity form, and using linear homogeneity of C so that $C = C_h c_h + C_f c_f$,

$$\frac{\partial \ln C}{\partial \ln \tau^X} = -\frac{C_f c_f}{C} \cdot \frac{\tau^M c_f + \mathcal{R}}{\tau^M c_f} = -\frac{s_f}{\chi}.$$

For the import cost, $\partial c_f / \partial \tau^M\big|_{\tilde{e}} = \big[-(\tau^M c_f + \mathcal{R}) + \mathcal{R}\big]/(\tau^M)^2 = -c_f/\tau^M$, so $\partial \ln C / \partial \ln \tau^M = -C_f c_f / C = -s_f$. □

The gap between the two elasticities is exactly the factor $1/\chi_t$, as in Proposition 3. The factor $1/\chi_t$ comes

from the balance of payments alone. The export cost enters the balance of payments through total external payments, imports plus debt service, while the import cost enters only through the import bill; the ratio of the two exposures is $1/\chi_t$ regardless of whether the import margin sits in production or in preferences. The production side objects of the benchmark only determine the common scale, $\alpha_M(1-s_t)Y_t/c_t$ in (22) and $s_{f,t}$ here.

C.4 Borrowing incentives and sovereign spreads

The government's problem is (24) with $C^*(\tau_t^X, \tau_t^M, \mathcal{R}_t)$ in place of $C(\cdot)$, under Assumption 2. One unit of foreign currency relaxes the balance of payments and buys $1/\tau_t^M$ units of the imported good, so the shadow value of foreign currency is

$$\Phi_t \;\equiv\; u'(C_t)\,\frac{C_f(c_{h,t}, c_{f,t})}{\tau_t^M}, \tag{C.40}$$

the counterpart of $u'(c_t)e_t$ in (25), and the Euler equation is $\Phi_t\big[q(b_{t+1}) + q'(b_{t+1})b_{t+1}\big] = \beta\,\mathbb{E}\,\Phi_{t+1}$. By (C.34), $\Phi_t = \frac{\rho}{\rho-1}u'(C_t)C_h e_t$, so up to the constant markup, which cancels from both sides of the Euler equation, Φ_t is the direct analogue of $u'(c_t)e_t$. With i.i.d. shocks the right side depends on b_{t+1} only, so current trade costs move desired borrowing only through Φ_t, exactly as in Section 3.3.

Proposition 8 (Borrowing incentives and spreads with consumption imports)**.** *For any concave u, $\rho > 1$ and $\chi_t \in (0,1]$,*

$$\Delta_t \;\equiv\; \frac{\partial \ln \Phi_t}{\partial \ln \tau_t^X} - \frac{\partial \ln \Phi_t}{\partial \ln \tau_t^M} \;=\; 1 \;+\; (1-\chi_t)\left[\left(\gamma_t - \tfrac{1}{\sigma}\right)\frac{s_{f,t}}{\chi_t} \;+\; \frac{\sigma + \rho\psi_t}{\sigma D_t}\right], \tag{C.41}$$

which is strictly positive whenever $\gamma_t\,\sigma \geq 1$. Under this condition, if the marginal revenue of issuance is positive and strictly decreasing at the optimum, optimal issuance b_{t+1} rises by strictly more after an export cost shock than after an import cost shock of equal size, and the sovereign spread rises by more.

Proof. Log-differentiate (C.40). For the CES aggregator, $\ln C_f = \frac{1}{\sigma}\ln\omega + (\zeta-1)\ln c_f + (1-\zeta)\ln C$ with $\zeta - 1 = -1/\sigma$ and $1-\zeta = 1/\sigma$, so $\hat{C}_f = -\frac{1}{\sigma}\big(\hat{c}_f - \hat{C}\big)$ and

$$\frac{\partial \ln \Phi}{\partial \ln \tau} = -\gamma\,\hat{C} + \hat{C}_f - \mathbf{1}\{\tau = \tau^M\}, \qquad \tau \in \{\tau^X, \tau^M\}.$$

Three differences are needed. First, by Proposition 7, $\hat{C}_X - \hat{C}_M = -s_f(1-\chi)/\chi$. Second, from (C.36),

since the shock terms enter $\hat{c}_f$ only through the common sum $\hat{\hat{e}} + \hat{\tau}^X + \hat{\tau}^M$,

$$\hat{c}_{f,X} - \hat{c}_{f,M} = -(\sigma + \rho\psi)\left(\hat{\hat{e}}_X - \hat{\hat{e}}_M\right) = -\frac{(\sigma + \rho\psi)(1-\chi)}{D},$$

using $\hat{\hat{e}}_X - \hat{\hat{e}}_M = [(1-\chi\sigma) - \chi(1-\sigma)]/D = (1-\chi)/D$ from (C.37). Third, the indicator contributes $+1$ to the difference. Collecting,

$$\Delta = 1 + \gamma\,\frac{s_f(1-\chi)}{\chi} - \frac{1}{\sigma}\left[-\frac{(\sigma+\rho\psi)(1-\chi)}{D} + \frac{s_f(1-\chi)}{\chi}\right] = 1 + (1-\chi)\left[\left(\gamma - \tfrac{1}{\sigma}\right)\frac{s_f}{\chi} + \frac{\sigma+\rho\psi}{\sigma D}\right].$$

If $\gamma\sigma \geq 1$ every term is nonnegative and the leading term is 1, so $\Delta > 0$. The issuance and spread conclusions then follow from the Euler equation by the argument in the proof of Proposition 4. □

The structure of (C.41) is term for term that of (27), which rearranges to $1 + (1-\chi_t)\left[\gamma_t\,\frac{\alpha_M(1-s_t)Y_t/c_t}{\chi_t} + \frac{\eta_t}{\eta_t(\rho-1)+\chi_t}\right]$: both expressions equal exactly 1 at $\chi_t = 1$, both contain a depreciation gain term that coincides with the benchmark at $\eta_t = 1/\sigma$, $\psi_t \to 0$, and both contain a consumption smoothing term scaled by $(1-\chi_t)/\chi_t$. The single new element is the coefficient $\gamma_t - 1/\sigma$ in place of γ_t: an import cost shock makes the imported good scarce, raising its marginal utility C_f and partially propping up the value of foreign currency after τ_t^M, an offset of size $1/\sigma$. The ranking is therefore guaranteed when risk aversion is at least the inverse substitution elasticity, $\gamma_t\sigma \geq 1$; log utility with substitutes suffices, and the counterpart of our calibration ($\gamma = 2$, $\sigma = 3$) satisfies the condition by a factor of six.

D Moments in different models

To analyze the roles of productivity shocks z_t, import cost shocks τ_t^M, and export cost shocks τ_t^X in driving the model's trade and sovereign risk, we shut down one shock at a time by setting its standard deviation to zero and re-solving the model, holding the remaining parameters fixed at their benchmark values. The column "No z shock" in Table D.1 reports the simulated moments when we shut down the productivity shock. The columns "No τ^M shock" and "No τ^X shock" report the moments when the import cost shock τ^M and the export cost shock τ^X are shut down, respectively.

When we shut down productivity shocks (column "No z shock"), both income risk and default risk fall sharply. Output volatility declines from 4.4% to 1.2%, indicating that productivity shocks are the dominant source of aggregate GDP fluctuations in the model. Sovereign risk also collapses: the mean spread drops from 1.3% to 0.1% and the standard deviation of spreads from 1.1% to near zero. With default risk essentially eliminated, the country borrows more cheaply, and the mean debt-to-GDP ratio

rises from 26% to 36%. Trade moments are largely unaffected: average trade-to-GDP remains near 56%, and the standard deviations of trade-to-GDP, import-to-GDP, and export-to-GDP move only slightly. The standard deviations of the import and export wedges are essentially unchanged at 15 and 19, since these depend on τ_t^M and τ_t^X rather than on z_t. Productivity shocks therefore drive both the level and volatility of spreads in the model, while contributing little to trade dynamics.

Shutting down the import-cost shock τ_t^M has more limited effects on aggregate moments but a sharp effect on the import wedge. Output volatility is essentially unchanged, with the standard deviation of GDP moving from 4.4% to 4.3%, and average trade-to-GDP also barely shifts. Trade becomes moderately less volatile: the standard deviation of import-to-GDP falls from 3.9% to 3.0%, the standard deviation of export-to-GDP from 2.7% to 2.3%, and the standard deviation of trade-to-GDP from 6.0% to 4.7%. The import-wedge volatility collapses from 15 to near zero, while the export-wedge volatility is unchanged at 19. Spreads move slightly in the opposite direction, with the mean rising from 1.3% to 1.5% and the standard deviation from 1.1% to 1.4%. These results indicate that import-cost shocks are a meaningful source of variation in the import wedge and gross trade volatility, but contribute little to GDP volatility, average openness, or the level of sovereign risk.

Shutting down the export-cost shock τ_t^X produces the most pronounced collapse in spread volatility. The standard deviation of spreads falls from 1.1% to 0.2%, a decline of about 80%. Output volatility is similar, with the standard deviation of GDP moving from 4.4% to 4.3%, and average trade-to-GDP remains near 56%. Trade volatility, in contrast, declines noticeably: the standard deviation of trade-to-GDP falls from 6.0% to 3.6%, the standard deviation of import-to-GDP from 3.9% to 2.5%, and the standard deviation of export-to-GDP from 2.7% to 1.6%. The export wedge becomes constant by construction, with its standard deviation falling from 19 to zero, while the import-wedge volatility is unchanged at 15. Together, these results indicate that τ_t^X is the key shock governing the time variation of spreads around their mean, even though it plays only a small role for GDP volatility or trade openness.

E Correlations between spreads and wedges in the model

Table E.2 reports the counterparts of the regressions in Table 1, using data generated from the calibrated model. Although the coefficients in these regressions are not direct calibration targets, the model produces magnitudes that are quantitatively comparable to those observed in the data. In particular, the total trade wedge is positively associated with spreads, and this relationship is largely driven by the export wedge. The export wedge displays a stronger positive correlation with spreads across specifications than the

Table D.1: Moments in different models

	Model	No z shock	No τ^M shock	No τ^X shock	Local currency debt
Targeted moments					
Mean(Spread)	1.33	0.10	1.50	1.26	1.88
Std(Spread)	1.10	0.03	1.35	0.23	0.31
Mean(Debt/GDP)	26.35	36.34	26.64	27.27	16.6
Mean(Working capital/GDP)	7.19	7.25	7.19	7.18	6.88
Std(GDP)	4.37	1.23	4.31	4.28	4.48
Mean(Trade/GDP)	56.28	55.72	56.11	55.93	57.9
Std(Import/GDP)	3.87	3.68	2.97	2.48	3.91
Std(Export/GDP)	2.69	2.40	2.32	1.62	2.45
Untargeted moments					
Mean(%)					
Mean(Import/GDP)	30.52	30.42	30.42	30.23	29.15
Mean(Export/GDP)	25.76	25.30	25.69	25.70	28.75
Standard deviation(%)					
Std(Export wedge)	19	20	19	0	19
Std(Import wedge)	15	15	1	15	15
Std(Trade/GDP)	6.02	6.04	4.74	3.64	6.15
Std(Trade balance/GDP)	2.77	1.46	2.38	2.05	2.16
Std(ln(TOT))	5	4	4	3	5
Std(ln(RER))	5	4	4	3	5
Std(Consumption)	3	2	3	3	2
Comovement(%)					
Corr(spread, GDP)	-4	-1	-1	11	-30
Corr(Import wedge, Export wedge)	2	0	13	0	1
Corr(Trade/GDP, GDP)	19	99	10	7	20
Corr(Trade/GDP, spread)	-7	-2	-10	-3	-18

Notes: This table reports simulated moments for three counterfactuals that shut down one shock at a time: no productivity shock z, no import cost shock τ^M, and no export cost shock τ^X, as well as the model with local currency debt. For each "No x shock" column we re-solve the Bellman equation with $\sigma_x = 0$ and simulate from the re-solved decision rules, so agents internalize that shock x is deterministic. The top panel reports the targeted moments used for calibration; the bottom panel reports the untargeted moments. For the construction of moments in the data, see Appendix I.7 for the details. The model moments are given by the averages across 5,000 simulations. All in percentage.

import wedge. When export and import wedges are included jointly, the positive correlation between spreads and the trade wedge continues to be accounted for primarily by the export wedge, consistent with the empirical evidence. A one–standard-deviation increase in the export wedge raises the spread by roughly 1.6 percentage points. This magnitude is comparable to those estimated in the data, as shown in Table 1. In contrast, a one–standard-deviation increase in the import wedge is associated with an increase in spreads of about 0.5 percentage points. This contemporaneous correlation between export and import wedges and sovereign spreads reinforces the conclusion that the export wedge is the primary driver of the positive relationship between wedges and sovereign default risk, consistent with the findings in Section 4.1.

Table E.2: Correlations between spreads and wedges in the model

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.560***	1.623***			1.549***	1.610***
	(0.0130)	(0.0124)			(0.0129)	(0.0123)
Import wedge			0.558***	0.505***	0.525***	0.454***
			(0.00684)	(0.00633)	(0.00656)	(0.00604)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,908,652	1,903,902	1,908,652	1,903,902	1,908,652	1,903,902
R-squared	0.056	0.136	0.025	0.101	0.060	0.138

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

F Theoretical validation

To verify that the model reproduces the theoretical predictions in Section 3, we use simulated data from the calibrated benchmark model to estimate the responses to the shocks, τ_t^X and τ_t^M, and their heterogeneity across countries with different debt positions.

We first simulate the economy at a quarterly frequency by drawing the productivity shock z_t, the import-cost shock τ_t^M, and the export-cost shock τ_t^X stochastically. We discard any simulated path that experiences a default within its final five quarters[9].

