Trade Barriers and Sovereign Default Risk*

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Abstract

We develop a general equilibrium sovereign default model with both trade and financial frictions to study the interaction between sovereign default risk and trade. In this model, an increase in trade cost shock elevates default risk, leading to higher borrowing costs and a further decrease in total trade. The model endogenously generates elevated default risk arising from trade frictions and can capture the trade costs of defaults. It successfully replicates the observed comovement between trade and sovereign default risk. Quantitatively, the financial friction component accounts for nearly half of the variations in total trade costs.

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

JEL classification: F12, F34

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1 Introduction

Empirical literature documents the trade costs associated with sovereign defaults, showing that trade tends to slump during or after the default events (see Rose, 2005; Borensztein and Panizza, 2010; Martinez and Sandleris, 2011; Zymek, 2012, among others). However, there is no consensus on the underlying mechanisms or the magnitude of these effects. Moreover, Figure 1 demonstrates a contemporaneous correlation between trade and sovereign default risk, as measured by CDS spread. Then the relationship between sovereign default and trade may also work in reverse: a decline in trade openness can lead to economic slowdowns, which in turn increase the risk of default, thereby further depressing international trade and creating a reinforcing cycle. This reverse causality complicates the study of the interaction between sovereign default risk and trade. In this project, we aim to provide a theoretical explanation for the interaction between sovereign default risk and trade, and quantity how much of the observed trade decline can be attributed to heightened default risk.

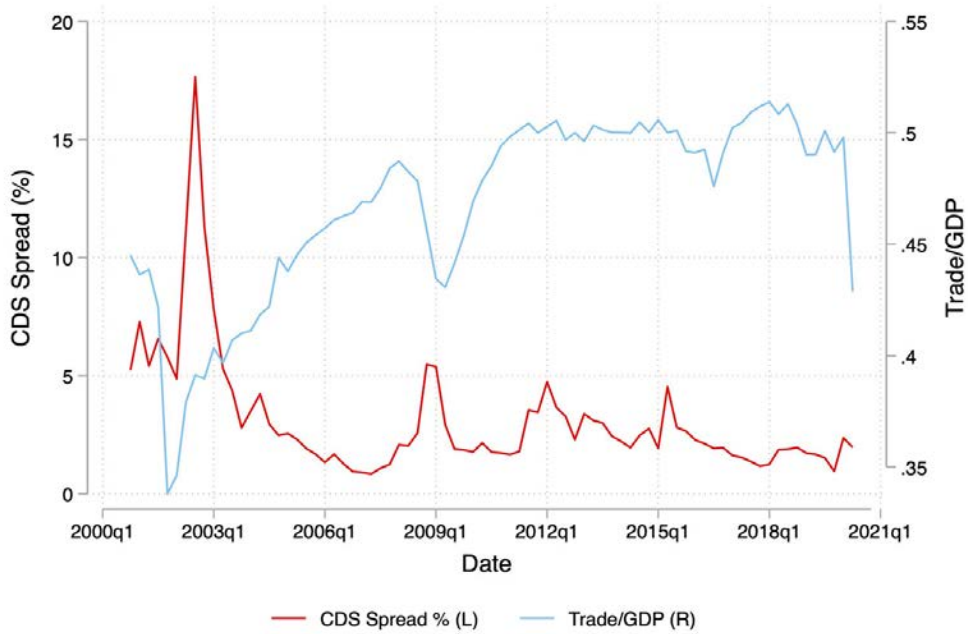


Figure 1: International trade and sovereign spread

Notes: The red line refers to the population weighted average CDS spread, which is a measure of sovereign risk. The blue line is population weighted average trade-to-GDP ratio, which is (export X+ import M)/GDP. More discussions on the 16-economy sample used can be found in Section 3.1.

We start by developing a general equilibrium sovereign default model with trade to model the interaction between trade and financial friction. In our model, there are households, final goods producers, intermediate goods producers, and a central government. Final goods producers produce with both domestic intermediate goods and foreign imported intermediate goods, and consumed by both domestic and foreign households. Government borrows by issuing state-uncontingent bonds and it can default with the cost of getting excluded from the international financial market. The financial frictions arise from both the sovereign and firms. The risk of sovereign default introduces financial frictions and also transmits to the firms. We derive a model-implied measure of trade costs, defined as the gap between observed trade flows and those predicted by relative expenditures and prices, which we refer to as the *measured trade wedge*. This model-implied wedge consists of two components: a conventional trade wedge and a financial friction component. When iceberg trade costs rise, the conventional trade wedge goes up directly, as a result of elevated trade friction. In the meanwhile, domestic output depresses and sovereign default risk rises. The increasing sovereign default risk passes through to the financing cost of final goods producers. The interaction between trade and sovereign default risk further magnifies the conventional trade wedge, increasing the total trade costs.

We test the model's implications on the relationship between trade costs and sovereign default risk using a 16-economy sample. Based on the model-implied formula for the trade wedge, we construct its empirical counterpart to measure total trade costs. Financial frictions in each economy are captured by the CDS spread. We aggregate trade costs and sovereign default risk by calculating the population-weighted averages across the 16 economies. The measured trade wedge is negatively correlated with the weighted average of total trade, indicating that it effectively captures trade costs. The measured trade wedge positively correlates with the sovereign spread, validating our model's prediction of a link between sovereign default risk and trade costs.

Using the calibrated model, we quantify the importance of financial friction in explaining the measured trade wedge. We first show the interaction between trade and financial friction by presenting the impulse responses to trade cost shock. With a positive trade cost shock, the domestic output shrinks and sovereign spread goes up. The increased sovereign spread passes through to a higher firm borrowing interest rate. As a result, the domestic final goods producers import less foreign intermediate goods. Next, we decompose the fluctuations of measured trade wedge using the model simulated data. The interaction between trade and financial friction accounts for 47% of the variation in measured trade wedge, conditional on not defaulting.

Literature review This paper relates to the literature on sovereign default. There is little discussion on the relationship between sovereign risk and international trade in the previous work on sovereign default (see Eaton and Gersovitz, 1981; Aguiar and Gopinath, 2006; Arellano, 2008; Cuadra et al., 2010; Cuadra et al., 2010; Yue, 2010; Hatchondo et al., 2016; Hamann et al., 2018; Sosa-Padilla, 2018a; Espino et al., 2020; Arellano et al., 2020; Alessandria et al., 2020; Deng and Liu, 2024, among others). A decline in trade openness can lead to an economic slowdown, which in turn increases the likelihood of default. This increase in default risk may further depress international trade, creating a feedback loop. Therefore, reverse causality is always an issue when we study the interaction between sovereign defaults and trade, whether examining the determinants of sovereign spreads or the trade costs associated with defaults.

Our work adds to the literature on the determinants of sovereign spreads (see Uribe and Yue, 2006; Longstaff et al., 2011; Gilchrist et al., 2022; Du and Schreger, 2022; Deng, 2024; Deng and Khederlarian, 2025, among others) by introducing trade friction as a key driver for the dynamics of sovereign spreads. Motivated by the observed negative correlation between sovereign default risk and total trade, we build a sovereign default model with both trade and financial frictions. A key innovation of our model is its ability to endogenously generate elevated sovereign spreads due to trade friction.

Moreover, this paper is closely related to literature studying the trade costs of sovereign defaults. Empirical studies have documented the existence of trade costs associated with sovereign defaults and attribute the decline in trade during and after defaults either to direct import sanctions or constrained trade finance (see Rose, 2005; Borensztein and Panizza, 2010; Martinez and Sandleris, 2011; Zymek, 2012, among others). However, there is no consensus on the micro-foundations that explain how sovereign defaults affect international trade. We contribute to this strand of literature by filling the theoretical gap that linking sovereign defaults with international trade. We provide a mechanism that explains how trade frictions drive up sovereign default risk, which in turn depresses trade. Besides, we quantify the extent to which the heightened sovereign default risk, driven by trade frictions, amplifies trade declines during crises.

This is not the first paper to address the theoretical gap by exploring the interactions between sovereign defaults and trade. 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 his framework, the key assumption is that default leads to an increase in trade costs. Instead of assuming a direct link between default and trade costs, our model endogenously generates higher trade costs due to sovereign default risk. Andreasen et al. (2024) finds that firms in more import-intensive and working-capital-intensive industries are more negatively affected by sovereign risk, which supports our model setting. Our model is closely related to Mendoza and Yue (2012). The key difference is that we include trade cost that could endogenously drive up sovereign spreads in our framework. Using our model, we are able to quantify how the sovereign default risk and trade cost amplify each other.

Our work also connects to the literature on trade wedge (Alessandria et al., 2013; Levchenko et al., 2010). Our primary contribution lies in taking financial frictions into account, highlighting that financial frictions can amplify the conventional trade wedge owing to trade friction and explain a significant share of the overall trade wedge. We also extend the focus of the literature from developed countries to including emerging markets.

Roadmap The rest of the paper is organized as follows. Section 2 describes the general equilibrium sovereign default model. Section 3 presents the 16-economy data and test the correlation between financial friction and measured trade wedge. Section 4 discusses the quantitative properties of the model. Section 5 concludes.

2 Model

Our model builds on the general equilibrium model of Mendoza and Yue (2012). We consider a small open economy. The economy comprises households, final goods producers, intermediate goods producers, and a central government. For production, there are two production sectors: sector f with final goods producers and sector m with intermediate goods producers. The final goods are produced using both domestic intermediate goods and foreign imported intermediate goods, and consumed by both domestic and foreign households. Our model features both firm financial frictions and international financial frictions. The firms need working capital to finance part of their imports. The government borrows with state-uncontingent debt in foreign goods. If the government defaults, the economy enters into financial autarky and there is a trade sanction of losing access to some imports.

2.1 Households

Households choose consumption c_t and labor supply L_t to maximize a time-separable utility function $E\left[\sum_{t=0}^{\infty}\beta^t u\left(c_t - g\left(L_t\right)\right)\right]$, where $0 < \beta < 1$ is the discount factor. Households take as given the wage rate w_t, profits paid by firms in the f and m sectors $\left(\pi_t^f, \pi_t^m\right)$ and government transfers (T_t). Thus, the households' optimization problem is given by:

$$\max_{c_t, L_t} E\left[\sum \beta^t u\left(c_t - g\left(L_t\right)\right)\right]$$

$$\text{s.t.} \quad P_{ft}c_t = w_t L_t + \pi_t^f + \pi_t^m + P_{ft}T_t,$$

where P_{ft} is the price of the domestic final goods. The optimality condition for labor supply is:

$$P_{ft}g'\left(L_t\right) = w_t$$

2.2 Final goods producers

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

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

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 $\tau_t p_{jt}^*$ for $j \in [0,1]$, where τ_t 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:

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

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 assume the sovereign risk passes to the firm in a reduced form: firm borrowing interest rate is given by $r_t = r_f^* + \chi * \text{spread}_t$, where r_f^* is the firm benchmark interest rate and χ captures the pass-through from sovereign risk to firm interest rate.[1]

The final goods producers choose factor demands in order to maximize date-t profits taking $P_{ft}, w_t, r_t, \tau_t, p_{jt}^*$, and p_t^d as given. Date-t profits for the final goods producers are:

$$\pi_t^f = P_{ft} z_t (M_t)^{\alpha_M} \left(L_t^f\right)^{\alpha_L} k^{\alpha_k} - r_t \tau_t \int_0^\theta p_{jt}^* m_{jt}^* dj - \tau_t \int_0^1 p_{jt}^* m_{jt}^* dj$$
$$- p_t^d m_t^d - w_t L_t^f$$

The price p_t^* of m_t^* is the standard CES price index. Because some imported inputs carry the financing cost of working capital and the presence of trade cost we can express this price index for home country as follows:

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

When the sovereign defaults, the economy loses access to the subset $[0, \theta]$ of the imported input varieties (equivalent to interest rate r_t goes to infinity for this subset of inputs), the price index of imported inputs becomes:

$$p_{t,aut}^* = \left[\int_\theta^1 \left(\tau_t p_{jt}^* \right)^{1-\mu} dj \right]^{\frac{1}{1-\mu}}. \tag{2}$$

We use a standard two-stage budgeting approach to characterize the solution of the final goods producers' optimization problem. In the first stage, firms choose L_t^f, m_t^d, and m_t^*, given the factor

[1] For a more structured modelling of transmission of sovereign risk to firm borrowing cost, see Neumeyer and Perri, 2005; Sosa-Padilla, 2018b; Arellano et al., 2020; Deng and Liu, 2024, among others.

prices P_{ft}, w_t, p_t^d, and p_t^*, to maximize date-t profits:

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

where $M_t = \left[\left(m_t^d \right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(m_t^* \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$. Then, in the second stage they choose their demand for each variety of imported inputs.

The first-order conditions of the first stage are:

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

Given m_t^*, the second stage yields a standard CES system of demand functions for imported inputs that can be split into a subset for varieties that do not require working capital and the subset in Ω:

$$\begin{aligned}
m_{jt}^* &= \left(\frac{\tau_t p_{jt}^*}{p_t^*} \right)^{-\mu} m_t^*, \quad \text{for } j \in [\theta, 1] \\
m_{jt}^* &= \left(\frac{\tau_t p_{jt}^* \left(1 + r_t \right)}{p_t^*} \right)^{-\mu} m_t^*, \quad \text{for } j \in [0, \theta].
\end{aligned}$$

When the sovereign defaults, the demand functions for imported inputs are given by:

$$\begin{aligned}
m_{jt}^* &= \left(\frac{\tau_t p_{jt}^*}{p_{t,aut}^*} \right)^{-\mu} m_t^*, \quad \text{for } j \in [\theta, 1] \\
m_{jt}^* &= 0, \quad \text{for } j \in [0, \theta].
\end{aligned}$$

Since the firms cannot finance the subset of imports that require working capital, a sovereign default leads to endogenous output losses.

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 $A \left(L_t^m \right)^{\alpha}$, 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:

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

Their labor demand satisfies this standard optimality condition:

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

2.4 Foreign demand for domestic final goods

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

$$X_t = \left(\frac{\bar{\tau} P_{ft}}{P_{ft}^*}\right)^{-\rho} \xi = (\frac{e_t}{\bar{\tau}})^\rho \xi$$

where 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. ξ 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. $\bar{\tau}$ is the iceberg cost for exports, which we assume is time invariant. 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, trade cost τ_t, and the interest rate r_t, the equilibrium factor allocations and prices are given by the values of $\left[m_t^*, m_t^d, L_t^f, L_t^m, L_t\right]$ and $\left[P_{ft}, p_t^d, w_t\right]$ that satisfy the following optimality conditions. Let's label this equilibrium in factor markets and production as $PE(z_t, \tau_t, r_t, D_t)$, where $D_t = 1$ if the government defaults.

$$P_{ft}\alpha_M z_t k^{\alpha_k} \left(M\left(m_t^d, m_t^*\right)\right)^{\alpha_M - 1 + \frac{1}{\sigma}} \left(L_t^f\right)^{\alpha_L} \omega^{\frac{1}{\sigma}} \left(m_t^*\right)^{-\frac{1}{\sigma}} = p_t^* \tag{3}$$

$$P_{ft}\alpha_M z_t k^{\alpha_k} \left(M\left(m_t^d, m_t^*\right)\right)^{\alpha_M - 1 + \frac{1}{\sigma}} \left(L_t^f\right)^{\alpha_L} \left(m_t^d\right)^{-\frac{1}{\sigma}} = p_t^d \tag{4}$$

$$P_{ft}\alpha_L z_t k^{\alpha_k} \left(M\left(m_t^d, m_t^*\right)\right)^{\alpha_M} \left(L_t^f\right)^{\alpha_L - 1} = w_t \tag{5}$$

$$\alpha p_t^d A \left(L_t^m\right)^{\alpha - 1} = w_t \tag{6}$$

$$P_{ft} g'\left(L_t\right) = w_t \tag{7}$$

$$L_t^f + L_t^m = L_t \tag{8}$$

$$A\left(L_t^m\right)^{\alpha} = m_t^d. \tag{9}$$

2.6 The sovereign government

The sovereign government can borrow by issuing state-uncontingent bonds to foreign lenders. The government chooses whether to default by maximizing the payoff:

$$V\left(b_t, z_t, \tau_t\right) = \max\left\{v^c\left(b_t, z_t, \tau_t\right), v^d\left(z_t, \tau_t\right)\right\} \tag{10}$$

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

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

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

subject to

$$P_{ft}c_t + b_t - q_t b_{t+1} = w_t L_t + \pi_t^f + \pi_t^m$$

$$PE\left(z, \tau_t, r_t(q_t), D_t = 0\right) \in \mathcal{P},$$

where $\mathcal{P}$ denotes the set of equilibria in factor markets and production.

Alternatively, we can rewrite the repayment value under the consolidated problem. 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:

$$v^c(b_t, z_t, \tau_t) = \max_{c_t, m_t^d, m_t^*, L_t^f, L_t^m, L_t, b_{t+1}} \left\{ \begin{array}{l} u(c_t - g(L_t)) \\ +\beta \mathbb{E}\left[V(b_{t+1}, z_{t+1}, \tau_{t+1})\right] \end{array} \right\}, \tag{11}$$

subject to

$$\begin{aligned} P_{ft}c_t + b_t - q_t b_{t+1} &= P_{ft} z_t M\left(m_t^d, m_t^*\right)^{\alpha_M} \left(L_t^f\right)^{\alpha_L} k^{\alpha_k} - p_t^* m_t^* \\ P_{ft}\left(\frac{e_t}{\tau}\right)^{\rho} \xi &= p_t^* m_t^* + b_t - q_t b_{t+1} \\ L_t^f + L_t^m &= L_t \\ A\left(L_t^m\right)^{\alpha} &= m_t^d. \end{aligned}$$

The first constraint is the resource constraint of the economy. The second constraint is the balanced payment condition. The last two constraints are the resource constraints in the markets for labor and domestic inputs, respectively.