For each outcome variable of interest y and each horizon $h = 0, 1, \ldots, 8$, we estimate the panel local

[9] A default realized at the very end of a path is particularly problematic for the local projections below, because it leaves too few post-default observations to be informative while contaminating the forward-dated outcomes $y_{i,t+h}$ used at longer horizons.

projection with country (simulation) fixed effects:

$$y_{i,t+h} \;=\; \beta_h^X\,\tau_{i,t}^X + \gamma_h^X\big(\tau_{i,t}^X \times \bar{b}_i\big) + \beta_h^M\,\tau_{i,t}^M + \gamma_h^M\big(\tau_{i,t}^M \times \bar{b}_i\big) + \beta_h^z\,z_{i,t} + \gamma_h^z\big(z_{i,t} \times \bar{b}_i\big) + \alpha_i + \varepsilon_{i,t+h}, \tag{F.42}$$

where α_i is a country (simulation) fixed effect. Because the shocks are observed directly in the simulated data, (F.42) recovers the dynamic response of y to each structural shock cleanly. The level coefficients $\{\beta_h^X, \beta_h^M, \beta_h^z\}$ trace the impulse responses of y to a one-unit innovation in τ_t^X, τ_t^M, and z_t, respectively, while the interaction coefficients $\{\gamma_h^X, \gamma_h^M, \gamma_h^z\}$ measure how those responses vary with the debt position $\bar{b}_i$. For each path i we construct a time-invariant measure of the debt position as the average over the first ten quarters

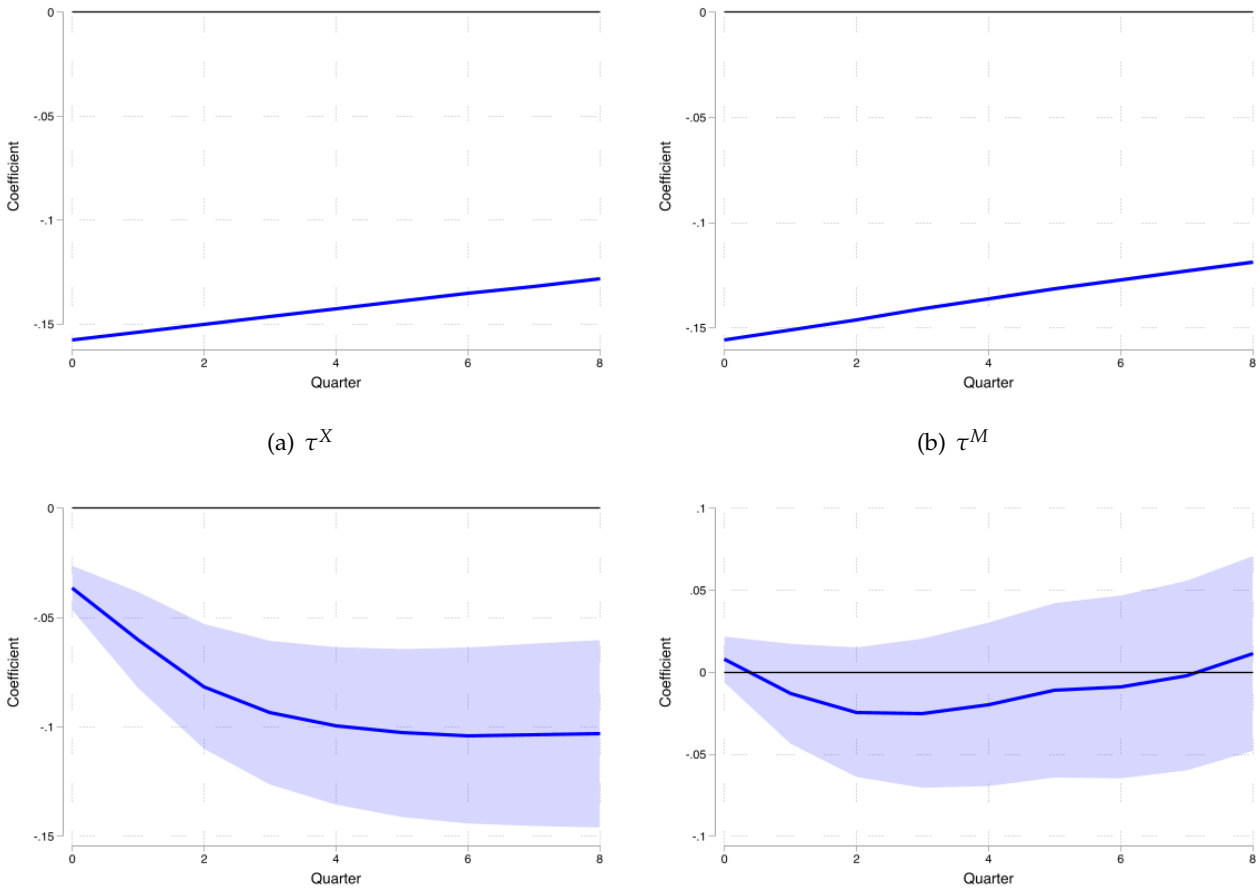
$$\bar{b}_i \;=\; \frac{1}{10}\sum_{t=0}^{9}\big(b_{i,t} - q_{i,t}\,b_{i,t+1}\big), \tag{F.43}$$

where $b_{i,t} - q_{i,t}\,b_{i,t+1}$ is the sovereign's repayment to foreign lenders net of new issuance. This is precisely the debt-repayment term that governs the import share of total foreign obligations λ, and hence the asymmetry between τ_t^X and τ_t^M in Section 3.2: the larger the debt-repayment burden, the more pronounced the predicted asymmetry. Interacting the shocks with $\bar{b}_i$ therefore provides a direct test of this mechanism on simulated data. We plot each of the coefficient paths for τ_t^X and τ_t^M against the horizon h.

Figures F.1 and F.2 report the local-projection coefficients from Equation (F.42) for log real GDP and the sovereign spread, respectively, plotted against the horizon $h = 0, \ldots, 8$. The level responses (Panels (a) and (b) of Figure F.1) show that the two trade-cost shocks generate comparable declines in real GDP. The heterogeneous responses in Panels (c) and (d) confirm the asymmetry effects, which is governed by the debt-repayment burden $\bar{b}_i$: the interaction of τ_t^X with $\bar{b}_i$ is sizable and significantly negative, whereas the interaction of τ_t^M with $\bar{b}_i$ is not significantly different from zero. For the spread, the asymmetry is more pronounced. On average, the response to τ_t^X is significantly positive, while the response to τ_t^M is significantly negative. The heterogeneous effects across countries with different debt positions amplify this asymmetry further: countries with a higher debt position face a larger increase in spreads in response to an export-cost shock.

G Event analysis: more figures

Figure G.3 repeats the decomposition but allows pairs of shocks to move, reporting the same set of objects (GDP, wedges, spreads, and trade shares). Two messages emerge for the GDP decline. The all-shock benchmark produces a peak-to-trough GDP decline of 3.8 standard deviations. Shutting down the export-



(a) τ^X

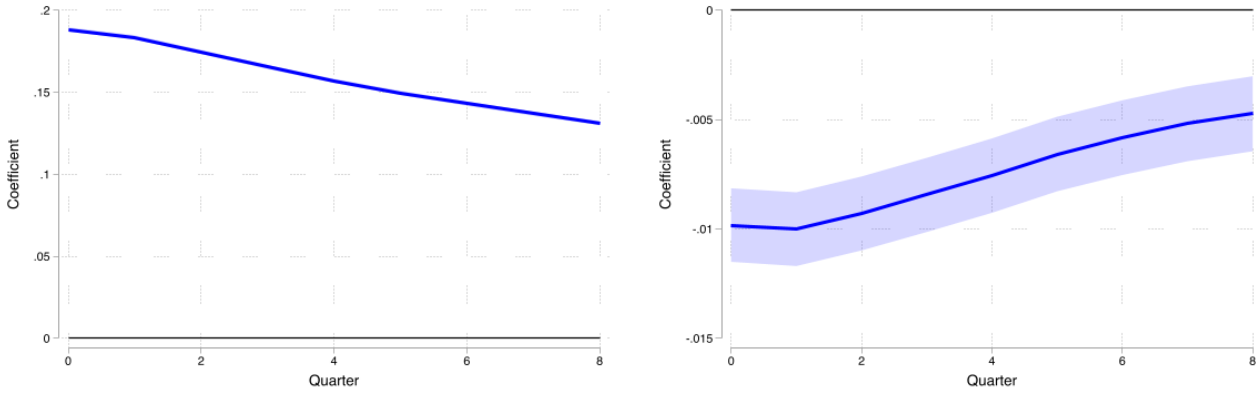
(b) τ^M

(c) $\tau^X_{i,t} \times \overline{b}_i$

(d) $\tau^M_{i,t} \times \overline{b}_i$

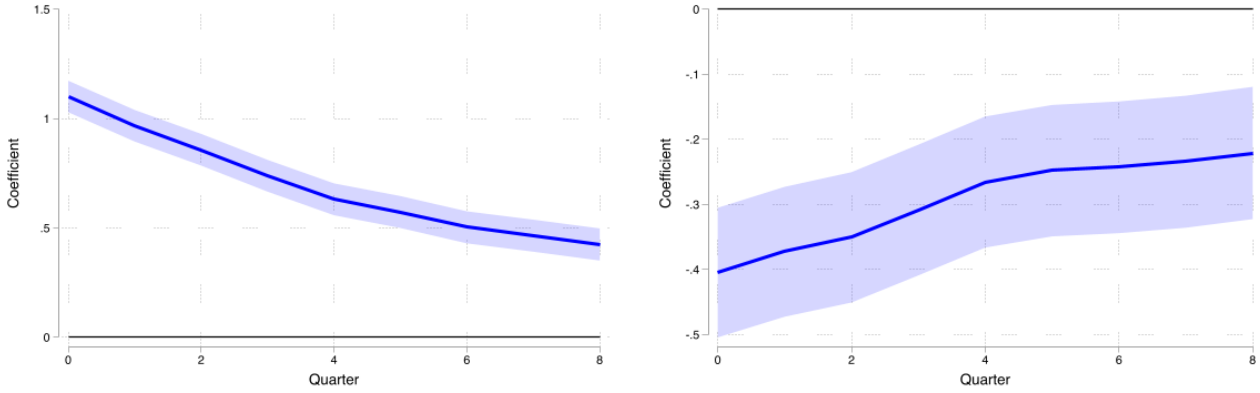
Figure F.1: Response to τ^X and τ^M shocks, log of real GDP

Notes: Each panel plots the local-projection coefficient from Equation (F.42) against the horizon $h = 0, \ldots, 8$ quarters. Panels (a) and (b) report the level responses to the export- and import-cost shocks; panels (c) and (d) report the corresponding interactions with the average debt repayment burden $\overline{b}_i$. Shaded areas are 90% confidence bands.



(a) τ^X

(b) τ^M



(c) $\tau^X_{i,t} \times \overline{b}_i$

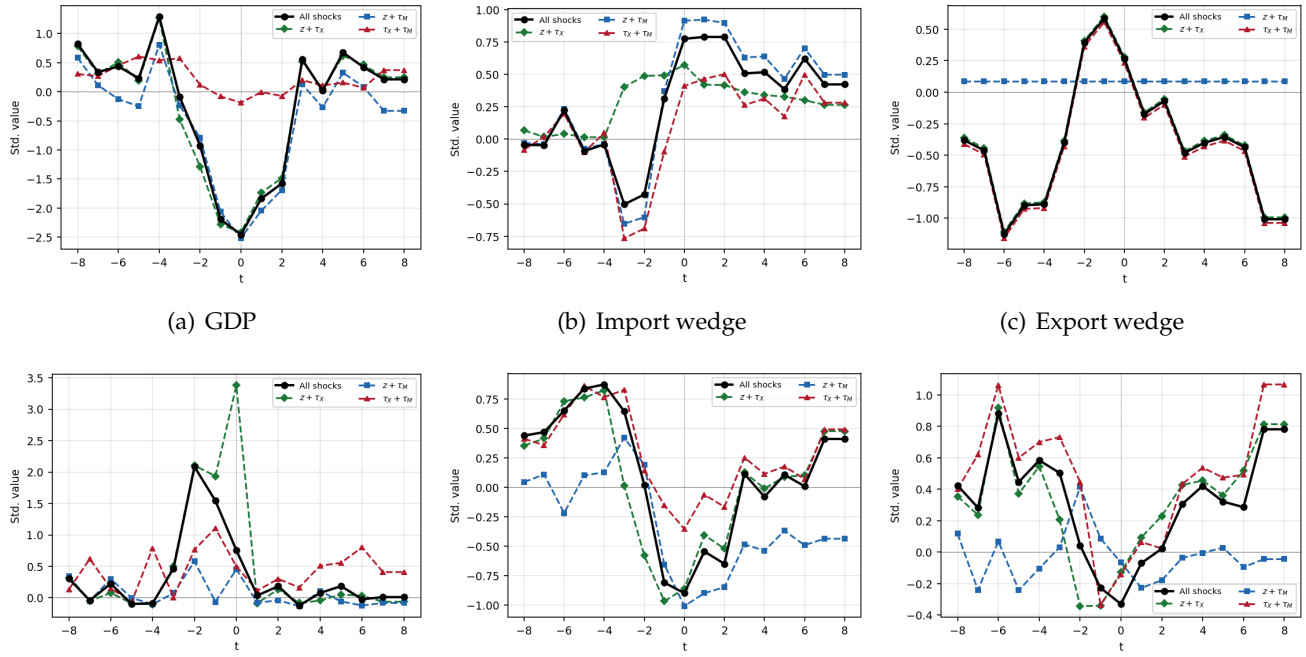
(d) $\tau^M_{i,t} \times \overline{b}_i$

Figure F.2: Response to τ^X and τ^M shocks, sovereign spread

Notes: Each panel plots the local-projection coefficient from Equation (F.42) against the horizon $h = 0, \ldots, 8$ quarters. Panels (a) and (b) report the level responses to the export- and import-cost shocks; panels (c) and (d) report the corresponding interactions with the average debt repayment burden $\overline{b}_i$. Shaded areas are 90% confidence bands.

cost shock ($z + \tau_M$) reduces the decline only modestly, to 3.3, implying that τ_t^X and its interactions account for about 11% of the GDP decline. Shutting down the import-cost shock ($z + \tau_X$) leaves the decline almost unchanged at 3.7, so τ_t^M accounts for about 2%. Shutting down productivity ($\tau_M + \tau_X$) collapses the decline to 0.8 standard deviations, indicating that z_t and its interactions with the trade-cost shocks explain roughly 80% of the GDP downturn. The depth of the event is therefore overwhelmingly a productivity story; trade-cost shocks contribute to the contraction primarily through interactions rather than on their own.

The spread response under pairwise shocks is non-monotonic. The all-shock benchmark spike is 2.1 standard deviations; shutting down τ_t^M raises it to 3.4, while shutting down τ_t^X lowers it to 0.6 and shutting down z_t lowers it to 1.1. Productivity and the export-cost shock interact strongly to drive the spike: the $(z + \tau_X)$ economy alone produces a spread response larger than the benchmark. Adding τ_t^M back dampens the spike.

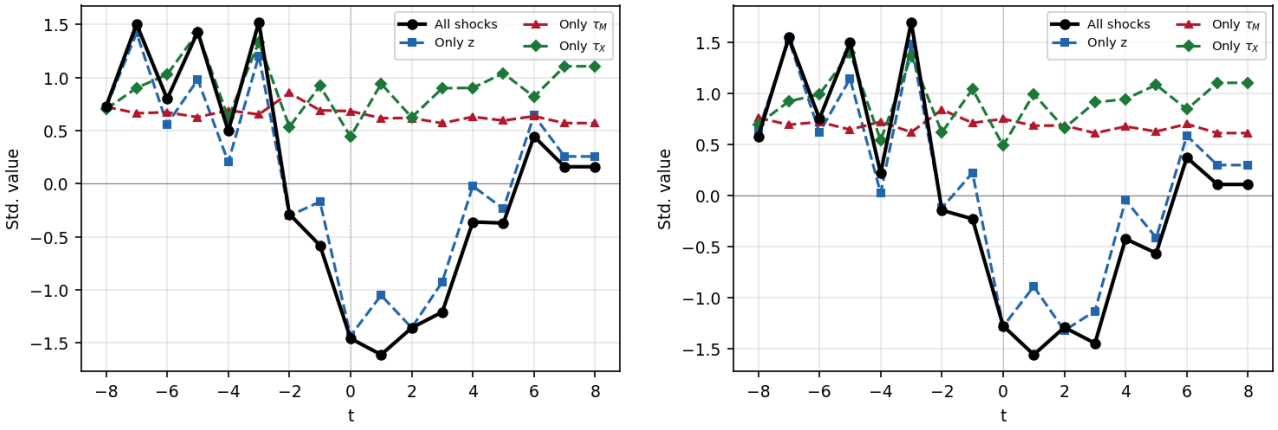


(a) GDP (b) Import wedge (c) Export wedge

(d) Spread (e) Import/GDP (f) Export/GDP

Figure G.3: Event Analysis: Decomposition with Two Shocks At a Time

Figure G.4 plots debt and debt-to-GDP ratio in the event analysis. The "only z" counterfactual tracks the benchmark most closely through the collapse and the recovery, indicating that productivity is the dominant force behind the debt retrenchment in this episode. In contrast, "only τ_M" and "only τ_X" fail to reproduce the sharp decline, implying that trade-cost shocks alone are insufficient to account for the debt dynamics.