The value of default under consolidated problem is:

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

subject to:

$$\begin{aligned} P_{ft}c_t &= P_{ft} z_t M\left(m_t^d, m_t^*\right)^{\alpha_M} \left(L_t^f\right)^{\alpha_L} k^{\alpha_k} - p_{t,aut}^* m_t^* \\ P_{ft}\left(\frac{e_t}{\tau}\right)^{\rho} \xi &= p_{t,aut}^* m_t^* \\ L_t^f + L_t^m &= L_t \\ A\left(L_t^m\right)^{\alpha} &= m_t^d. \end{aligned}$$

When the default value $v^d(z_t, \tau_t)$ is larger than the repayment value $v^c(b_t, z_t, \tau_t)$, 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 $q_t(b_{t+1}, z_t, \tau_t)$ satisfies:

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

2.7 Recursive equilibrium

The model's recursive equilibrium is given by (i) a decision rule $b_{t+1}(b_t, z_t, \tau_t)$ for the sovereign government with associated value function $V(b_t, z_t, \tau_t)$, consumption and transfers rules $c(b_t, z_t, \tau_t)$ and $T(b_t, z_t, \tau_t)$, and default probabilities $D(b_{t+1}, z_t, \tau_t)$; and (ii) an equilibrium pricing function for sovereign bonds $q_t(b_{t+1}, z_t, \tau_t)$ such that:

1. Given $q_t(b_{t+1}, z_t, \tau_t)$, the decision rule $b_{t+1}(b_t, z_t, \tau_t)$ solves the social planner's recursive maximization problem (10).
2. The consumption plan $c(b_t, z_t, \tau_t)$ satisfies the resource constraint of the economy. Factor allocations are consistent with a competitive equilibrium in factor markets.
3. The transfers policy $T(b_t, z_t, \tau_t)$ satisfies the government budget constraint $T(b_t, \varepsilon_t) = q_t b_{t+1} - b_t$.
4. The bond pricing function $q_t(b_{t+1}, z_t, \tau_t)$ satisfies the arbitrage condition of foreign lenders.

Solutions for the recursive equilibrium include solutions for sectoral factor allocation and production, with or without credit market access. The solutions for wages, profits, and domestic input prices follow the firm optimality conditions and the definition of profit described earlier.

2.8 Measured trade wedge in the model

The fluctuations in international trade that cannot be explained in standard models by changes in expenditures and relative prices are often attributed to trade wedges (Alessandria et al., 2013). Correspondingly, in our model, trade wedge is the variation in trade that cannot be explained by domestic and foreign demand, terms of trade, intermediate goods price, and the real exchange rate. In the model, import is given by:

$$\ln(m_t^*) = \ln\left((\alpha_M y_t)^\sigma M_t^{1-\sigma} \omega (p_t^*)^{-\sigma} (P_{ft})^\sigma\right),$$

and export is given by:

$$\ln(X_t) = \ln\left(\left(\bar{\tau} P_{ft} / P_{ft}^*\right)^{-\rho} \xi\right).$$

Thus, trade is given by the sum of import and export, and we further rewrite it as[2]:

$$\text{Trade} = \underbrace{-\sigma \ln\left(\frac{p^*_{jt}}{P_{ft}}\right)}_{\text{TOT}} + \underbrace{\rho \ln\left(\frac{P^*_{ft}}{P_{ft}}\right)}_{\text{RER}} + \ln \underbrace{(y_t)}_{\substack{\text{domestic}\\ \text{demand}}} + \ln \underbrace{(\xi)}_{\substack{\text{foreign}\\ \text{demand}}} - (1-\sigma)\ln \underbrace{\left(\frac{P_{Mt}}{P_{ft}}\right)}_{\substack{\text{inter. goods}\\ \text{price}}} - \text{wedge}, \quad (12)$$

where

$$\text{wedge} = \underbrace{\ln\left(\bar{\tau}^{\rho}\omega^{-1}\alpha_M^{-1}\tau_t^{\sigma}\right)}_{\text{conventional trade wedge}} + \underbrace{\sigma \ln\left(\left[\theta(1+r_t)^{1-\mu} + 1 - \theta\right]^{\frac{1}{1-\mu}}\right)}_{\text{financial friction}}. \quad (13)$$

We differentiate elasticities ρ and σ in the model, where ρ is the elasticity of substitution between exported domestic final goods and foreign final goods, while σ is the elasticity of substitution between domestic intermediate goods m_t^d and imported foreign intermediate goods m_t^*.

There are two components in the measured trade wedge. The first component is the counterpart to the conventional trade wedge in the literature, which is derived from the trade shock (iceberg cost τ_t). The second component is the financial friction term, which stems from the working capital requirement in the domestic intermediate goods producers' problem.

3 Trade Wedge Measuring

This section brings our model implied trade wedge to the data and studies how financial frictions are correlated with the observed trade wedge using a sample of 16 economies . First, we describe the data required to derive the empirical counterpart of the trade wedge, by estimating Equation (12). Next, we calculate the trade wedge from the data and demonstrate that it is positively correlated with financial frictions, measured by CDS spreads. Finally, we provide some interpretation for our measured trade wedge by comparing it with alternative measures of aggregate financial and trade frictions.

3.1 Data

We construct a quarterly cross-country panel data of 16 economies, including a set of country-specific variables, such as CDS spread, national accounts, and some trade-related variables. Due to

[2]The intermediate goods price satisfies $P_{Mt}^{1-\sigma} = (p_t^d)^{1-\sigma} + \omega(p_t^*)^{1-\sigma}$.

data limitations, we keep 16 economies, with required data for deriving measured trade wedge, in our baseline sample, namely Argentina, Brazil, Bulgaria, Colombia, Greece, Hungary, Indonesia, Ireland, Italy, Lithuania, Mexico, Peru, Philippines, South Africa, Spain and Turkey. This section presents the main variables used and their summary statistics.

National accounts. The measured trade wedge requires national accounts data on real exports (X), real imports (M), domestic demand (y) and foreign demand (ξ). 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. 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 national accounts data for Peru is sourced from the Central Reserve Bank of Peru, while the data for the Philippines is based on the unadjusted series from the IMF IFS.

Sovereign risk. We use quarterly CDS spread data from Bloomberg, to measure financial friction of each country.

Real exchange rate. We take the quarterly average of real exchange rate from Global Economic Monitor (GEM). The nominal exchange rate from GEM is titled as "Exchange rate, new LCU per USD extended backward, period average". We adjust the nominal exchange rate using the CPI data.

Terms of trade. The data on terms of trade (TOT) of 16 economies, except Colombia, is also 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. [3]

Intermediate goods price. We do not directly observe quarterly intermediate goods price. Nevertheless, using the OECD Inter-Country Input-Output (ICIO) Tables, we can infer annual relative intermediate goods price from the production function as

$$\frac{P_{Mt}}{P_{ft}} = \frac{\alpha_M}{M_t/Y_t},$$

where $Y_t = z_t \left(M\left(m_t^d, m_t^*\right)\right)^{\alpha_M} \left(L_t^f\right)^{\alpha_L} k^{\alpha_k}$.

[3] 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 1 summarizes the statistics of key variables used in deriving trade wedge. Appendix A.1 has more details on the variable construction and data source.

Table 1: Summary statistics

	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
$\ln(\xi_t)$	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.

3.2 Measured Trade Wedge in Data

In order to illustrate the comovement between trade barriers and financial friction, we bring the model to the data, and estimate the trade cost, using the theoretical decomposition in Equation (12).[4] We use the parameter values ($\sigma = \rho = 3$) as in the model. Considering the cross-country variations, we demean each series before deriving the trade wedge measure.[5] And then we take weighted average trade wedge across countries, using population as the weight. The country-specific figures can be found in Appendix A.3, where we demonstrate that the weighted average series are not driven by any individual economy.

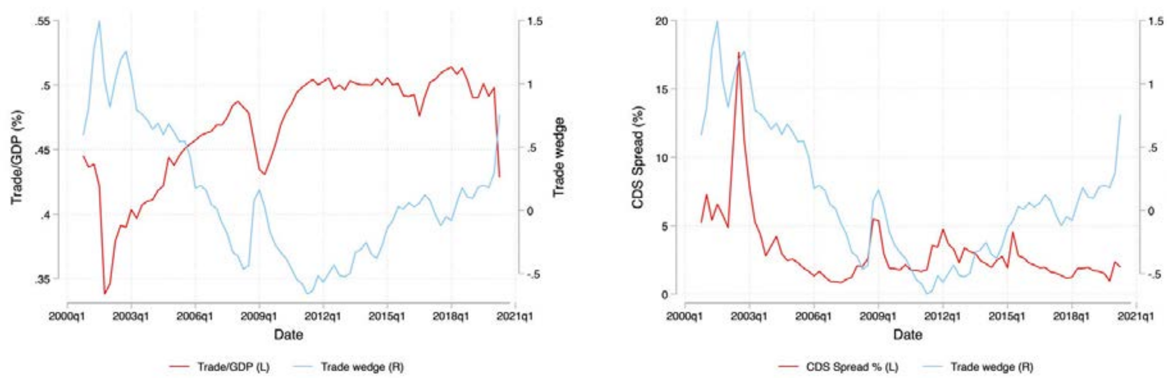
Figure 2 plots the correlation of weighted average measured trade wedge with trade-to-GDP ratio and CDS spread. This trade wedge, as a proxy for trade barriers, shows a strong negative correlation with the ratio of total trade to GDP, as shown in Panel (a) of Figure 2, with a correlation of -0.79. The movements in this measured trade wedge term are consistent with major trade events. The period of trade liberalization starting from 2002 coincides with a pronounced decline in the measured trade wedge. During the 2008-09 Global Financial Crisis, 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 trade wedge peaked,

[4] 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.