(a) Debt

(b) Debt-to-GDP

Figure G.4: Event analysis: debt

H Computation Algorithm

We first solve the equilibrium in factor markets and production by solving the system of equations in section A.2 as well as the balanced payment condition, taking shocks and government decisions as given. This step generates the equilibrium schedules for prices $\{P_f, p^d, w\}$ and allocations $\{m_t^*, m_t^d, L_t^f, L_t^m, L_t\}$. We solve the schedules under default and repayment separately. Given the private sector equilibrium, we solve the sovereign government problem. We describe the computational algorithm in detail as follows.

1. Create grids and discretize Markov process for the productivity shock z, import iceberg cost shock τ^M, and export iceberg cost shock τ^X. Create grids for government bonds b.
2. Create grids for interest rate r and $b - qb'$. Note that r and $b - qb'$ are both endogenous in the model, here we create exogenous grids to save for schedules. That is, given any realized r and $b - qb'$, the schedules return private equilibrium results.
3. For given values of $(z, \tau^M, \tau^X, r, b - qb')$, solve the private sector equilibrium by solving the system of equations, which gives price schedules $\{P_f, p^d, w\}$ and allocation schedules $\{m_t^*, m_t^d, L_t^f, L_t^m, L_t\}$.
4. Guess an initial value function of government $v_0(z, \tau^M, \tau^X, b)$ and a bond price function $q_0(z, \tau^M, \tau^X, b)$.
5. Given private sector equilibrium schedules and the value function and bond price in the previous step, update the repayment value $v^c(z, \tau^M, \tau^X, b)$ and the default value $v^d(z, \tau^M, \tau^X)$.
6. Compare $v^c(z, \tau^M, \tau^X, b)$ and $v^d(z, \tau^M, \tau^X)$, and update the defaulting rule, bond price, government optimal policy $b'(z, \tau^M, \tau^X, b)$ and the value function of the government $v(z, \tau^M, \tau^X, b)$.
7. Check the distance *dist* between updated value function and the one from last iteration. If distance is larger than tolerance level, then go back to 5, otherwise, stop.

I Data

I.1 Variables

This section shows more details on the variable construction and data source.

1. ***CDS spread***

The quarterly CDS spread data is from Bloomberg. The series we use is "CDS USD SR 5Y D14 Corp" of each economy.

2. ***Exports & imports***

Quarterly real exports and imports from IMF National Accounts data.

3. ***Real exchange rate***

Monthly exchange rate data are obtained from the Global Economic Monitor (GEM). We use the series "Exchange rate, new LCU per USD extended backward, period average," which reports local currency units (LCU) per U.S. dollar, with observations prior to a currency's introduction expressed in the new currency's terms. The monthly nominal exchange rate series is first averaged to quarterly frequency and then deflated using consumer price index (CPI) data.

4. ***Exports & imports price***

In the baseline 16-economy sample, we use the price index of merchandise (goods) exports & imports from GEM. TOT_t is then constructed as the ratio of imports price index to exports price index.

5. ***GDP***

The domestic demand is measured as each country i's real GDP (seasonally adjusted). The foreign demand is measured as U.S. real GDP. The national accounts data is mostly from International Financial Statistics of International Monetary Fund, except Malaysia, Peru and Philippines. For Malaysia, the data are from the Department of Statistics Malaysia. For Peru, the data are from the Central Reserve Bank of Peru. For the Philippines, the data are taken from the IMF's IFS. We use unadjusted series for the Philippines and perform seasonal adjustment ourselves.

6. ***Population***

When we construct the weighted average series, we use the population of each economy in 2012. The population data is from World Bank.

7. ***Terms of trade***

The data on terms of trade (TOT) of 16 economies, except Colombia, is obtained from GEM. GEM reports quarterly trade price data, namely "The price index of Merchandise (goods) exports (f.o.b.)" and "The price index of Merchandise (goods) imports (c.i.f.)" . The TOT data for Colombia is from OECD. [10]

I.2 Sample selection

Our baseline 16-economy sample is constructed as follows (in order of operation):

[10]OECD reports "Term of Trade: Goods and Services". GEM also has TOT data for Hungary, and the difference between TOT from GEM and TOT from OECD is minor.

Table I.3: Summary statistics for 16 countries

	N	Mean	SD	Min	Max	p25	Median	p75
$\ln(X_t)$	980	12.502	2.924	8.238	20.172	10.476	11.478	13.852
$\ln(M_t)$	980	12.528	2.937	8.271	20.14	10.455	11.479	14.011
$\ln(RER_t)$	980	2.388	2.836	-.451	9.461	-.007	1.205	3.738
$\ln(TOT_t)$	980	.062	.462	-4.001	2.896	-.056	.008	.059
$\ln\left(\frac{M}{Y}\right)$	659	.286	.13	-.006	.55	.196	.294	.375
$\ln(y_t)$	980	13.74	3.017	8.829	21.747	11.99	12.873	15.144
$\ln(D_t^*)$	980	15.218	.086	15.011	15.385	15.161	15.205	15.285
CDS Spread (%)	980	3.387	11.237	.022	254.228	1.023	1.598	2.67

Notes: Statistics are calculated using the 16-economy sample, covering the period from 2000q4 to 2020q2.

1. Keep economies with available export/import price and CDS spread;

2. Keep economies with average CDS spread higher than 1%;

The 16 economies left are Argentina, Brazil, Bulgaria, Colombia, Greece, Hungary, Indonesia, Ireland, Italy, Lithuania, Mexico, Peru, Philippines, South Africa, Spain and Turkey.

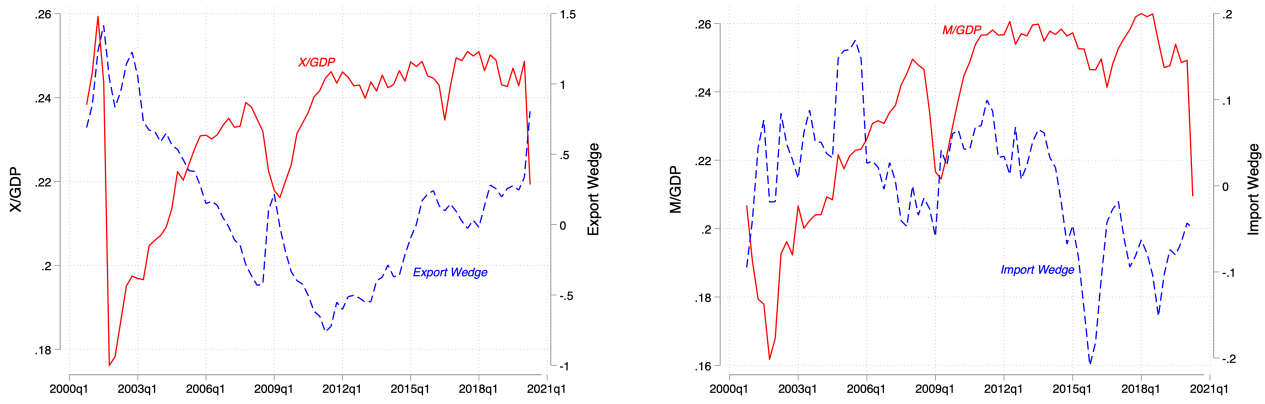
I.3 Trade Wedge & Trade

The export and import wedges are good proxies for the corresponding export and import barriers. Figure I.5 plots the weighted average export wedge against the export-to-GDP ratio in Panel (a), and the import wedge against the import-to-GDP ratio in Panel (b). Panel (a) shows that the export wedge is a good proxy for export-side trade barriers: it exhibits a strong negative correlation with the export-to-GDP ratio, with a correlation coefficient of 0.54. The import wedge is constructed analogously and, as Panel (b) shows, is also negatively correlated with the import-to-GDP ratio, with a correlation coefficient of 0.30.

I.4 By-country trade wedge

There are 37 economies with available data on CDS spreads and export, import prices. In this section, we compare the estimated export and import wedges with each country's CDS spread.

For the baseline analysis, we focus on countries with an average CDS spread higher than 1%, which includes Argentina, Brazil, Bulgaria, Colombia, Greece, Hungary, Indonesia, Ireland, Italy, Lithuania, Mexico, Peru, the Philippines, South Africa, Spain, and Turkey. Most of these countries have similar correlations as observed in the weighted average series. It is worth noting that the weighted average results are not drive by any single economy. The population weight of this 16-economy sample in 2012 is shown in Figure I.6. While Indonesia has the largest population share, the weighted average CDS spread



(a) Export wedge

(b) Import wedge

Figure I.5: Export & import wedges and trade-to-GDP ratios

Notes: The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

is significantly higher than Indonesia's CDS spread. Brazil, which has the second largest population share, experienced relatively stable CDS spread after the trade liberalization period of 2002-2007, especially when compared to the more volatile period during its economic crisis in the early 2000s.

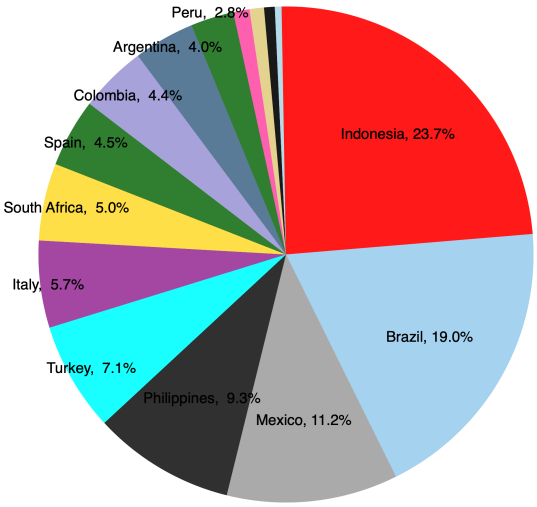


Figure I.6: Population share in 2012: 16-economy sample

We did not specifically select the 16 economies that exhibit consistent patterns with the weighted average series. Several of the other 21 economies from the 37-economy sample also show correlations between the estimated wedges and financial frictions, despite having relatively mild variations in CDS spreads. Including these 21 economies does not bias the observed correlations, as demonstrated in Section I.5. Similarly, the overall results are not driven by any single country in the 37-economy sample. Figure

I.7 presents the population weights for these 37 economies. Moreover, our baseline correlations between the wedges, trade, and financial frictions remain robust when alternative weighting schemes are applied, as discussed in Section I.5.

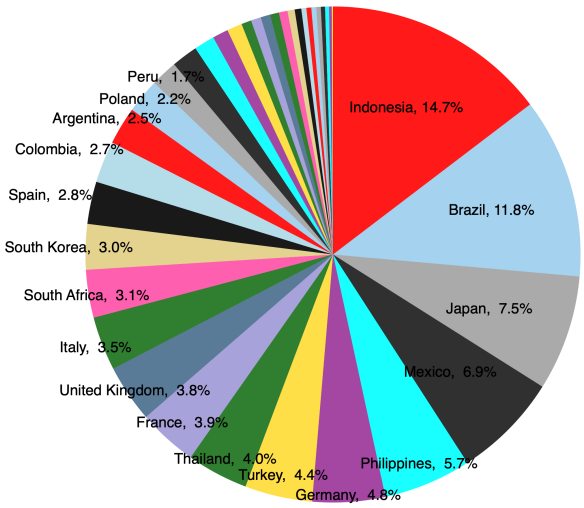


Figure I.7: Population share in 2012: 37-economy sample

I.5 Robustness

We conduct several robustness checks to verify that our baseline findings are not sensitive to specific sample or methodological choices. First, we verify that the baseline time-series patterns are not driven by any single economy by aggregating across countries using the sample median and 2019 nominal GDP weights as alternatives to our baseline 2012 population weights. In all cases, the main conclusions are unchanged. Second, we expand the sample from 16 to 37 economies by relaxing the requirement that sovereign spreads exceed 1%, and find that the positive correlation between the export wedge and sovereign risk remains robust, with the export wedge continuing to dominate the import wedge. Third, we show that the results are robust to alternative values of the elasticities of substitution, considering $(\sigma, \rho) \in \{(1.5, 1.5), (1.5, 3), (6, 6)\}$ in place of the baseline parameterization. Fourth, rather than demeaning variables by their country-specific means, we remove a within-country linear trend to account for secular movements in trade, and obtain qualitatively identical results. Finally, we further incorporate annual intermediate goods price data to construct the wedges. The export wedge remains strongly and significantly correlated with CDS spreads.

Alternative Weights In our baseline, we use the 2012 population as the weight to construct the weighted average series. A potential concern is that these weighted average results might be driven by a single

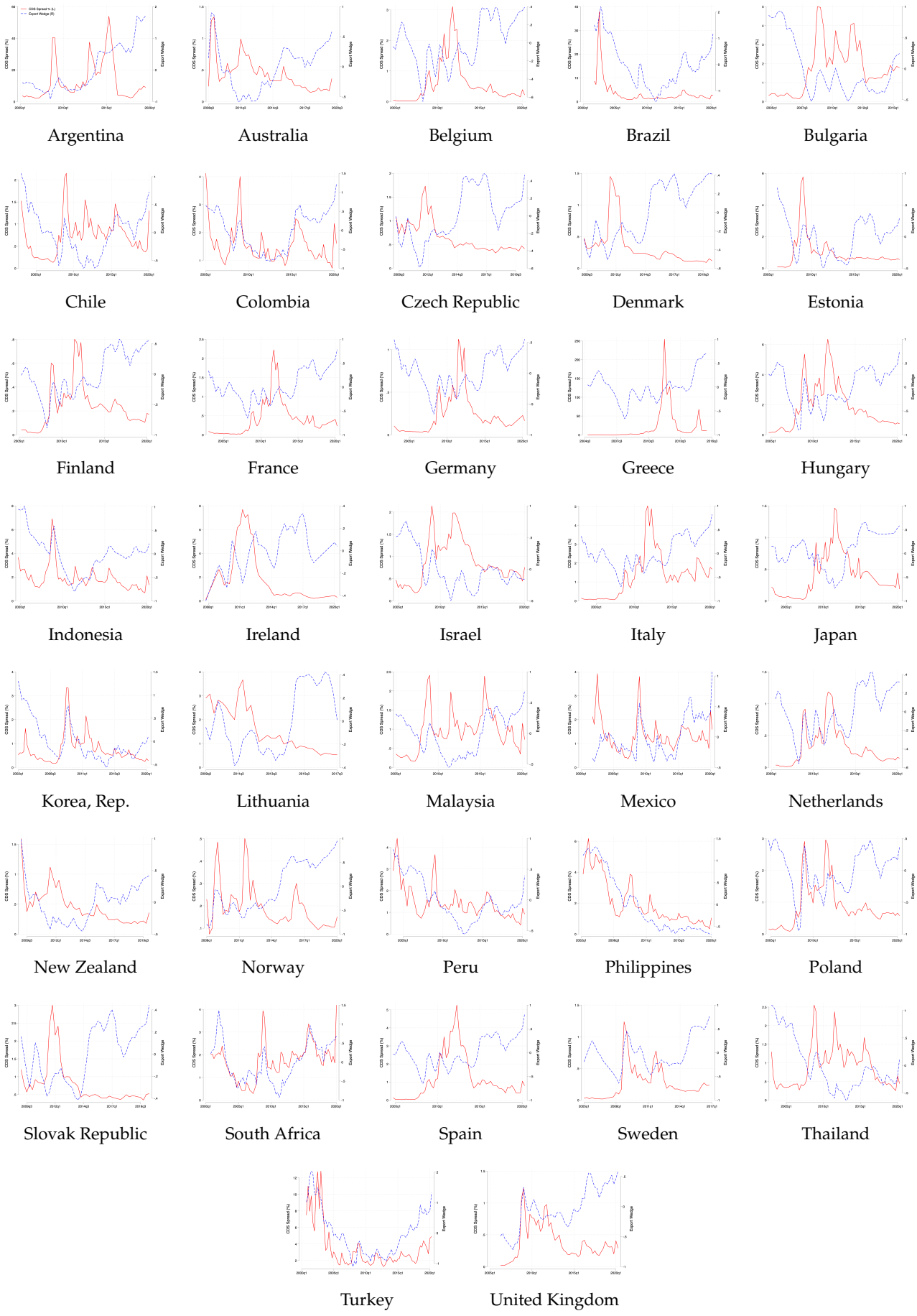


Figure I.8: Export wedge and CDS spread

Notes: Each figure plots the model-implied export wedge (blue dashed line) and CDS spread (red solid line).

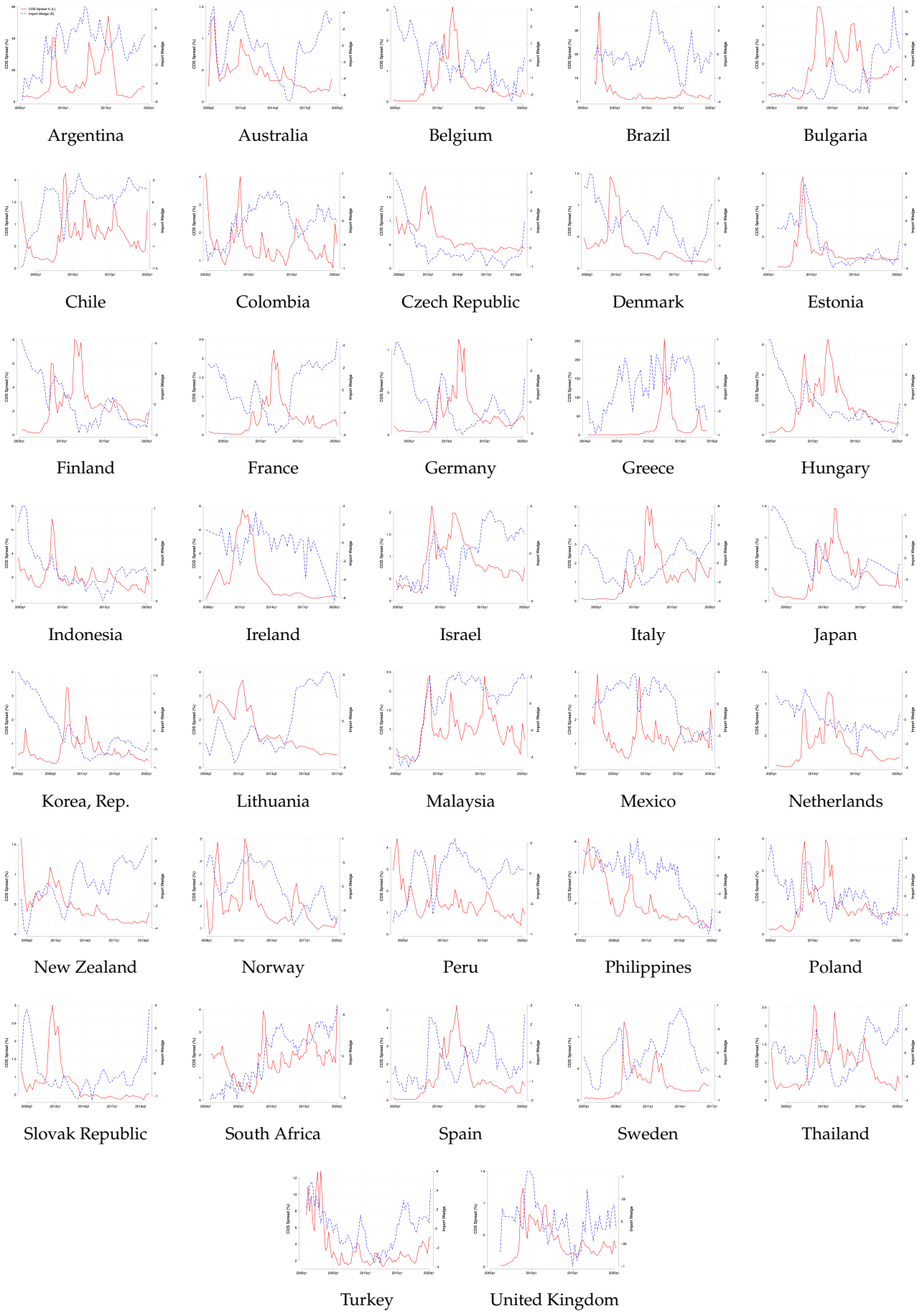
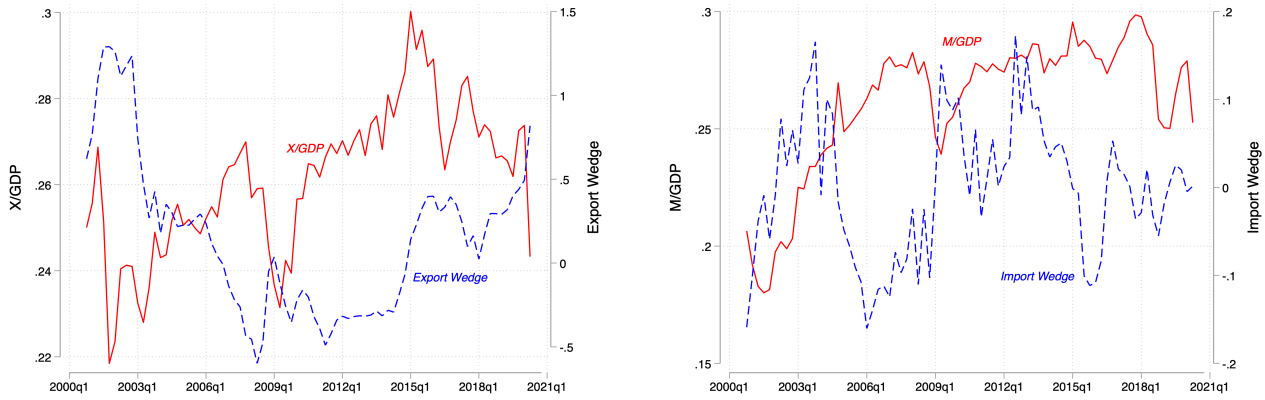


Figure I.9: Import wedge and CDS spread

Notes: Each figure plots the model-implied import wedge (blue dashed line) and CDS spread (red solid line).

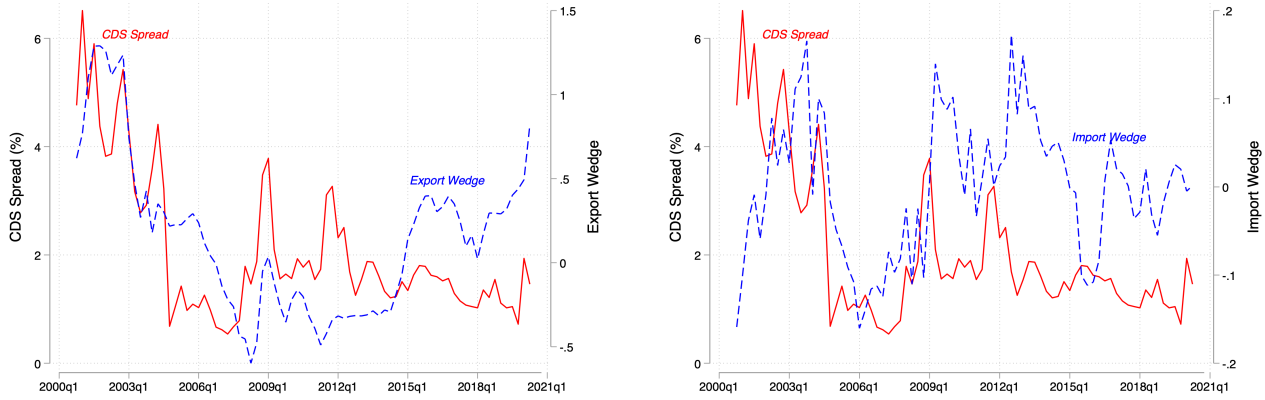
economy in the sample. To address this, we show that the observed correlations between the wedges, trade and financial frictions are robust to alternative weighting methods. Specifically, we aggregate the data across 16 economies either by taking the median value (Figure I.10 and I.11) or using nominal GDP in 2019 as weights (Figure I.12 and I.13). The patterns are robust.



(a) Export wedge (b) Import wedge

Figure I.10: Export & import wedges and trade-to-GDP ratios, median

Notes: Aggregate up using sample median across 16 economies. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

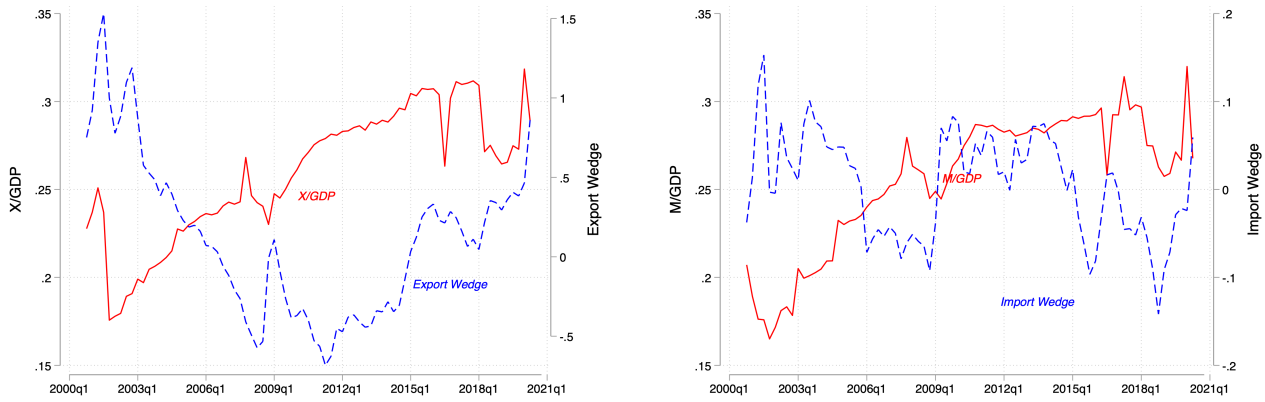


(a) Export wedge (b) Import wedge

Figure I.11: Export & import wedges and CDS spread, median

Notes: Aggregate up using sample median across 16 economies. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

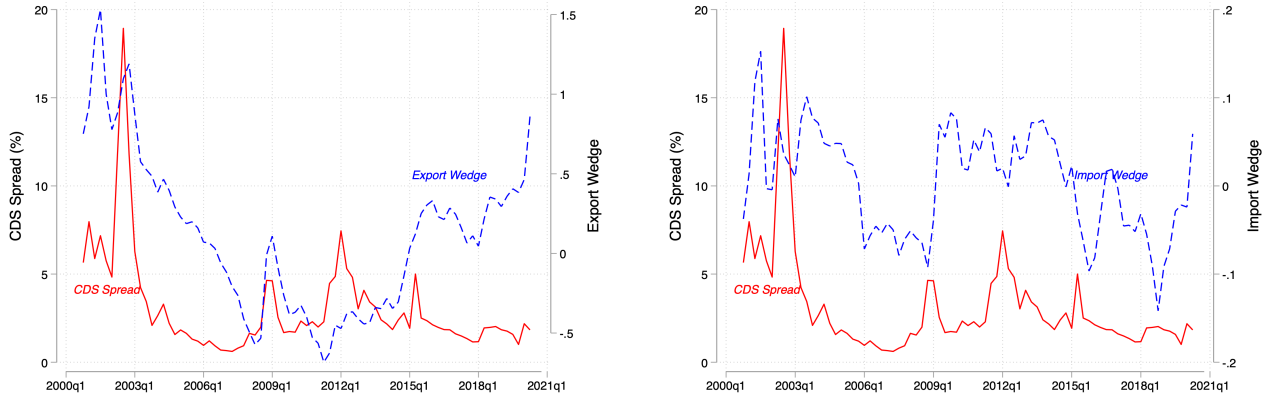
Alternative 37-economy Sample We now relax the baseline requirement that sovereign spreads exceed 1%, allowing more countries to enter the sample for a total of 37. Table I.4 summarizes the key variable



(a) Export wedge (b) Import wedge

Figure I.12: Export & import wedges and trade-to-GDP ratios, GDP weighted average

Notes:Results using nominal GDP in 2019 as weights when taking the weighted average. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.



(a) Export wedge (b) Import wedge

Figure I.13: Export & import wedges and CDS spread, GDP weighted average

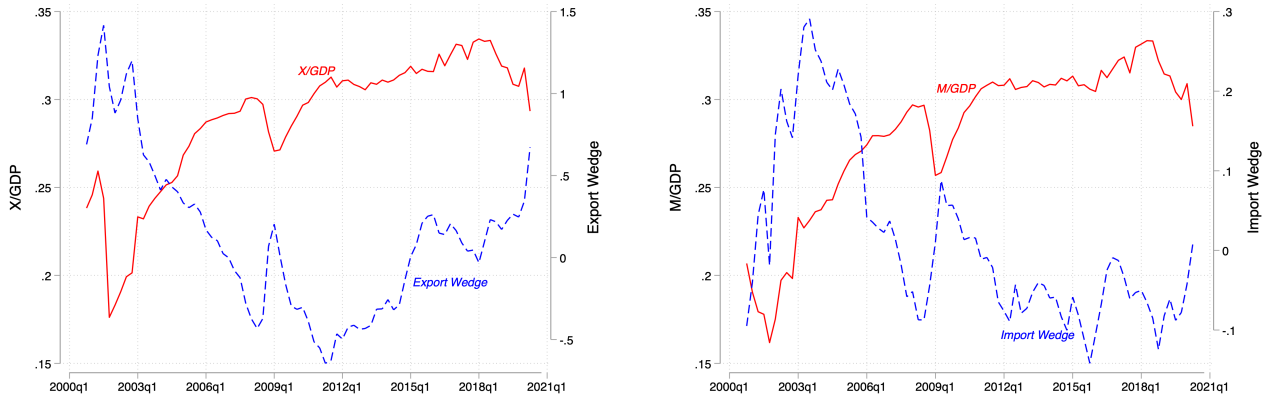
Notes: Results using nominal GDP in 2019 as weights when taking the weighted average. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

statistics. Consistent with our benchmark, both the export and import wedges serve as good proxies for trade barriers, as shown in Figure I.14 in the appendix. The export wedge exhibits a correlation of -0.70 with the export-to-GDP ratio, while the import wedge shows a correlation of -0.64 with the import-to-GDP ratio.

Table I.4: Summary statistics: 37-economy sample

	N	Mean	SD	Min	Max	p25	Median	p75
$\ln(X_t)$	2179	12.567	2.723	7.677	20.172	10.686	11.911	13.758
$\ln(M_t)$	2179	12.542	2.717	7.6	20.14	10.773	11.885	13.777
$\ln(RER_t)$	2179	1.953	2.634	-2.043	9.461	-.182	1.178	3.14
$\ln(TOT_t)$	2179	.021	.322	-4.001	2.896	-.046	.004	.04
$\ln\left(\frac{M}{Y}\right)$	836	.259	.141	-.064	.55	.139	.261	.352
$\ln(y_t)$	2179	13.568	2.873	8.171	21.747	11.998	13.017	14.646
$\ln(D_t^*)$	2179	15.227	.083	15.011	15.385	15.167	15.218	15.289
CDS Spread (%)	2179	1.84	7.673	.011	254.228	1.351	.796	1.603

Notes: Statistics are calculated using the 37-economy sample, covering the period from 2000q4 to 2020q2.