[5] 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.

reflecting a surge in trade barriers. Following the 2008 financial crisis, trade barriers slightly increased, indicating a shift towards geoeconomic fragmentation. This trend can be attributed to the rise of protectionism, as governments prioritized domestic industries and employment over free trade after the crisis.

This trade wedge measure incorporates a financial friction component, which is reflected in its correlation with aggregate financial friction indicators. We show that the measured trade wedge is positively correlated with the CDS spread, a proxy for a country's perceived risk of default. As indicated in Panel (b) of Figure 2, the measured trade wedge and CDS spread have an overall correlation of 0.58. From 2002 to 2007, both the trade wedge and the CDS spread declined. The trade wedge peaks during periods of elevated sovereign spreads, such as the emerging market crises period before 2002 and the 2008-2009 global financial crisis. However, we observe that it also peaks in periods of stable CDS spreads, such as during times of geoeconomic fragmanetation. We conclude that these latter peaks are mainly driven by trade friction rather than financial frictions.



(a) Trade-to-GDP and trade wedge

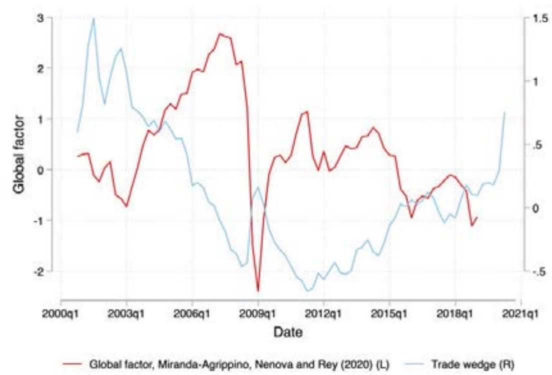
(b) CDS spread and trade wedge

Figure 2: Measured trade wedge, trade-to-GDP and CDS spread

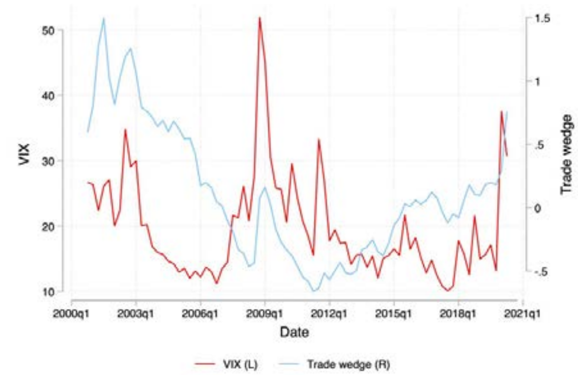
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

For further interpretation of the measured trade wedge, we observe that it is also closely correlated with indices of financial volatility and trade uncertainty. Figure 3 shows these comovements between the trade wedge (blue line), the global factor in risky asset prices, the VIX, and U.S. trade policy uncertainty (TPU) measures.

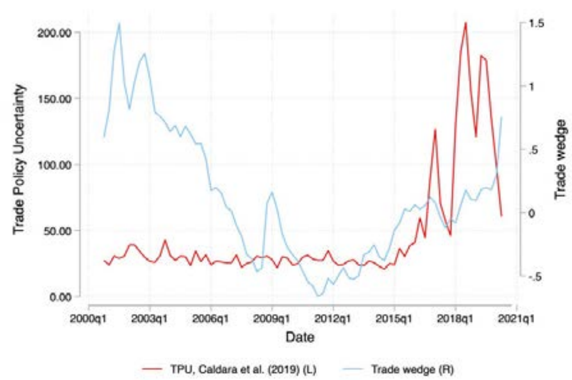
Panel (a) of Figure 3 plots the global common factor (red line), estimated from world-wide cross-



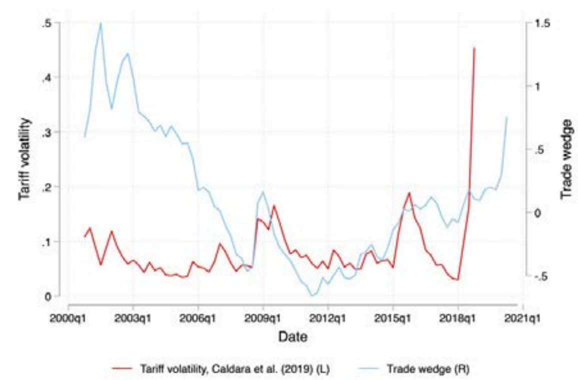
(a) Global factor



(b) VIX



(c) U.S. TPU



(d) Tariff volatility

Figure 3: Measured trade wedge & market aggregate series

Notes: Panel (a) plots our measured trade wedge (blue line) and compares it to the time series of global factor (red line). Panel (b), (c), and (d) show corresponding plots for the VIX, U.S. TPU, and expected tariff volatility, respectively. All time series represent population-weighted averages across 16 economies, with 2012 population shares used as weights.

section of risky asset prices using the method in Miranda-Agrippino et al. (2015). This global factor captures aggregate volatility and risk aversion, and is negatively correlated with the measured trade wedge (blue line). This correlation is especially strong during crises. Similarly, Panel (b) shows that when markets are expected to be more volatile, as indicated by peaks in the VIX index, the trade wedge also increases. This is particularly evident during the emerging market crises and the global financial crisis, suggesting that the trade wedge is sensitive to financial volatility.

In Panel (c), the red line represents the U.S. trade policy uncertainty measure from Caldara et al. (2020). During periods of geoeconomic fragmentation, when financial frictions are relatively muted, the increase in the trade wedge is mainly driven by trade policy uncertainty, which is based on newspaper coverage of TPU-related news. As validation, Caldara et al. (2020) also estimate tariff volatility using a stochastic volatility model, which aligns with the trade wedge after the global financial crisis, as shown in Panel (d) of 3. These trade uncertainty measures capture both first-moment trade shocks and increased second-moment uncertainty about future tariffs.

In sum, the trade wedge derived from our model provides insights into both first-order and second order trade and financial frictions.

3.3 Robustness

In this section, we demonstrate that the correlations among the measured trade wedge, trade and financial frictions remain robust across different samples and alternative data cleaning methods. First, while the baseline sample focuses on countries with significant movements in perceived default risk, we find that the correlations between the trade wedge and trade and financial frictions still hold when extending the sample to include countries with milder default risk dynamics. Second, in the baseline sample, we demean each variable of interest before deriving the trade wedge and use population as a weight to calculate the weighted average series. We show that this measure is robust to replacing the constant with a linear trend in each variable. Moreover, we use alternative weights to derive the weighted average series, and the observed correlations remain robust.

3.3.1 Alternative 37-economy sample

This section constructs an alternative 37-economy sample, based on the data availability of CDS spread and trade price data. Using this alternative sample, we find that the positive correlation between the trade wedge and the financial friction is robust to this alternative sample. Table 2 summarizes the statistics of key variables, which is the counterpart to Table 1.

Table 2: 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
$\ln(\xi_t)$	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.

Using the 37-economy sample, we construct the population-weighted average trade wedge, trade-to-GDP ratio, and CDS spread, as shown in Figure 4. The blue line in both panels refers to the trade wedge estimated from the 37-economy sample. In the left panel of Figure 4, even after including economies with relatively stable default risk, the weighted average trade wedge continues to effectively measure overall trade barriers. It has a strong negative correlation with the trade-to-GDP ratio, with a correlation coefficient of -0.80.