(a) Export wedge

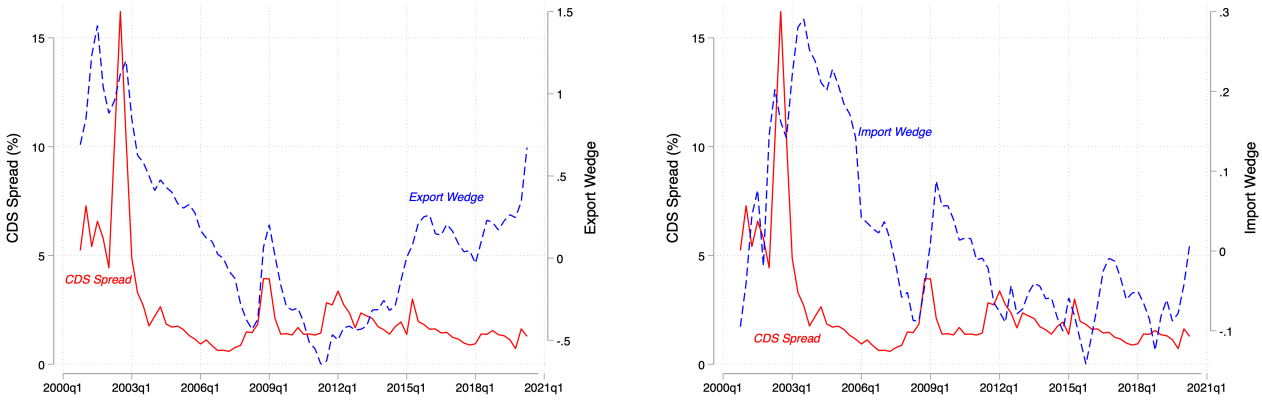
(b) Import wedge

Figure I.14: Export & import wedges and trade-to-GDP ratios

Notes: Results using the 37-economy sample. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Figure I.15 in the appendix compares the population-weighted average export and import wedges with the CDS spread. The correlation between the export wedge and the CDS spread is 0.61, while the corresponding correlation for the import wedge is 0.30. These results confirm our baseline finding that the relationship between the estimated wedges and sovereign risk is more pronounced on the export side.

We further estimate Equation (32) using the 37-economy sample. Consistent with the baseline results, Columns (1) and (2) of Table I.5 confirm that the export wedge is significantly positively correlated with spreads. The import wedge, by contrast, exhibits a weaker and less consistent positive correlation, as shown in Columns (3) and (4). Because the expanded sample includes more countries with relatively



(a) Export wedge (b) Import wedge

Figure I.15: Export & import wedges and CDS spread

Notes: Results using the 37-economy sample. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

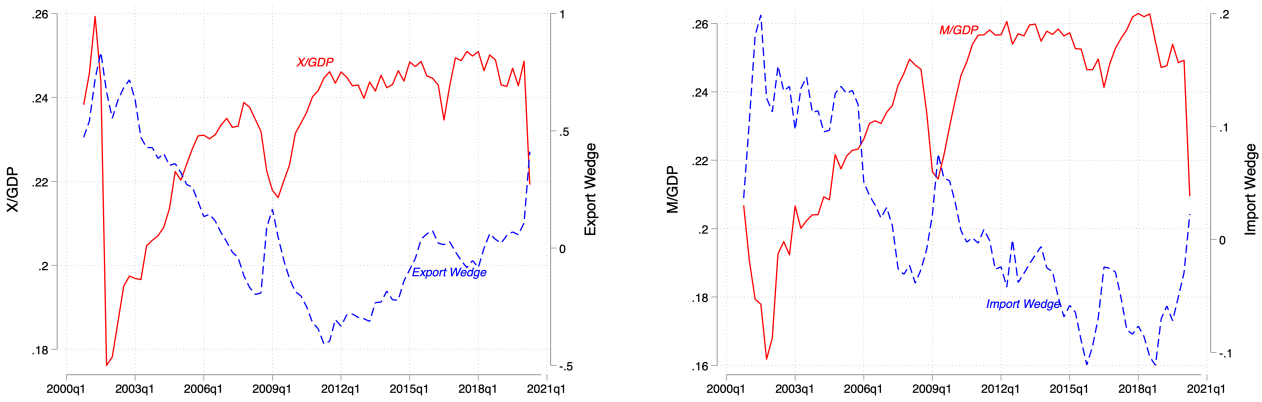
Table I.5: Correlations using 37-economy sample

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.139***	0.801***			1.145***	0.809***
	(0.196)	(0.150)			-0.197	-0.151
Import wedge			0.057	-0.065**	0.094	-0.085**
			(0.059)	(0.031)	-0.062	-0.033
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,179	1,384	2,179	1,384	2,179	1,384
R-squared	0.241	0.562	0.231	0.542	0.242	0.563

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

mild variation in sovereign risk, the estimated coefficients on the export wedge are smaller in magnitude. Nevertheless, the export wedge continues to exhibit a dominant correlation with the CDS spread when both wedges are included jointly. Overall, expanding the sample does not change our main conclusion: the export and import wedges effectively capture overall trade barriers and comove with aggregate financial frictions.

Alternative Elasticities Here we show that our baseline findings are robust to alternative values of elasticity of substitution between domestic and foreign final goods, ρ, and the elasticity of substitution between domestic intermediate goods and imported foreign intermediates, σ. Specifically, we examine the classic IRBC value of 1.5 as well as the commonly used value of 6 in the trade literature. Accordingly, we report three sets of results: (i) $\sigma = 1.5$ and $\rho = 1.5$ (Figure I.16 and I.17, Table I.6); (ii) $\sigma = 1.5$ and $\rho = 3$ (Figure I.18 and I.19, Table I.7); (iii) $\sigma = 6$ and $\rho = 6$ (Figure I.20 and I.21, Table I.8). The baseline findings remain robust.



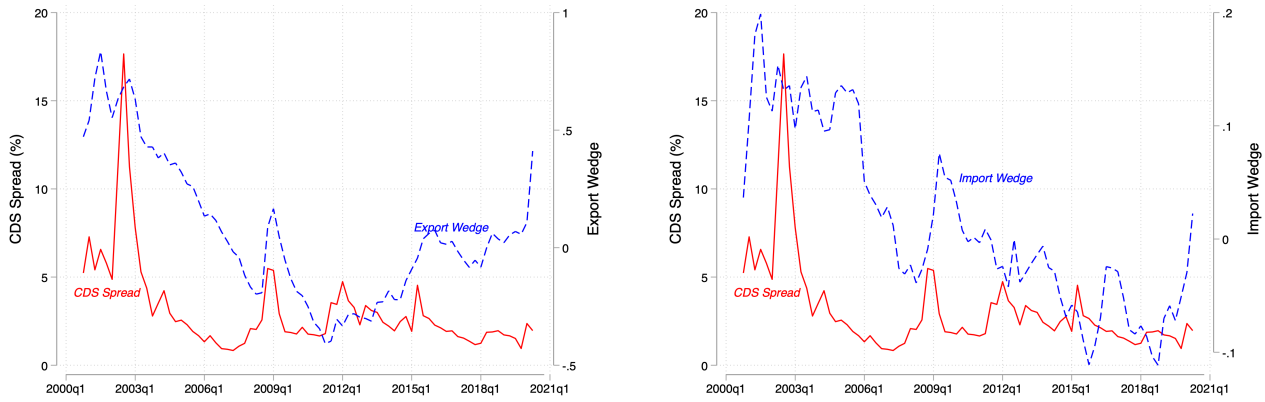
(a) Export wedge (b) Import wedge

Figure I.16: Export & import wedges and trade-to-GDP ratios

Notes: Wedges are constructed using $\sigma = 1.5$ and $\rho = 1.5$. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

A Linear Trend within Countries In the baseline construction of trade wedges, we demean all trade, price, and demand variables by removing their country-specific means. In this section, we instead remove a linear trend from each variable to account for secular trends in trade observed in some economies, then estimate the export and import wedges following Definition 1. The corresponding results are presented in Figures I.22 and I.23 in the appendix. Our baseline findings remain robust.

Table I.9 reestimates Equation (32) using wedges constructed using linearly detrended variables. The



(a) Export wedge (b) Import wedge

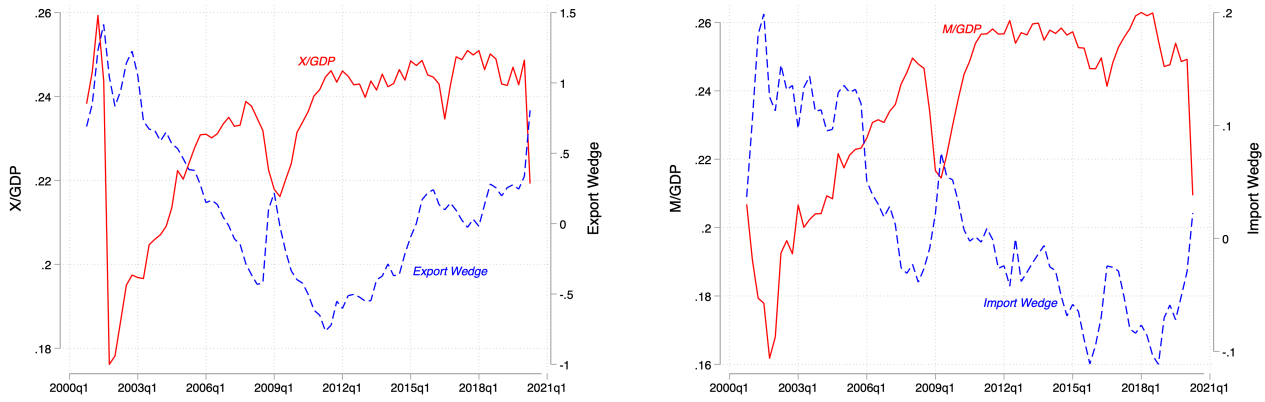
Figure I.17: Export & import wedges and CDS spread

Notes: Wedges are constructed using $\sigma = 1.5$ and $\rho = 1.5$. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.6: Correlations with wedges estimated under $\sigma = 1.5$ and $\rho = 1.5$

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	2.165***	1.439***			2.161***	1.482***
	(0.419)	(0.349)			(0.419)	(0.355)
Import wedge			0.151	-0.121*	0.115	-0.202**
			(0.138)	(0.072)	(0.126)	(0.084)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.256	0.561	0.237	0.529	0.256	0.564

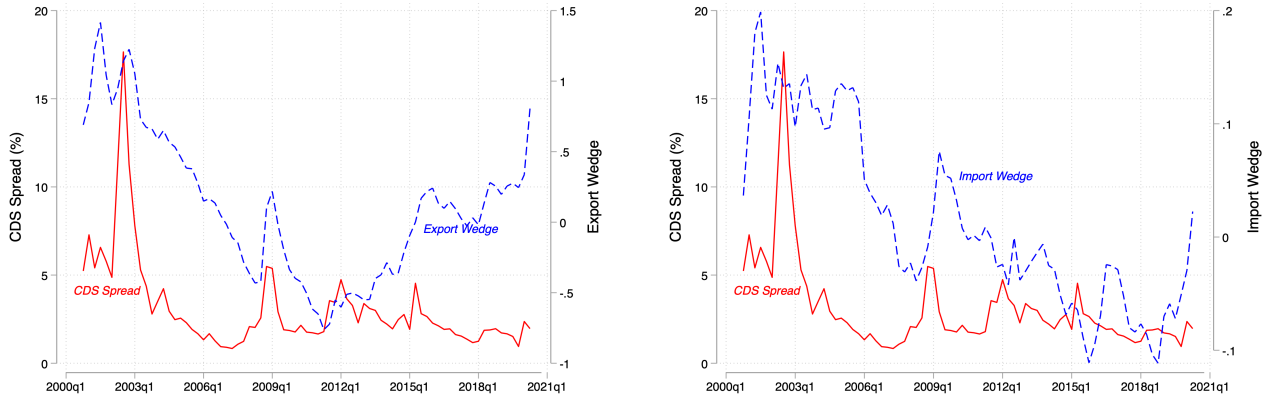
Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.



(a) Export wedge (b) Import wedge

Figure I.18: Export & import wedges and trade-to-GDP ratios

Notes: Wedges are constructed using $\sigma = 1.5$ and $\rho = 3$. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.



(a) Export wedge (b) Import wedge

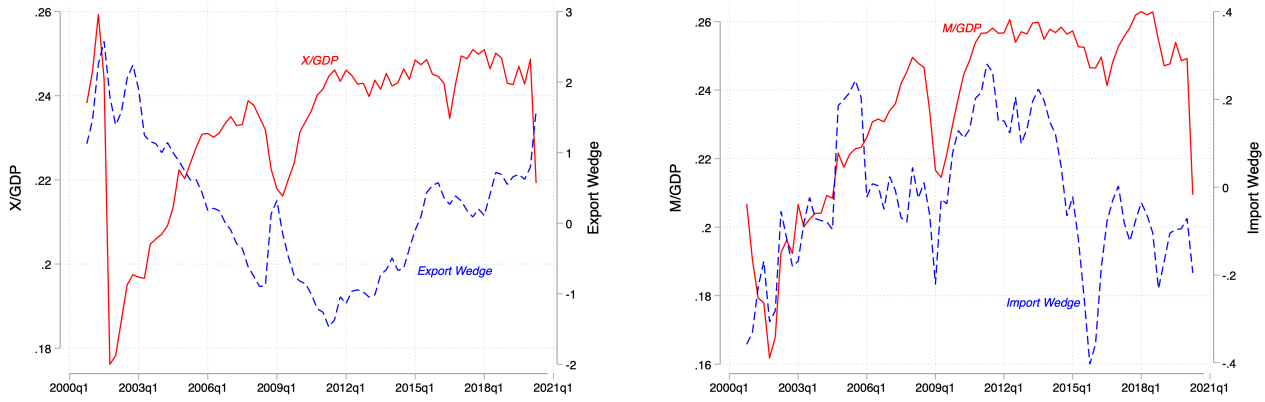
Figure I.19: Export & import wedges and CDS spread

Notes: Wedges are constructed using $\sigma = 1.5$ and $\rho = 3$. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.7: Correlations with wedges estimated under $\sigma = 1.5$ and $\rho = 3$

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	2.059***	1.508***			2.056***	1.558***
	(0.371)	(0.311)			(0.370)	(0.318)
Import wedge			0.151	-0.121*	0.120	-0.217**
			(0.138)	(0.072)	(0.130)	(0.085)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.253	0.565	0.237	0.529	0.253	0.568

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

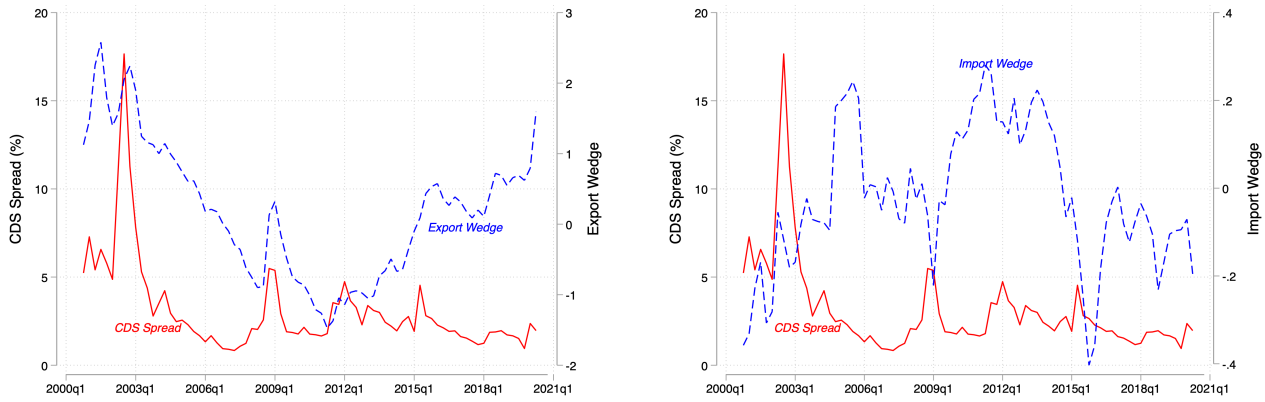


(a) Export wedge

(b) Import wedge

Figure I.20: Export & import wedges and trade-to-GDP ratios

Notes: Wedges are constructed using $\sigma = 6$ and $\rho = 6$. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.



(a) Export wedge

(b) Import wedge

Figure I.21: Export & import wedges and CDS spread

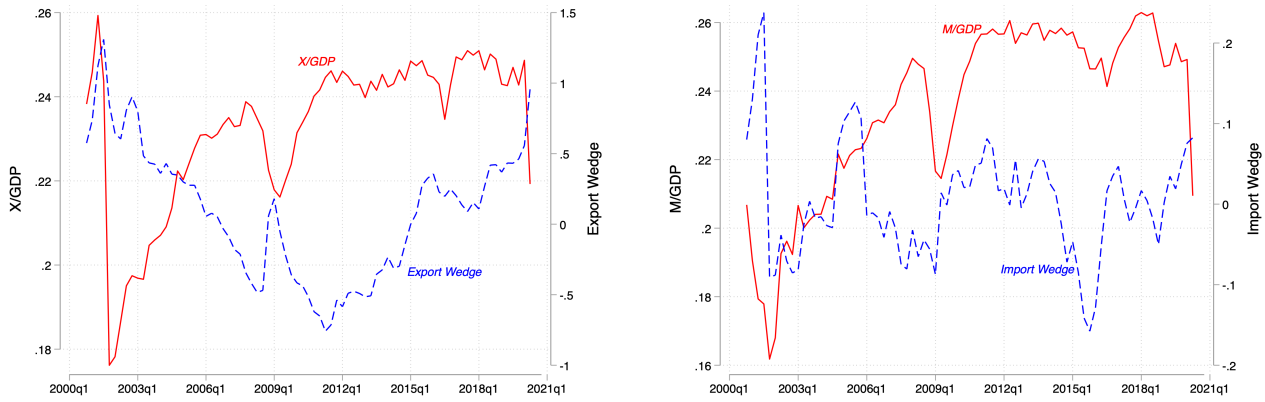
Notes: Wedges are constructed using $\sigma = 6$ and $\rho = 6$. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.8: Correlations with wedges estimated using $\sigma = 6$ and $\rho = 6$

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.943***	1.507***			1.943***	1.548***
	(0.335)	(0.286)			(0.335)	(0.290)
Import wedge			-0.034	-0.155**	-0.022	-0.230***
			(0.116)	(0.078)	(0.115)	(0.087)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.251	0.566	0.237	0.530	0.251	0.569

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

export wedge remains significantly and positively correlated with the CDS spread, while the import wedge shows only a weak correlation, consistent with the baseline results.



(a) Export wedge (b) Import wedge

Figure I.22: Linearly detrended export & import wedges and trade-to-GDP ratios

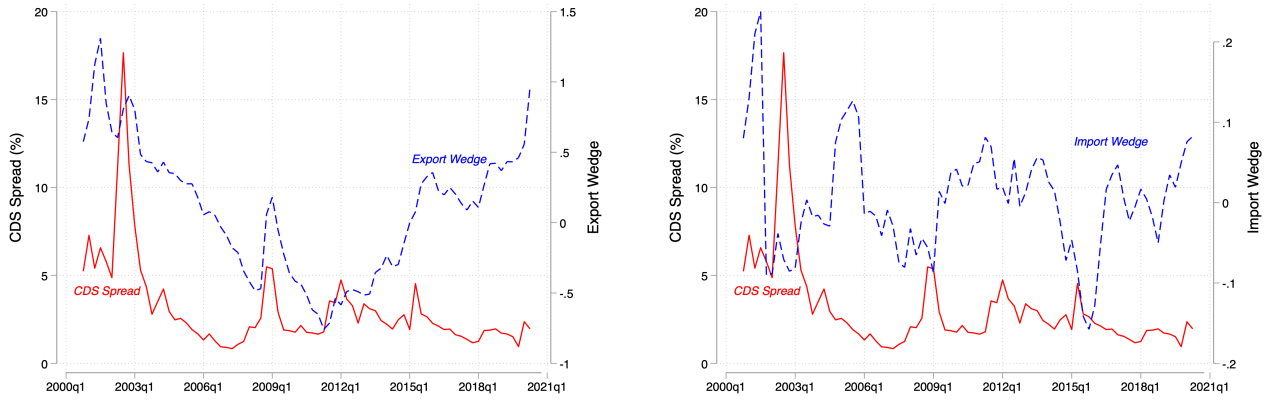
Notes: Wedges are constructed using linearly detrended variables for each country. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.9: Correlations when removing linear trends

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.781***	0.870***			1.776***	0.885***
	(0.364)	(0.184)			(0.364)	(0.185)
Import wedge			0.115	-0.038	0.048	-0.083
			(0.182)	(0.074)	(0.192)	(0.080)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.247	0.542	0.237	0.529	0.247	0.542

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Excluding Crisis Episodes As shown in Appendix I.4, there are a small number of acute crisis episodes, such as Greece during the 2010–2012 euro-area sovereign debt crisis, Argentina around its 2001 default and again during the 2019–2020 debt distress, Brazil during the 2002 pre-election confidence crisis, and Turkey during the 2018 currency and debt crisis. A natural concern is that these few extreme, country-specific



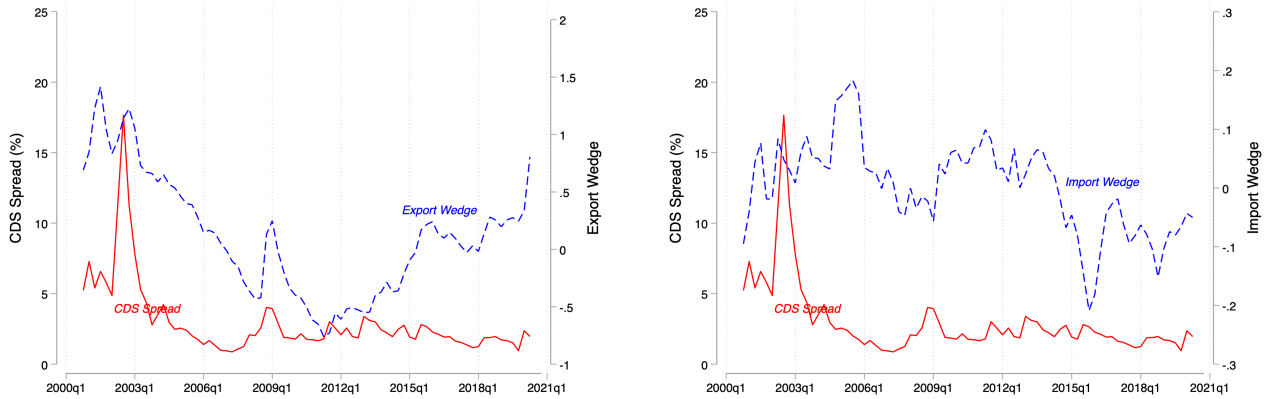
(a) Export wedge (b) Import wedge

Figure I.23: Linearly detrended export & import wedges and CDS spread

Notes: Wedges are constructed using linearly detrended variables for each country. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

observations might drive the estimated relationship between the export wedge and sovereign spreads.

To address this, we replot the time-series patterns of the export and import wedges against the sovereign spread and re-estimate the baseline regression in Equation (32) after trimming the sovereign spread at progressively tighter symmetric cutoffs. We first set observations whose spread lies below the 1st or above the 99th percentile to missing, and then tighten the cutoff to the 5th/95th and 10th/90th percentiles in turn. This helps remove the influence of the crisis observations.



(a) Export wedge (b) Import wedge

Figure I.24: Export & import wedge and CDS spread, spreads trimmed at 1/99

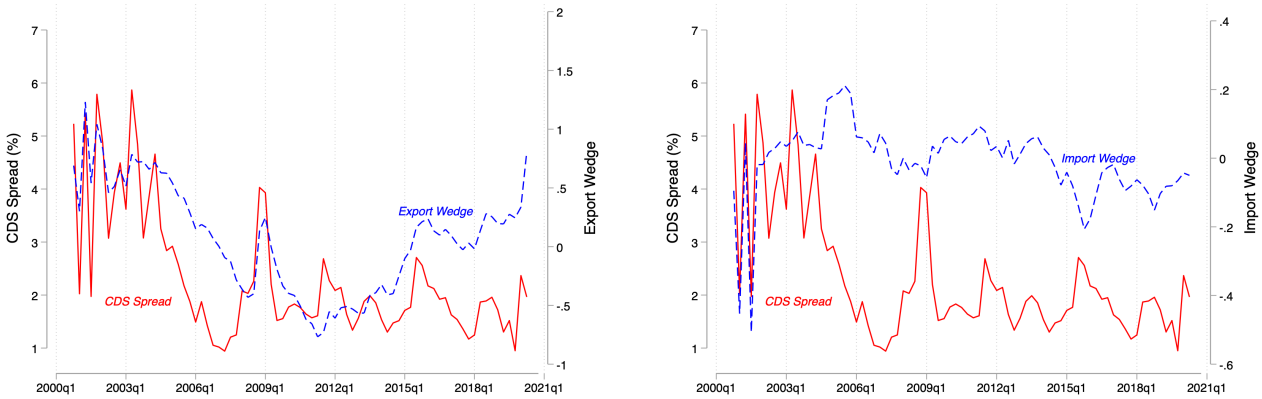
Notes: The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The sovereign spread is trimmed at the 1st and 99th percentiles. The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Figures I.24–I.26 replot the weighted-average export and import wedges against the CDS spread after

Table I.10: Correlations between spreads and wedges, spreads trimmed at 1/99

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.533***	1.477***			1.533***	1.508***
	(0.164)	(0.228)			(0.164)	(0.231)
Import wedge			-0.015	-0.078	-0.019	-0.157**
			(0.052)	(0.052)	(0.050)	(0.062)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	962	686	962	686	962	686
R-squared	0.524	0.620	0.442	0.561	0.524	0.623

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. The sovereign spread is trimmed at the 1st and 99th percentiles. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.



(a) Export wedge

(b) Import wedge

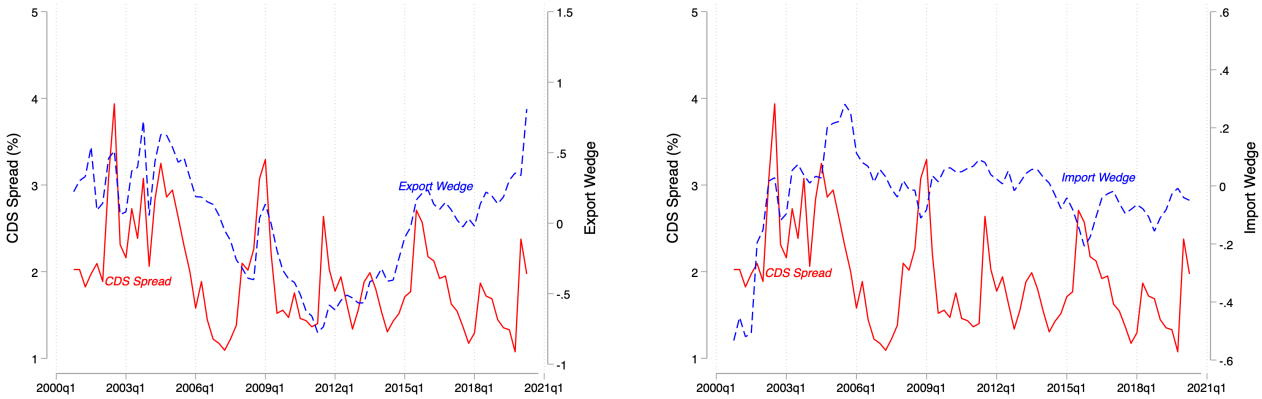
Figure I.25: Export & import wedge and CDS spread, spreads trimmed at 5/95

Notes: The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The sovereign spread is trimmed at the 5th and 95th percentiles. The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.11: Correlations between spreads and wedges, spreads trimmed at 5/95

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	0.880***	0.521***			0.880***	0.523***
	(0.050)	(0.057)			(0.050)	(0.058)
Import wedge			0.016	0.025	0.006	-0.010
			(0.026)	(0.022)	(0.030)	(0.023)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	880	662	880	662	880	662
R-squared	0.653	0.798	0.509	0.759	0.653	0.798

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. The sovereign spread is trimmed at the 5th and 95th percentiles. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.



(a) Export wedge

(b) Import wedge

Figure I.26: Export & import wedge and CDS spread, spreads trimmed at 10/90

Notes: The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The sovereign spread is trimmed at the 10th and 90th percentiles. The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.12: Correlations between spreads and wedges, spreads trimmed at 10/90

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	0.704***	0.417***			0.711***	0.442***
	(0.040)	(0.038)			(0.041)	(0.037)
Import wedge			-0.076***	-0.024	-0.095***	-0.062***
			(0.027)	(0.022)	(0.028)	(0.022)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	780	609	780	609	780	609
R-squared	0.602	0.805	0.423	0.753	0.610	0.810

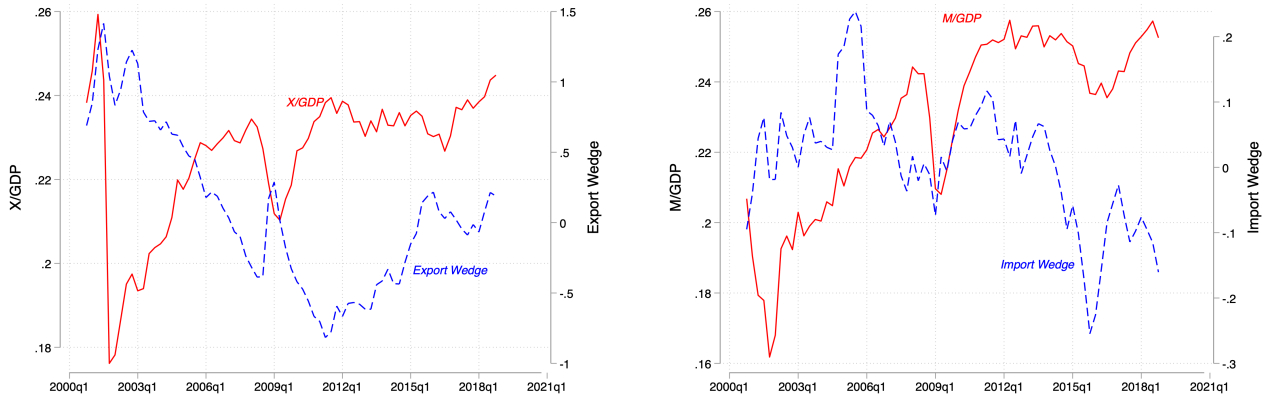
Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. The sovereign spread is trimmed at the 10th and 90th percentiles. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

trimming the sovereign spread at the 1st/99th, 5th/95th, and 10th/90th percentiles, respectively. As the trimming window tightens and the crisis spikes are progressively removed, the export wedge continues to track the sovereign spread closely, whereas the import wedge shows little systematic comovement.

Tables I.10–I.12 report the estimates after trimming the sovereign spread at the 1st/99th, 5th/95th, and 10th/90th percentiles, respectively. The export wedge remains positive and statistically significant at the 1% level in every specification and trimming window, with or without controls, while the import wedge stays economically small and either insignificant or negative. The export wedge thus continues to dominate the import wedge throughout, confirming that the positive comovement between the export wedge and sovereign spreads is a broad-based feature of the panel and not an artifact of a few extreme crisis episodes. As expected, discarding these observations compresses the magnitude of the export-wedge coefficient. In Column (6) of Tables I.10–I.12, it falls from 1.51 under 1/99 trimming to 0.52 under 5/95 and 0.44 under 10/90 trimming. This attenuation is mechanical, since the crisis tail accounts for much of the level variation in spreads. The qualitative conclusions, however, are unchanged.