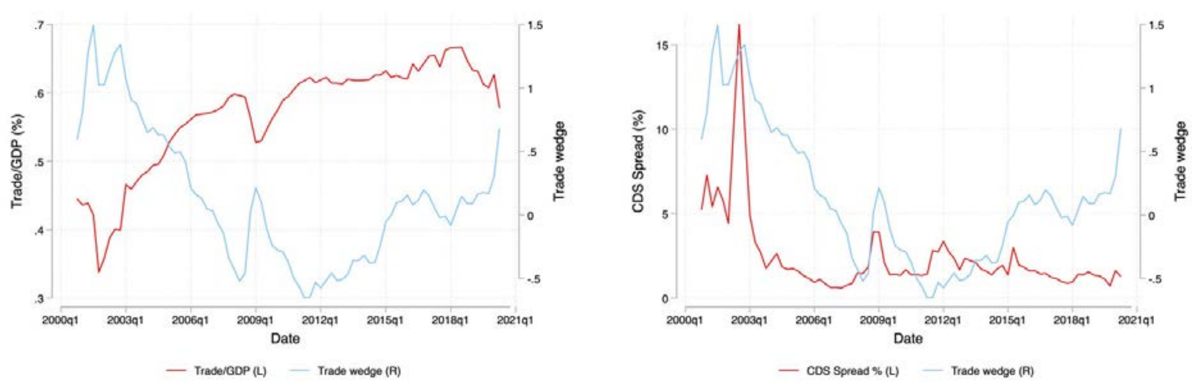


Figure 4: Measured trade wedge & CDS spread & Trade-to-GDP, 37-economy sample

Notes: Results using the 37-economy sample. The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

Consistent with the baseline 16-economy sample, the measured trade wedge is strongly correlated with the population-weighted average CDS spread, with a correlation of 0.60. This positive correlation becomes more pronounced during emerging market crises and the global financial crisis. Thus, expanding the sample does not bias our main conclusion that this trade wedge measure—incorporating both trade and financial components—effectively captures overall trade barriers and comoves with aggregate financial frictions.

3.3.2 A linear trend within countries

In this section, we remove a linear trend from each variable of interest, rather than a constant trend as in the baseline, to account for trends in trade for some economies. We then estimated the trade wedge using Equation (12). The correlations between the trade wedge, trade and financial frictions remain robust, as shown in Figure 5.

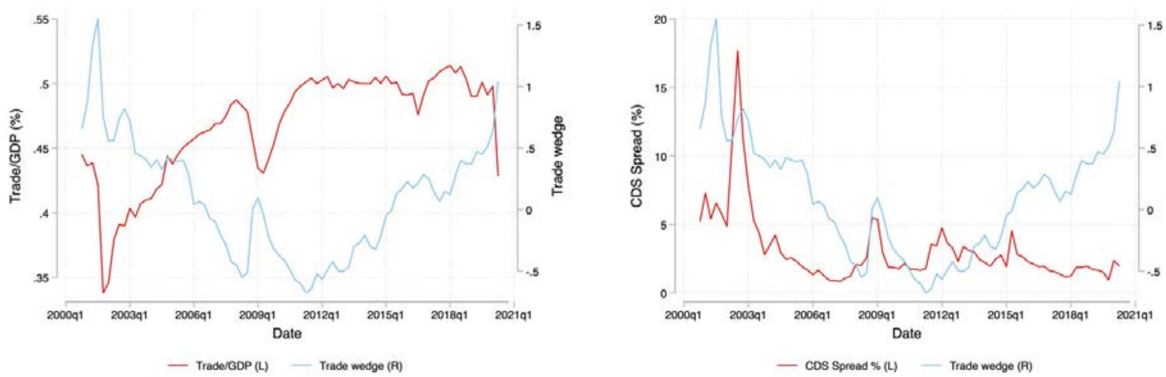


Figure 5: Linearly-detrended trade wedge & CDS spread & Trade/GDP

Notes: Results with a linear trend within countries. The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

3.3.3 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 economy in the sample. To address this, we show that the observed correlations between the trade wedge, 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 6) or using nominal GDP in 2019 as weights (Figure 7). The patterns are robust.

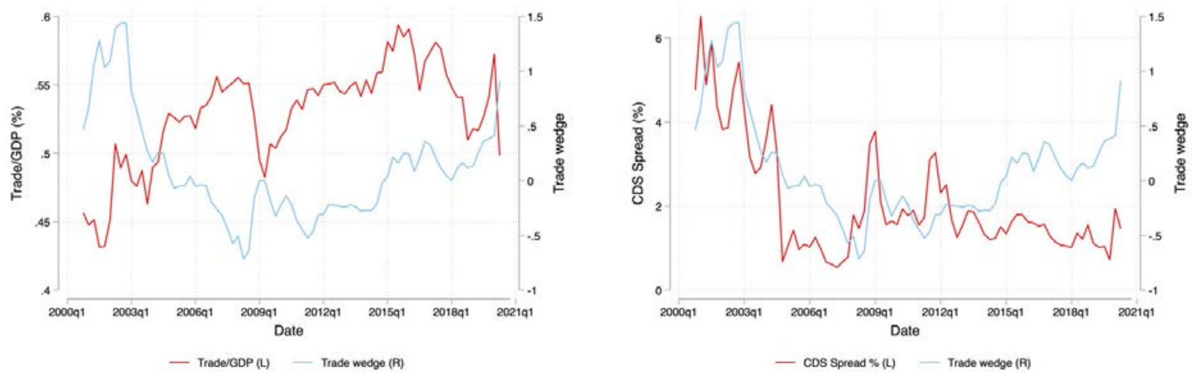


Figure 6: Median across 16 economies

Notes: Results when using the median across the sample. The left panel plots the median measured trade wedge (blue line) and the median trade-to-GDP ratio (red line) across 16 economies. The right panel plots the median measured trade wedge (blue line) and the median CDS spread (red line).

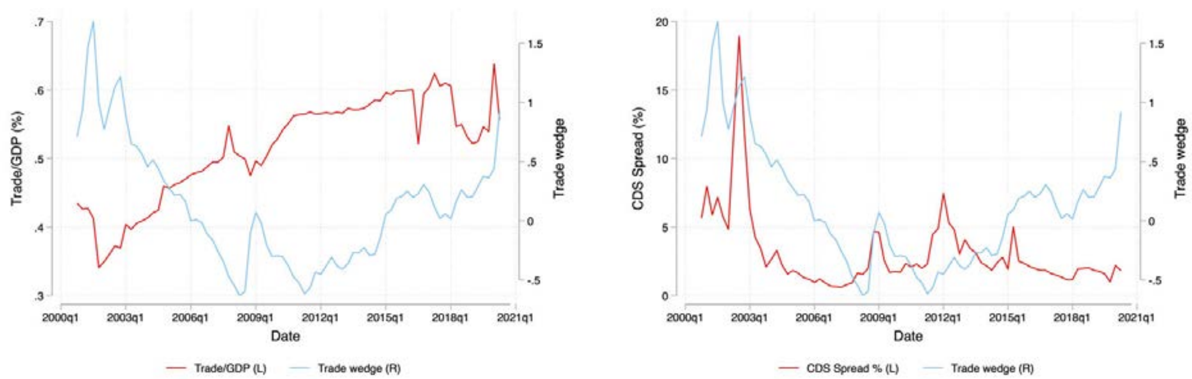


Figure 7: Nominal GDP weighted average across 16 economies

Notes: Results using nominal GDP in 2019 as weights when taking the weighted average. The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the nominal GDP in 2019. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

3.3.4 A sub-sample with available intermediate goods price

Due to data limitations, intermediate goods price data is available for only 11 out of the 16 economies: Brazil, Bulgaria, Colombia, Hungary, Indonesia, Lithuania, Mexico, Peru, the Philippines, South Africa, and Turkey. Therefore, in Equation (12), the baseline trade wedge omits this intermediate goods price. In this section, we show that using the sub-sample with available intermediate goods price data, the observed correlations between the trade wedge, trade frictions, and financial frictions remain unchanged, as shown in Figure 8.

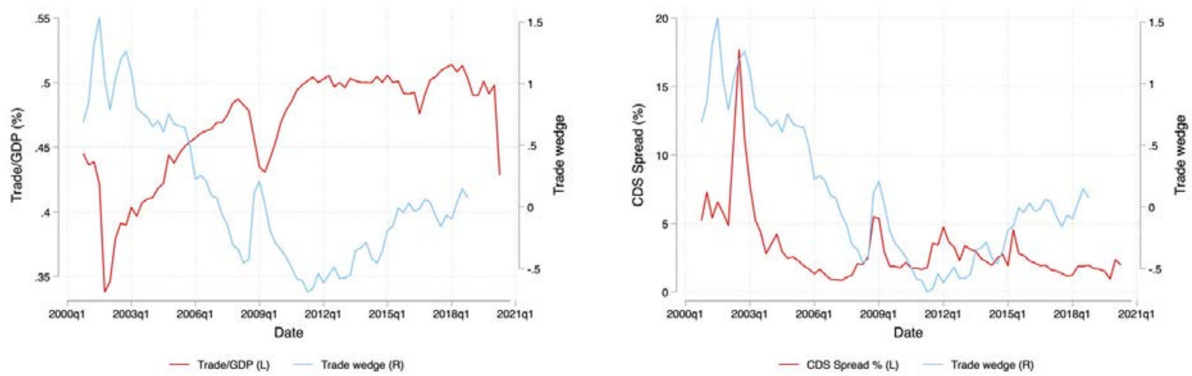


Figure 8: Measured trade wedge with intermediate goods prices

Notes: Results using a sub-sample with available intermediate goods price data. The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

4 Quantitative Analysis

We evaluate the quantitative properties of the model in this section. We parameterize the model to our 16-economy sample, as described Section 3.1. To highlight the interaction between trade and financial frictions, we first study the impulse responses to trade cost shock, to show that trade cost shock could drive up the sovereign spread. Second, we present how sovereign spread could contribute to trade wedge by decomposing the measured trade wedge using model simulated data.