A sub-sample with available intermediate goods price The ratio of intermediate to final goods prices is inferred from the annual OECD Inter-Country Input–Output Tables. Such data are available for 11 of the 16 economies: Brazil, Bulgaria, Colombia, Hungary, Indonesia, Lithuania, Mexico, Peru, the Philippines, South Africa, and Turkey. Our baseline wedge construction abstracts from intermediate goods prices. Restricting the analysis to the subsample with available intermediate goods price yields qualitatively identical correlations between model-implied wedges, trade, and financial frictions.

Figure I.27 in the appendix shows that the export wedge is strongly negatively correlated with the export-to-GDP ratio at –0.52, while the import wedge shows a weaker negative correlation with the import-to-GDP ratio at –0.25. Figure I.28 documents a strong positive correlation between the export wedge and the CDS spread at 0.72, whereas the import wedge is only weakly correlated with sovereign risk at 0.07. Relative to the baseline results, these correlations reinforce the interpretation of the model-implied wedges as effective proxies for trade barriers. Moreover, the results confirm that the relationship between trade wedges and financial frictions is primarily driven by the export wedge. Table I.13 provides further evidence that the correlation between model-implied wedges and financial frictions is largely driven by the export wedge.



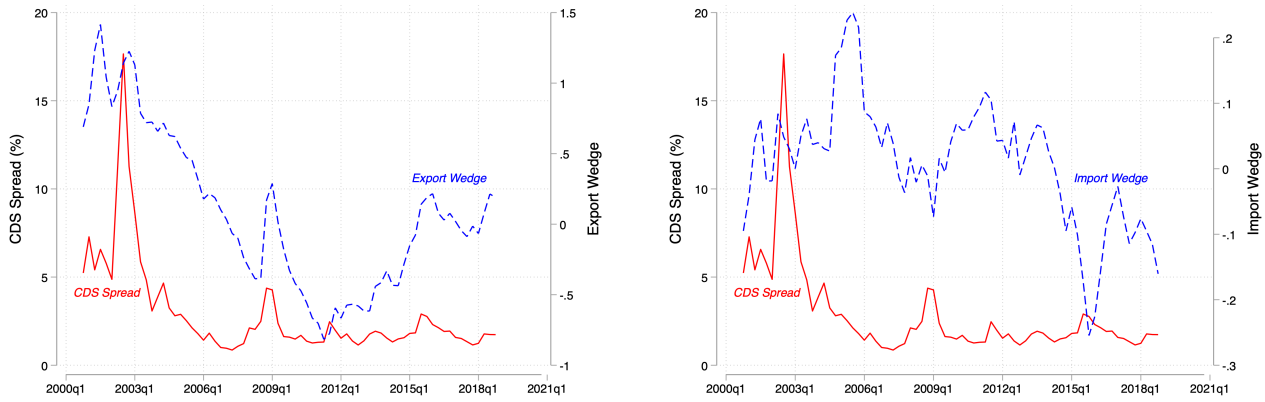
(a) Export wedge

(b) Import wedge

Figure I.27: Export & import wedges with P_M and trade-to-GDP ratios

Notes: Wedges are constructed using annual intermediate goods price data. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average export-to-GDP ratio (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Local Currency Debt Before 2008 Following Ottonello and Perez (2019), the share of sovereign debt denominated in local currency is procyclical. Then we adopt the global financial crisis as an alternative cutoff and test whether the comovement between the export/import wedges and the sovereign spread differs before and after 2008. The results are reported in Table I.14. On average, the export wedge enters with a positive coefficient, whereas the import wedge carries a smaller, negative coefficient after 2008. The before-2008 interaction term is positive and significant for both the export and import wedges, indicating that the comovement between the wedges and sovereign spreads is substantially stronger before the crisis. This pattern is consistent with the shift away from foreign currency debt. Overall, the positive comovement between the wedges and spreads is therefore still driven primarily by the export wedge.



(a) Export wedge

(b) Import wedge

Figure I.28: Export & import wedges with M_t/Y_t and CDS spread

Notes: Wedges are constructed using annual intermediate goods price data. The left panel plots the weighted average export wedge (blue dashed line) and the weighted average CDS spread (red solid line). The weight is the population of each economy in 2012. The right panel plots the counterpart for the import wedge.

Table I.13: Correlations using a subsample with M_t/Y_t

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	1.279***	0.780***			1.279***	0.781***
	(0.173)	(0.169)			-0.174	-0.172
Import wedge			0.027	0.042	0.015	-0.005
			(0.031)	(0.031)	-0.038	-0.032
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	659	590	659	590	659	590
R-squared	0.633	0.765	0.506	0.702	0.633	0.765

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table I.14: Correlations between spreads and wedges: local currency debt before 2008

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	2.157***	0.823**			2.117***	0.886**
	(0.727)	(0.397)			(0.727)	(0.407)
Export wedge $\times \mathcal{I}_{<08}$	-0.217	1.704***			-0.128	1.726***
	(0.903)	(0.531)			(0.904)	(0.529)
Import wedge			-0.127	-0.184**	-0.129	-0.274***
			(0.148)	(0.088)	(0.148)	(0.104)
Import wedge $\times \mathcal{I}_{<08}$			1.066**	0.424*	1.054**	0.869***
			(0.502)	(0.228)	(0.438)	(0.301)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.253	0.578	0.238	0.530	0.254	0.582

Notes: The dependent variable is the sovereign default risk, measured by the CDS spread. Both export and import wedges are standardized over the full sample. $\mathcal{I}_{<08}$ is an indicator variable equal to 1 for years before 2008. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

I.6 Trade Wedge and Terms of Trade

We further study the relationship between the wedges and the terms of trade by estimating Equation (32) with the terms of trade as the dependent variable. The terms of trade is defined as the ratio of the merchandise import price index to the export price index. The results are shown in Table I.15. We find that an increase in the export wedge is associated with an increase in the terms of trade, indicating that export prices fall relative to import prices. In contrast, the import wedge is strongly and negatively correlated with the terms of trade, suggesting that import prices fall relative to export prices. These findings are consistent with the model's predictions, as shown in Figure 2. In particular, if we interpret a uniform U.S. import tariff imposed on its trading partners as an increase in the export wedge faced by emerging markets, the results imply that the export prices of these economies decline relative to their import prices.

Table I.15: Correlations between TOT and model-implied wedges

	(1)	(2)	(3)	(4)	(5)	(6)
Export wedge	0.009	-0.056**			0.010***	0.013***
	(0.011)	(0.022)			(0.002)	(0.002)
Import wedge			-0.350***	-0.350***	-0.350***	-0.350***
			(0.001)	(0.001)	(0.001)	(0.001)
Controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	980	689	980	689	980	689
R-squared	0.462	0.439	0.995	0.997	0.995	0.997

Notes: The dependent variable is the terms of trade, defined as the ratio of the merchandise import price index to the export price index. Both export and import wedges are standardized over the full sample. Control variables include output growth, CPI inflation, and the government debt-to-GDP ratio. All regressions include country fixed effects and time fixed effects. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

I.7 Data moments

I.7.1 Targeted moments

This section describes how we construct the data moments used in calibration. The sample is the 16-economy baseline sample.

Average trade-to-GDP ratio Total trade is the sum of export and import. We first take average tradeto-GDP for each economy, and then use the median trade-to-GDP ratio across different economies.

Standard deviation of GDP First, we linearly detrended each economy's log of GDP series, and calculate the standard deviation of residuals of GDP for each economy i. Second, The moment of standard deviation is measured as the median standard deviation across 16 economies.

Standard deviation of import-to-GDP ratio We first calculate the standard deviation of import-to-GDP ratio for each economy, and then use the median value across different economies as the targeted moment.

Standard deviation of export-to-GDP ratio We first calculate the standard deviation of export-to-GDP ratio for each economy, and then use the median value across different economies as the targeted moment.

Average working capital/GDP The average working capital to GDP ratio is measured as the median loans-to-sales ratio across different economies. We collect firm-level data on short-term loans and sales of 16 economies in our baseline sample from ORBIS. Loans is defined as Short term financial debts (e.g. to credit institutions + part of Long term financial debts payable within the year,bonds, etc.). Sale is measured as net sales. First we take average loans-to-sales ratio for each firm i in country c. Second, we take the median loans-to-sales value of each country c. Third, we take the median loans-to-sales ratio across countries as our targeted moments, which is 7.1%.

Average CDS spread The spread is measured by CDS spread. We calculate the average spread for each economy and then take the median spread across 16 economies, which is 1.8%.

Standard deviation of CDS spread We calculate the standard deviation of CDS spread for each economy and then take the median value across 16 economies, which is 1.3%.

Average debt-to-GDP ratio The debt-to-GDP ratio is measured as the ratio of external debt to GDP. We first calculate the average debt-to-GDP ratio for each economy. Then we take the median value across 16

economies, which is 33.4%.

I.7.2 Untargeted moments

This section describes untargeted moments used for evaluating the calibration.

Standard deviation of model-implied wedges Following Definition 1, we construct the export and import wedges for each country in our baseline sample. For each economy, we first compute the standard deviation of each wedge measure. Then we take the median values across all countries as our untargeted moments.

Standard deviation of trade-to-GDP ratio We first calculate the standard deviation of trade-to-GDP ratio for each economy, and then take the median value across different economies.

Standard deviation of trade balance-to-GDP ratio We first calculate the standard deviation of trade balance-to-GDP ratio for each economy, and then take the median value across different economies. The median standard deviation is 3.7%.

Standard deviation of $ln(TOT)$ and $ln(RER)$ For each economy, we first compute the standard deviation of $ln(TOT)$ and $ln(RER)$. We then report the median standard deviation across the 16 economies, which is 10.7% for $ln(TOT)$, and 13.2% for $ln(RER)$.

Standard deviation of consumption First, we linearly detrended each economy's log of consumption series, and calculate the standard deviation of residuals of consumption for each economy i. Second, The moment of standard deviation is measured as the median standard deviation across 16 economies, which is 4.9%.

Correlation between spread and GDP We first calculate the correlation between CDS spread and linearly detrended log of GDP for each economy. Then we take the median correlation across 16 economies, which is -21.0%.

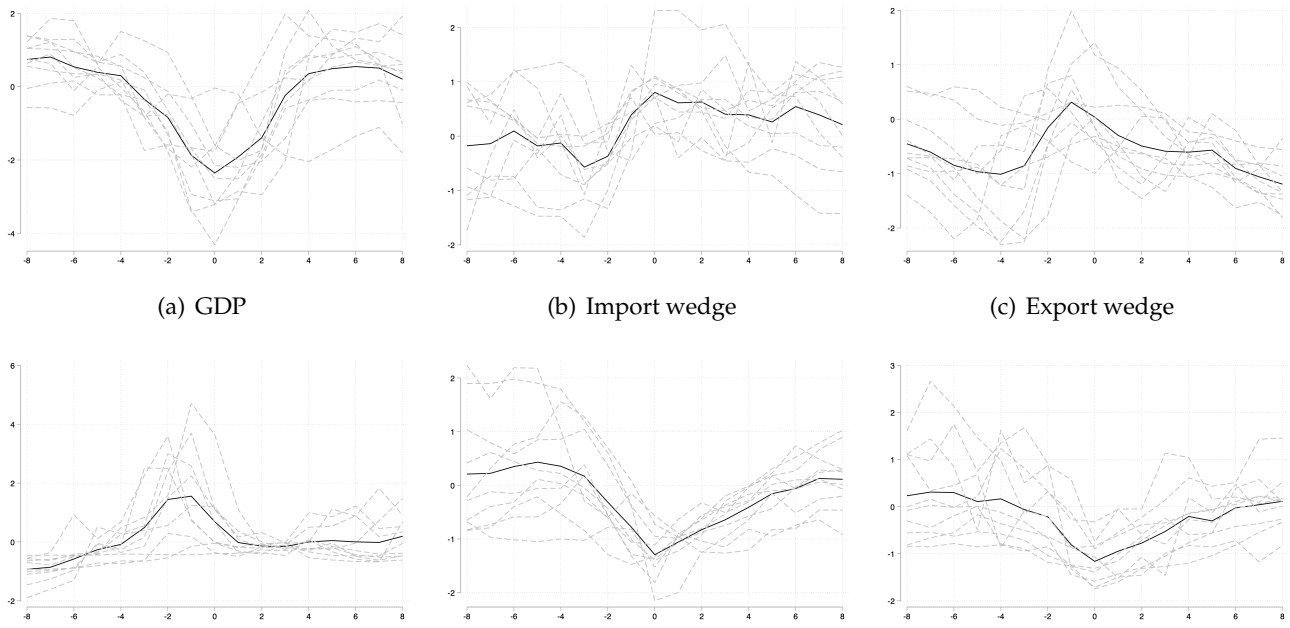
Correlation between import and export wedges We first calculate the correlation between export and import wedges for each economy. We then report the median correlation across the 16 economies, which is 4.8.

Correlation between trade-to-GDP ratio and GDP Trade-to-GDP ratio is measured as the ratio of total trade (export+import) to GDP. We calculate the correlation between trade-to-GDP ratio and linearly detrended log of GDP. The moment is the median correlation across 16 economies, which is 38.6% in the data.

Correlation between trade-to-GDP ratio and CDS spread We calculate the correlation between trade-to-GDP ratio and CDS spread. Then we take the median correlation across 16 economies, which is -22.7%.

I.8 Trade Collapse Events

We mainly focus on the trade collapse events around the Great Recession during 2008-2009. The trade collapse events are defined as periods in which a country's trade-to-GDP ratio[11] falls more than one standard deviation below its mean. The ten events trough at Argentina 2009Q3, Colombia 2009Q3, Greece 2009Q4, Hungary 2009Q2, Indonesia 2009Q1, Italy 2009Q2, Mexico 2009Q2, Philippines 2009Q1, South Africa 2009Q2, and Spain 2009Q1. The event window is defined as a 2-year window around the trough of each event.



(a) GDP (b) Import wedge (c) Export wedge

(d) Spread (e) Import/GDP (f) Export/GDP

Figure I.29: Trade Collapse Events

In Figure I.29, we plot the paths of output growth, import wedge, export wedge, spread, import-to-GDP

[11] We linearly detrend the trade-to-GDP ratio to account for the clear upward trend observed in some countries.

ratio, and export-to-GDP ratio for these events. The horizontal axis is in quarters, and 0 denotes the quarter with the trough in trade-to-GDP. In the event analysis of Section 4.4, we use the average paths of these events, which are plotted as solid lines in Figure I.29. The dashed lines in the figure represent the individual paths for each of the ten events. The figure shows that in all episodes, the trade collapse is associated with output declines, peaks in both import and export wedges, peaks in sovereign spreads, and troughs in both import-to-GDP and export-to-GDP ratios. Despite these common patterns, we also observe differences in the timing and magnitude of the fluctuations across countries, reflecting heterogeneity in the severity of the Great Recession across these economies.

Proofs for Section 5.1

The static block. The resource constraint and the definition of the exchange rate adjusted for export costs are unchanged. What changes is the balance of payments condition: the value in foreign goods of debt service is now $P_{ft} R_t^{LC} = R_t^{LC} / (\tilde{e}_t \tau_t^X)$, so that replacing R_t in equation (15) yields

$$\tilde{e}_t^{\rho-1} = \tau_t^X \tau_t^M m_t^* + \frac{R_t^{LC}}{\tilde{e}_t}, \qquad \Longleftrightarrow \qquad \tilde{e}_t^{\rho} = \tilde{e}_t \, \tau_t^X \tau_t^M \, m_t^* + R_t^{LC}.$$

Given (τ_t^X, τ_t^M) and R_t^{LC}, the private equilibrium consists of $\{c_t, m_t^*, \tilde{e}_t\}$ solving

$$c_t = Y(m_t^*) - \tilde{e}_t^{\rho}, \tag{I.44}$$

$$\tilde{e}_t^{\rho} = \tilde{e}_t \, \tau_t^X \tau_t^M \, m_t^* + R_t^{LC}, \tag{I.45}$$

$$Y'(m_t^*) = \frac{\rho}{\rho - \chi_t} \, \tilde{e}_t \, \tau_t^X \tau_t^M, \tag{I.46}$$

where the import share of external payments is now

$$\chi_t \equiv \frac{\tilde{e}_t \tau_t^X \tau_t^M m_t^*}{\tilde{e}_t \tau_t^X \tau_t^M m_t^* + R_t^{LC}} = \frac{\tau_t^M m_t^*}{\tau_t^M m_t^* + P_{ft} R_t^{LC}} \in (0, 1] \quad \text{for } R_t^{LC} \geq 0. \tag{I.47}$$

The statistic χ_t retains its interpretation from Section 3 as the fraction of export revenue spent on imports rather than debt service, except that debt service is now valued at the *current* exchange rate. This valuation margin is the new ingredient: within the period, χ_t comoves with $\tilde{e}_t$, because a depreciation deflates the value in foreign goods of obligations in home goods.

Derivation of the static block (I.44) to (I.46). Foreign lenders are paid the value in foreign goods of obligations in home goods. Since one home good is worth $P_{ft} = 1/(\tilde{e}_t \tau_t^X)$ foreign goods, the balance of payments condition (15) becomes $\tilde{e}_t^{\rho-1} = \tau_t^X \left[\tau_t^M m_t^* + R_t^{LC} / (\tilde{e}_t \tau_t^X) \right]$, which is (I.45). Imports are chosen to maximize $c_t = Y(m_t^*) - \tilde{e}_t^{\rho}$ subject to (I.45) defining $\tilde{e}_t(m_t^*)$. Differentiating the constraint,

$$\left(\rho \tilde{e}_t^{\rho-1} - \tau_t^X \tau_t^M m_t^* \right) \frac{d\tilde{e}_t}{dm_t^*} = \tau_t^X \tau_t^M \, \tilde{e}_t,$$

and imposing $dc_t / dm_t^* = Y'(m_t^*) - \rho \tilde{e}_t^{\rho-1} \, d\tilde{e}_t / dm_t^* = 0$ gives

$$Y'(m_t^*) = \frac{\rho \, \tau_t^X \tau_t^M \, \tilde{e}_t}{\rho - \tau_t^X \tau_t^M m_t^* / \tilde{e}_t^{\rho-1}} = \frac{\rho}{\rho - \chi_t} \, \tilde{e}_t \, \tau_t^X \tau_t^M,$$

using $\tau_t^X \tau_t^M m_t^* / \tilde{e}_t^{\rho-1} = \tilde{e}_t \tau_t^X \tau_t^M m_t^* / \tilde{e}_t^{\rho} = \chi_t$ from (I.45) and (I.47). The denominator is positive since $\rho > 1 \geq \chi_t$. □

Lemma 2 (Product structure). *In the system (I.44) to (I.46), the trade costs enter only through their product $\tau_t \equiv \tau_t^X \tau_t^M$. Hence, for any R_t^{LC}, the allocations (c_t, m_t^*), the adjusted exchange rate $\tilde{e}_t$, and the share χ_t respond identically to the two shocks,*

$$\frac{\partial \ln x_t}{\partial \ln \tau_t^X} = \frac{\partial \ln x_t}{\partial \ln \tau_t^M}, \qquad x \in \{c, m, \tilde{e}, \chi\},$$

and only the exchange rate $e_t = \tilde{e}_t \tau_t^X$ distinguishes them.

Proof of Lemma 2. Inspection of (I.44) to (I.46) and (I.47): τ_t^X and τ_t^M appear only as the product $\tau_t = \tau_t^X \tau_t^M$ (the function $Y(\cdot)$ involves no trade costs, and the repayment term in (I.45) carries no trade cost). Hence the map $(\tau_t^X, \tau_t^M, R_t^{LC}) \mapsto (c_t, m_t^*, \tilde{e}_t, \chi_t)$ factors through (τ_t, R_t^{LC}), and log derivatives with respect to $\ln \tau_t^X$ and $\ln \tau_t^M$ coincide for these objects. Since $\ln e_t = \ln \tilde{e}_t + \ln \tau_t^X$, the exchange rate carries one additional unit for the export cost. □

Proof of Proposition 5, part (i). Let hats denote log deviations, and write $\hat{\tau} \equiv \hat{\tau}_t^X + \hat{\tau}_t^M$; by Lemma 2 it suffices to compute the common response to $\hat{\tau}$. Log differentiating (I.45) holding R_t^{LC} fixed,

$$\rho\, \hat{\tilde{e}}_t = \chi_t \big(\hat{\tilde{e}}_t + \hat{\tau} + \hat{m}_t^*\big) \qquad \Longleftrightarrow \qquad \hat{\tau} + \hat{m}_t^* = \frac{\rho - \chi_t}{\chi_t}\, \hat{\tilde{e}}_t. \tag{I.48}$$

Log differentiating $\chi_t = \tilde{e}_t \tau_t m_t^* / \tilde{e}_t^{\rho}$ and substituting (I.48),

$$\hat{\chi}_t = (1-\rho)\hat{\tilde{e}}_t + \hat{\tau} + \hat{m}_t^* = \frac{\rho(1-\chi_t)}{\chi_t}\, \hat{\tilde{e}}_t, \qquad \text{so} \qquad d\chi_t = \rho(1-\chi_t)\, \hat{\tilde{e}}_t. \tag{I.49}$$

Log differentiating (I.46), using $d \ln\big(\rho/(\rho - \chi_t)\big) = d\chi_t/(\rho - \chi_t)$ and (I.49),

$$-\eta_t\, \hat{m}_t^* = \hat{\tilde{e}}_t + \hat{\tau} + \frac{\rho(1-\chi_t)}{\rho - \chi_t}\, \hat{\tilde{e}}_t = \Phi_t\, \hat{\tilde{e}}_t + \hat{\tau}, \qquad \Phi_t = 1 + \frac{\rho(1-\chi_t)}{\rho - \chi_t}. \tag{I.50}$$

Eliminating $\hat{m}_t^*$ between (I.48) and (I.50),

$$-\eta_t \Big(\frac{\rho - \chi_t}{\chi_t}\, \hat{\tilde{e}}_t - \hat{\tau}\Big) = \Phi_t\, \hat{\tilde{e}}_t + \hat{\tau} \qquad \Longrightarrow \qquad \hat{\tilde{e}}_t = \frac{\chi_t(\eta_t - 1)}{\eta_t(\rho - \chi_t) + \chi_t \Phi_t}\, \hat{\tau}.$$

Multiplying numerator and denominator by $(\rho - \chi_t)$ and using $\chi_t \Phi_t(\rho - \chi_t) = \chi_t(\rho - \chi_t) + \rho\chi_t(1 - \chi_t)$ gives

$$\frac{\partial \ln \tilde{e}_t}{\partial \ln \tau_t^X} = \frac{\partial \ln \tilde{e}_t}{\partial \ln \tau_t^M} = \frac{\chi_t(\eta_t - 1)(\rho - \chi_t)}{\Delta_t}, \qquad \Delta_t = \eta_t(\rho - \chi_t)^2 + \chi_t(\rho - \chi_t) + \rho\chi_t(1 - \chi_t) > 0, \quad \text{(I.51)}$$

with positivity of Δ_t from $\eta_t > 0$ (Lemma 1) and $\rho > 1 \geq \chi_t$. Then $\partial \ln e_t / \partial \ln \tau_t^M$ equals this expression and $\partial \ln e_t / \partial \ln \tau_t^X$ adds one:

$$\frac{\partial \ln e_t}{\partial \ln \tau_t^X} = 1 + \frac{\chi_t(\eta_t - 1)(\rho - \chi_t)}{\Delta_t} = \frac{\rho\left[\eta_t(\rho - \chi_t) + \chi_t(1 - \chi_t)\right]}{\Delta_t} > 0,$$

where the second equality uses $\Delta_t + \chi_t(\eta_t - 1)(\rho - \chi_t) = \eta_t(\rho - \chi_t)\rho + \rho\chi_t(1 - \chi_t)$. The gap of exactly one in (39) is immediate, and its foreign currency counterpart follows from Proposition 2: $\left[\eta_t(\rho - \chi_t) + \chi_t\right] / \left[\eta_t(\rho - 1) + \chi_t\right] = 1 + \eta_t(1 - \chi_t) / \left[\eta_t(\rho - 1) + \chi_t\right]$. The level elasticities in (I.51) also show that the export cost shock depreciates the exchange rate unambiguously while the import cost shock appreciates it if and only if $\eta_t < 1$, as in the benchmark.

Part (ii). By the envelope theorem applied to the static program, only the direct effect through the constraint matters. Holding m_t^* fixed and differentiating (I.45) with respect to $\ln \tau_t$,

$$\left(\rho \tilde{e}_t^{\rho} - \tilde{e}_t \tau_t m_t^*\right) \hat{\tilde{e}}_t = \tilde{e}_t \tau_t m_t^* \, d \ln \tau_t \qquad \Longrightarrow \qquad \left.\frac{\partial \tilde{e}_t^{\rho}}{\partial \ln \tau_t}\right|_{m_t^*} = \frac{\rho \, \chi_t}{\rho - \chi_t} \, \tilde{e}_t^{\rho}.$$

Hence $\partial c_t / \partial \ln \tau_t = -\rho\chi_t \tilde{e}_t^{\rho} / (\rho - \chi_t)$. Multiplying (I.46) by m_t^* and using $\tilde{e}_t \tau_t m_t^* = \chi_t \tilde{e}_t^{\rho}$ gives $Y'(m_t^*) m_t^* = \rho\chi_t \tilde{e}_t^{\rho} / (\rho - \chi_t)$, and the envelope elasticity of gross output (equation (B.21)) gives $Y'(m_t^*) m_t^* = \alpha_M(1 - s_t) Y_t$. Combining,

$$\frac{\partial c_t}{\partial \ln \tau_t} = -\alpha_M(1 - s_t) \, Y_t,$$

and dividing by c_t delivers (39), common to the two shocks by Lemma 2. Negativity follows as in Proposition 3. The same envelope calculation with respect to R_t^{LC} gives $\partial \tilde{e}_t^{\rho} / \partial R_t^{LC} = \rho / (\rho - \chi_t)$ and hence $\partial C / \partial R_t^{LC} = -\rho / (\rho - \chi_t)$, used in the Euler equation.

Proposition 9. *For any concave u, $\rho > 1$, and $\chi_t \in (0, 1]$:*

(i) the asymmetry in borrowing incentives is exactly

$$\Delta_t^{LC} \equiv \frac{\partial \ln S_t}{\partial \ln \tau_t^X} - \frac{\partial \ln S_t}{\partial \ln \tau_t^M} = 1 > 0, \quad \text{(I.52)}$$

and the export cost shock unambiguously raises the borrowing incentive, $\partial \ln S_t / \partial \ln \tau_t^X > 0$;

(ii) comparing with equation (27), evaluated at the same $(\eta_t, \chi_t, s_t, Y_t/c_t, \gamma_t)$*,*

$$\Delta_t^{FC} - \Delta_t^{LC} = \frac{\eta_t(1-\chi_t)}{\eta_t(\rho-1)+\chi_t} + \gamma_t \frac{1-\chi_t}{\chi_t}\alpha_M(1-s_t)\frac{Y_t}{c_t} \quad \geq \quad 0, \tag{I.53}$$

with equality if and only if $\chi_t = 1$ *(*$R_t = 0$*).*

Consequently, if the marginal revenue of issuance $Q(b_{t+1}) + Q'(b_{t+1})b_{t+1}$ *is positive and strictly decreasing at the optimum, optimal issuance* b_{t+1} *rises by strictly more after an export cost shock than after an import cost shock of equal size, and the default risk component of the spread (embedded in Q) rises by more, but the differential is strictly smaller than under foreign currency debt whenever net repayment is positive.*

Proof of Proposition 9. With local currency debt, the government solves the counterpart problem of (24):

$$V\left(b_t, \tau_t^X, \tau_t^M\right) = \max_{b_{t+1}} \; u\Big(C\left(\tau_t^X, \tau_t^M,\; b_t - q_t^{LC} b_{t+1}\right)\Big) + \beta\, \mathbb{E}\, V\left(b_{t+1}, \tau_{t+1}^X, \tau_{t+1}^M\right). \tag{I.54}$$

The first order condition of the government's problem together with $\partial C/\partial R_t^{LC} = -\rho/(\rho-\chi_t)$ and the envelope condition $V_b(b_t) = u'(c_t)\,\partial C/\partial R_t^{LC} \cdot \partial R_t^{LC}/\partial b_t = -u'(c_t)\rho/(\rho-\chi_t)$, yields (41). Under i.i.d. shocks the right side is a function $\Lambda(b_{t+1})$ of issuance only, so current shocks shift desired borrowing only through $S_t = u'(c_t)e_t/(\rho-\chi_t)$. Decomposing,

$$\frac{\partial \ln S_t}{\partial \ln \tau_t^i} = \frac{\partial \ln e_t}{\partial \ln \tau_t^i} \;-\; \gamma_t \frac{\partial \ln c_t}{\partial \ln \tau_t^i} \;+\; \frac{\rho(1-\chi_t)}{\rho-\chi_t}\frac{\partial \ln \tilde{e}_t}{\partial \ln \tau_t^i}, \qquad i \in \{X, M\}, \tag{I.55}$$

where the last term uses $d\ln\left(1/(\rho-\chi_t)\right) = d\chi_t/(\rho-\chi_t)$ and (I.49). For part (i), by Lemma 2 the second and third terms of (I.55) are common to the two shocks, and the first differs by exactly one (Proposition 5); hence $\Delta_t^{LC} = 1$. For the sign statement, collecting the exchange rate terms with common response $A_t \equiv \chi_t(\eta_t - 1)/\left[\eta_t(\rho-\chi_t) + \chi_t\Phi_t\right]$, with Φ_t as in (I.50),

$$\frac{\partial \ln S_t}{\partial \ln \tau_t^X} = 1 + \Phi_t A_t + \gamma_t\alpha_M(1-s_t)\frac{Y_t}{c_t} = \frac{\eta_t\left[(\rho-\chi_t)+\Phi_t\chi_t\right]}{\eta_t(\rho-\chi_t)+\Phi_t\chi_t} + \gamma_t\alpha_M(1-s_t)\frac{Y_t}{c_t} > 0,$$

and $\partial \ln S_t/\partial \ln \tau_t^M = \Phi_t A_t + \gamma_t\alpha_M(1-s_t)Y_t/c_t$, whose first term has the sign of $\eta_t - 1$ and is therefore ambiguous when import demand is elastic. Part (ii) follows by subtracting (I.52) from equation (27), using the decomposition of the benchmark's first term noted in the proof of Proposition 5; both terms of (I.53) are nonnegative since $\gamma_t \geq 0$, $\eta_t > 0$, and $\chi_t \leq 1$, and both vanish exactly at $\chi_t = 1$. The consequence for issuance follows from implicit differentiation of (41) at an optimum satisfying the second order condition, exactly as in the proof of Proposition 4: the leading positive fraction is common to both shocks, so the

ranking of $\partial b_{t+1}/\partial \ln \tau$ coincides with that of $\partial \ln S_t/\partial \ln \tau$; with $Q' < 0$, larger issuance after τ_t^X implies a larger decline in Q and a larger rise in the default risk component of the spread. □