4.1 Parameterization

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

$$\log(z_t) = \rho_z \log(z_{t-1}) + \sigma_z \varepsilon_t, \quad \varepsilon_t \sim N(0,1), \tag{14}$$

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 iceberg cost shock τ also follows a first-order autoregressive process:

$$\log(\tau_t) = (1-\rho_\tau)\log(\bar{\tau}) + \rho_\tau \log(\tau_{t-1}) + \sigma_\tau \varepsilon_t, \quad \varepsilon_t \sim N(0,1), \tag{15}$$

where ρ_τ captures the persistence of the trade shock, $\bar{\tau}$ is the mean of the trade cost, and σ_τ governs the volatility of the trade shock.

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 $\gamma > 0$.

The model is at a quarterly frequency. There are two groups of parameters. The parameters in the first group are fixed exogenously and 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 $\{\alpha_M, \alpha_L, \alpha_k, \omega, A, \alpha, \rho, \xi, \mu, \sigma, \eta, \gamma, r^*, r_f^*, \chi, \phi, \rho_z, \rho_\tau, k\}$. 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.[6] We normalize the intermediate goods TFP coefficient to 1. 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 normalize the export demand level ξ to 1. 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 pass through 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 and iceberg cost shocks to 0.9, which are conventional value in the literature. Finally,

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

we normalize capital to 1.

The remaining parameters in the model are $\{\sigma_z, \bar{\tau}, \sigma_\tau, \theta, \beta, d_1, d_2\}$. We jointly choose values for those parameters to minimize the sum of the distance between the moments in the model and their corresponding counterparts in the data. Although we choose all parameters jointly to match the moments, we can provide a heuristic description of how the moments inform specific parameters. First, the standard deviation of TFP innovations σ_z mainly affect standard deviation of GDP. Second, the average trade share mainly pin down the average iceberg cost parameter and the standard deviation of trade share informs the standard deviation of ice cost innovations. Third, there is a tight relationship between θ—share of imported inputs that needs working capital—and working capital to GDP ratio. Finally, the mean and volatility of the spread, as well as its correlation with trade and GDP, primarily inform the discount factor β and the punishment parameter in productivity when default $\{d_1, d_2\}$. Table 4 reports the moments in the data and in the model. The model generates similar statistics to the ones in the data.

The model also generates additional moments and business cycle co-movements that are mostly consistent with the data, as reported in bottom panel of Table 4. The model generates a lower level of debt (17.9%) compared to the data (34.9%). As in standard sovereign default models, the model produces a positive correlation between spread and debt to GDP ratio, with the data at 0.4 and the model at 0.3. With trade component in our general equilibrium model of sovereign default, we can also compare the correlations among trade, trade balance, trade wedge, spread, and GDP. The correlations involving the trade-to-GDP (Trade/GDP) ratio show that the model matches the empirical data reasonably well, with slight deviations. The correlation between Trade/GDP and GDP is 0.3 in the data and 0.2 in the model. The correlation between Trade/GDP and the spread is -0.6 in the data, indicating a strong inverse relationship, and the model's estimate of -0.5 closely captures this negative relationship. The correlation between Trade/GDP and the trade wedge is -0.8 in the data, showing a strong inverse relationship, while the model shows a less negative correlation of -0.5, suggesting a slight underestimation of this inverse relationship.

The correlations involving the trade balance-to-GDP (TB/GDP) ratio indicate that the model aligns reasonably well with the empirical data, with some differences. The correlation between TB/GDP and GDP is -0.4 in the data and -0.2 in the model. The correlation between TB/GDP and the spread is 0.3 in the data, showing a positive relationship, and the model estimates a somewhat higher correlation of 0.5, indicating a minor overestimation. For the correlation between TB/GDP and the trade wedge, the data shows a strong positive relationship at 0.7, whereas the model presents a lower correlation of 0.4.

Table 3: Parameters

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 (0.7)
ρ	Trade elasticity in foreign demand	3	Eaton et al. (2016)
ξ	Export demand level	1	Normalization
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 RBC value
r^*	Risk-free interest rate	0.5%	Standard RBC 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	0.9	Standard value
k	Capital	1	Normalization
Parameters from Moment Matching			
σ_z	Standard deviation of TFP innovations	0.01	SD of GDP
$\bar{\tau}$	Average iceberg trade cost	1.1	Average trade to GDP ratio
σ_τ	Standard deviation of iceberg cost innovations	0.005	SD of trade to GDP ratio
θ	imported inputs with working capital	0.52	Working capital to GDP ratio
β	Discount factor	0.85	Average spread
d_1	Punishment parameter	-0.83	Corr(spread, Import/GDP)
d_2	Punishment parameter	0.84	SD of spread

4.2 Trade cost increases spread

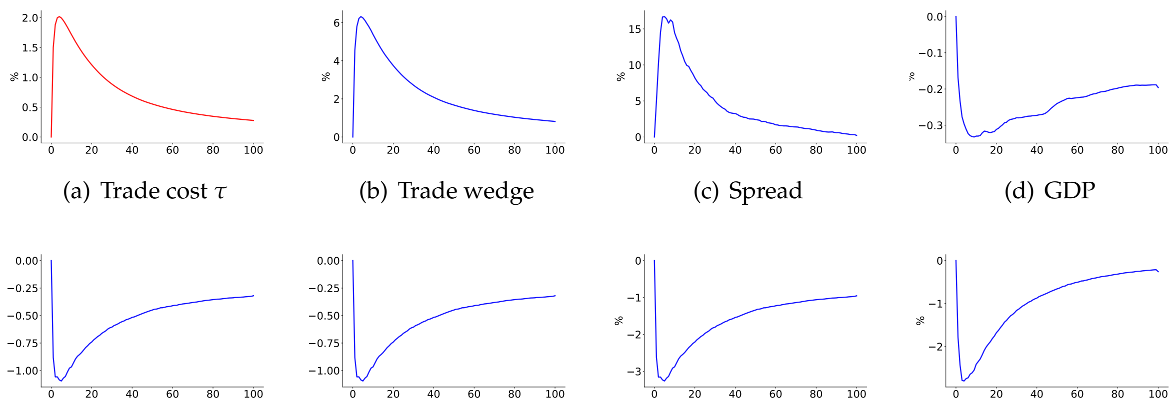
Our model features an interaction between trade wedge and financial friction. This section discusses how trade cost shock τ endogenously leads to an elevated sovereign spread, by plotting the impulse response functions to an iceberg trade cost shock.

Table 4: Moments in the data and model

	Data	Model
Targeted moments		
Std(GDP)(%)	4.3	4.3
Mean(Trade/GDP)(%)	46.8	46.5
Std(Trade/GDP)(%)	4.1	4.0
Mean(spread)(%)	3.1	2.8
Std(spread)(%)	2.6	4.8
Mean(working capital/GDP)(%)	7.1	7.1
Corr(spread, import/GDP)	-0.6	-0.5
Untargeted moments		
Mean(Debt/GDP)(%)	34.9	17.9
Corr(spread, debt/GDP)	0.4	0.3
Corr(spread, trade wedge)	0.6	0.7
Corr(Trade/GDP, GDP)	0.3	0.2
Corr(Trade/GDP, spread)	-0.6	-0.5
Corr(Trade/GDP, wedge)	-0.8	-0.5
Corr(TB/GDP, GDP)	-0.4	-0.2
Corr(TB/GDP, spread)	0.3	0.5
Corr(TB/GDP, wedge)	0.7	0.4

Notes: See Appendix A.4 for the construction of moments in the data.
Trade = Export + Import. Trade Balance (TB) = Export - Import.

We apply a one standard deviation increase in exogenous trade cost τ to the model, as plotted in panel (a). Following the increased trade cost, trade wedge increases (panel(b)). Recall that trade wedge can be decomposed into two parts: conventional trade wedge and a financial friction term. When trade cost increases, on one hand, there is a direct positive effect on measured trade wedge, via conventional trade wedge component. On the other hand, domestic output goes down (panel (d)) and sovereign default risk rises (panel (c)). An increasing sovereign passes to import financing cost of private sectors, which positively contribute to the trade wedge through the financial friction component. With an increased trade cost, both export (panel (g)) and import (panel (h)) decline.



(a) Trade cost τ (b) Trade wedge (c) Spread (d) GDP

(e) RER (f) TOT (g) Export (h) Import

Figure 9: IRFs to an increase in trade cost

Notes: Impulse responses to a one standard deviation increase in trade cost τ.

4.3 The role of financial frictions in trade wedge

This section decomposes the fluctuations of trade wedge variations to those of conventional trade wedge and financial friction component, to highlight the role of financial frictions in driving trade wedge. We perform a variance decomposition of the measured trade wedge according to effects of each component, using model simulated data sample. Specifically, following Shorrocks (2013), we conduct a Shapley decomposition that distributes the "payout" (e.g., variance explained, total change, or prediction) among a group of "players" (e.g., variables or sources of change), considering all possible orderings of contributions.[7]

[7]The Shapley value answers how a certain amount of outcome variable should be allocated among a set of predictors. The proposed solution to the general decomposition problem turns out to be formally equivalent to the Shapley value, and is therefore referred to as the Shapley decomposition. More details could be found in Shorrocks (2013), and Stata helpfile of command -shapley2-.

The results are listed in Table 5. The second column reports the decomposition using all observations, conditional on not defaulting. 47% of variation in measured trade wedge is explained by financial friction component. That is to say, the interaction between trade and financial friction contributes to almost half of the measured trade wedge. If we restrict to the observations with spread higher than median spread, financial friction can explain 54% of the overall measured trade wedge variation. The interaction between trade and financial friction is especially significant during debt crises, when sovereign spread is high.

Table 5: Decomposing Trade Wedge Volatility

	All	spread>p50
Trade wedge	100%	100%
conventional component	53%	46%
financial friction component	47%	54%

5 Conclusion

The central subject of this work is that there is an interaction between trade friction and financial friction arising from sovereign risk. We build a general equilibrium sovereign default model with trade and decompose the trade barriers into a conventional trade wedge term and a financial friction component. When trade cost is higher, the conventional trade wedge goes up directly due to the elevated trade cost. Meanwhile, the increasing trade cost drives down the domestic output and pushes up the sovereign default risk. The sovereign risk passes through to the import borrowing cost of private sector. The interaction between trade and financial friction amplifies the trade wedge, which is identified as the financial component of measured trade wedge.

The financial friction component of the measured trade wedge plays an important role both empirically and quantitatively. Empirically, we derive the measured trade wedge using the model implied decomposition and find a strong positive correlation between measured trade wedge and sovereign spread. Using the model simulated data, we find that the financial friction component can account for 47% of the variations in the measured trade wedge.

Our model emphasizes the interplay between trade friction and financial friction. It highlights that changes in trade costs can contribute to a rise in financial friction through the risk of sovereign default, which subsequently amplifies trade barriers. The heightened sovereign risk is not solely influenced by domestic fundamentals but can also be driven by international shocks transmitted through trade. The baseline framework serves as a useful tool for examining additional interactions between trade-related shocks and financial friction.

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Online Appendix to "Trade Barriers and Sovereign Default Risk"

A Data

A.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. ***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.

4. ***Real exchange rate***

We apply monthly nominal exchange rate - local currency units (LCU) per U.S. dollar, with values prior to the currency's introduction presented in the new currency's terms - from GEM, deflated by CPI, as our main measure for real exchange rate. We take the quarterly average real exchange rate as the quarterly value.

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. The national accounts data for Malaysia, Peru and Philippines is from CEIC database.

6. ***Population***

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

A.2 Sample selection

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

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.

A.3 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 trade wedge with each country's trade-to-GDP ratio and 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, including Brazil, Bulgaria, Colombia, Hungary, Indonesia, Italy, Mexico, Philippines, South Africa, Spain, and Turkey. 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 A.1. While Indonesia has the largest population share, the weighted average trade-to-GDP ratio does not reflect its trade decline after 2012, and the weighted average CDS spread is significantly higher than Indonesia's CDS spread. Brazil, which has the second largest population share, did not experience a trade decline in 2020, and its CDS spread remained relatively stable after the trade liberalization period of 2002-2007, especially when compared to the more volatile period during its economic crisis in the early 2000s.

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, including Australia, Estonia, Finland, Israel, South Korea, Malaysia, the Netherlands, Poland, Thailand, and the United Kingdom, also show correlations between the trade wedge, trade, 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 3.3.1. Similarly, the overall results are not driven

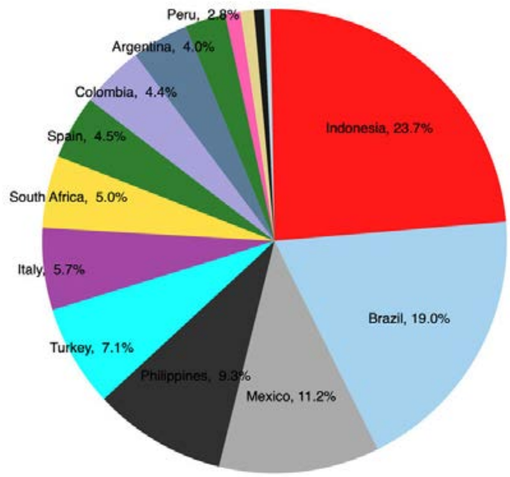


Figure A.1: Population share in 2012: 16-economy sample

by any single country in the 37-economy sample. Figure A.2 presents the population weights for these 37 economies. Moreover, our baseline correlations between the trade wedge, trade, and financial frictions remain robust when alternative weighting schemes are applied, as discussed in Section 3.3.3.

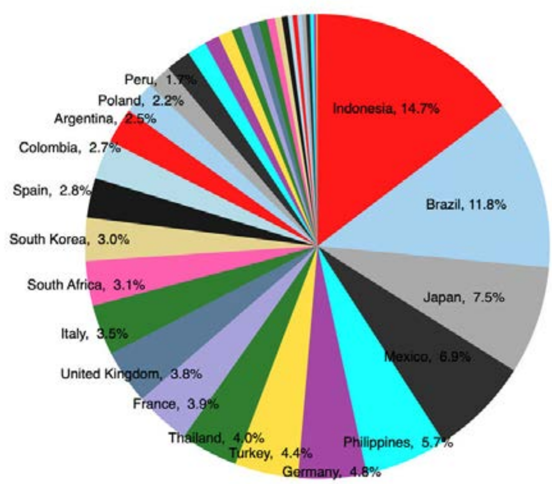
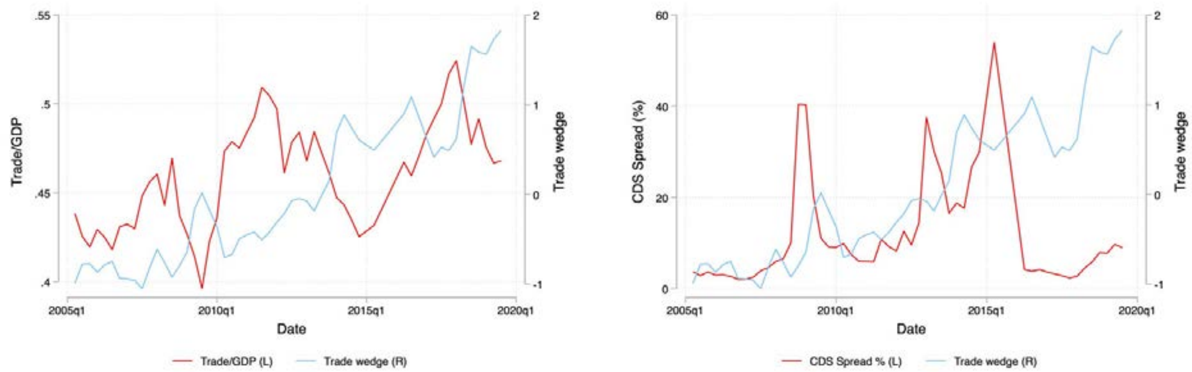


Figure A.2: Population share in 2012: 37-economy sample

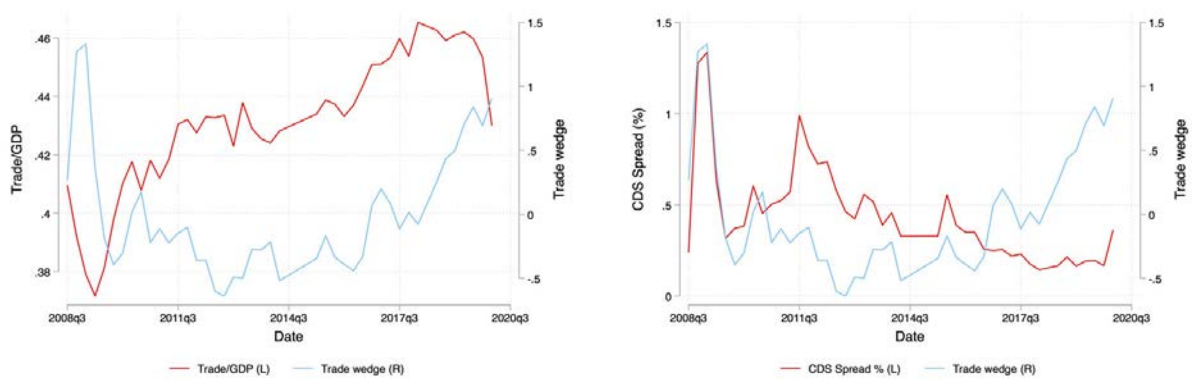


(a) Trade/GDP

(b) CDS spread

Figure A.3: Argentina: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

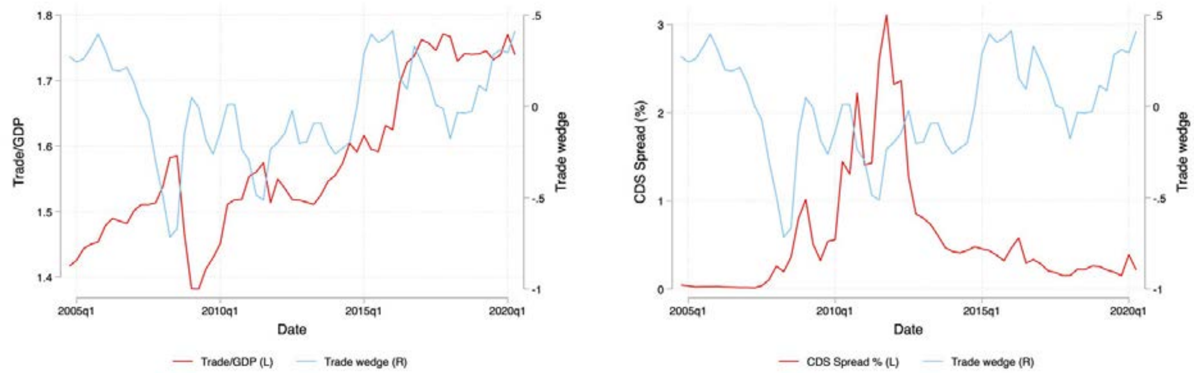


(a) Trade/GDP

(b) CDS spread

Figure A.4: Australia: trade wedge, trade/GDP and CDS spread

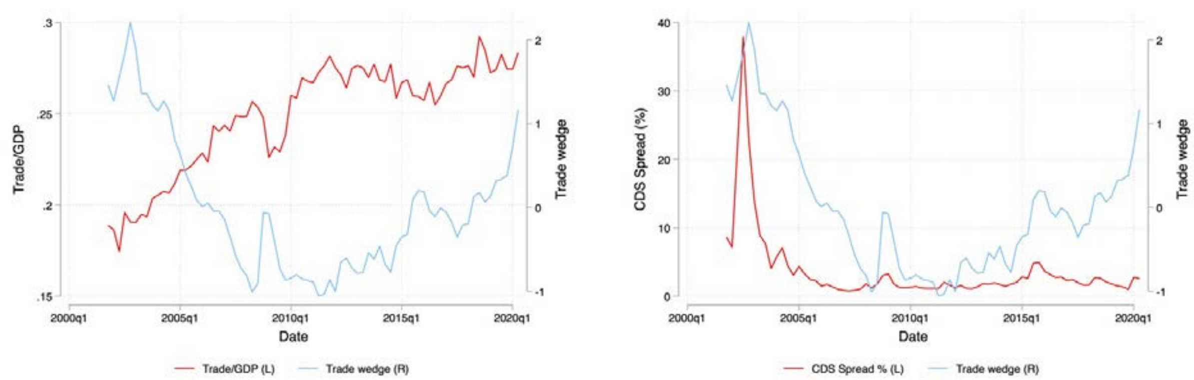
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.5: Belgium: trade wedge, trade/GDP and CDS spread

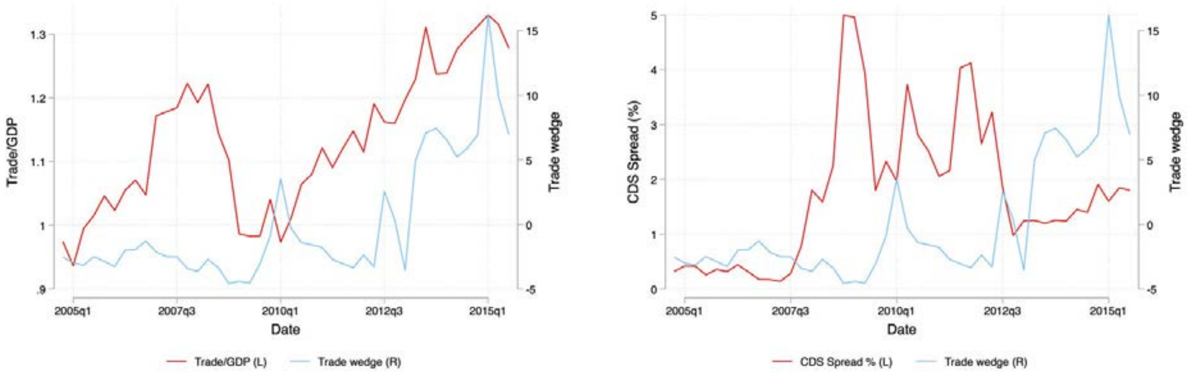
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.6: Brazil: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

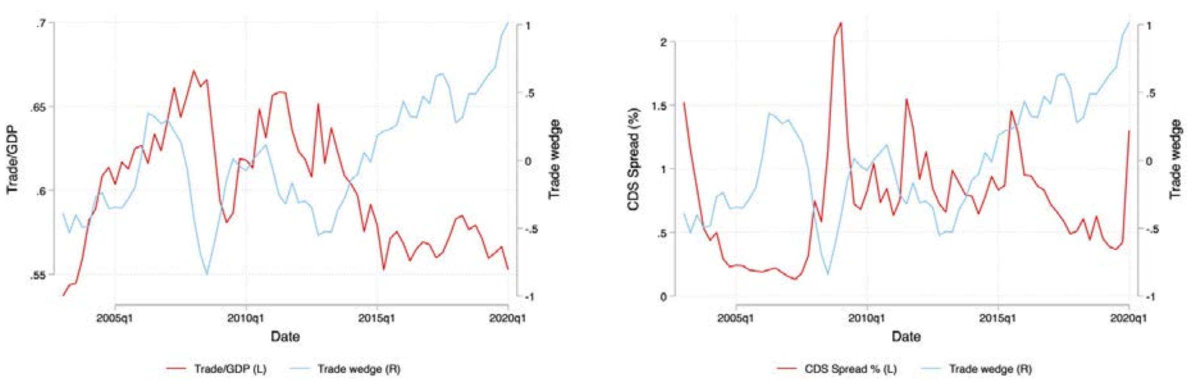


(a) Trade/GDP

(b) CDS spread

Figure A.7: Bulgaria: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

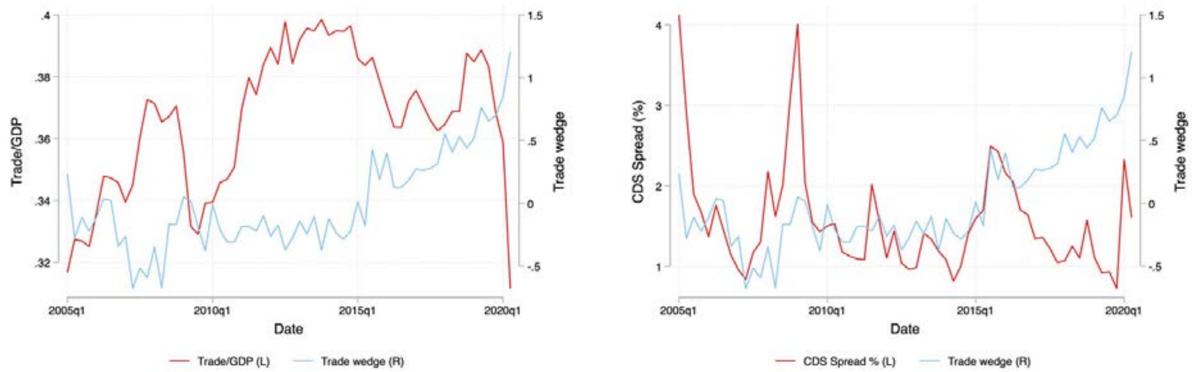


(a) Trade/GDP

(b) CDS spread

Figure A.8: Chile: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

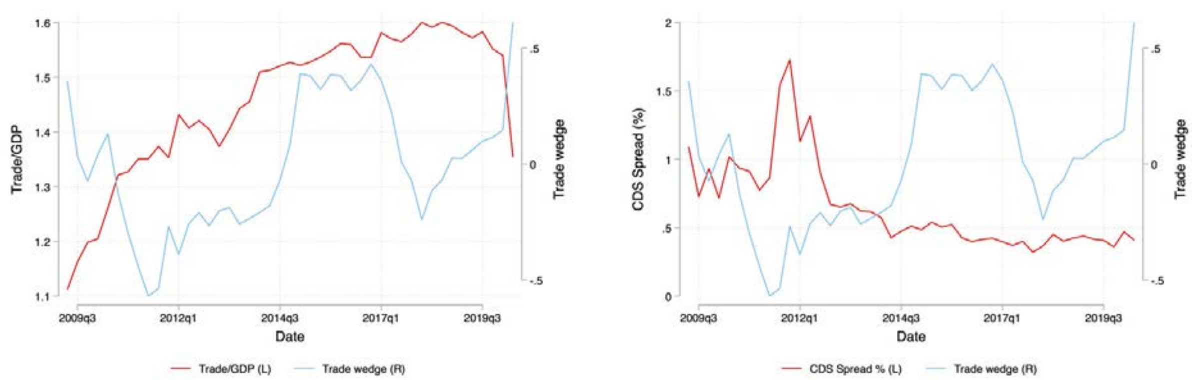


(a) Trade/GDP

(b) CDS spread

Figure A.9: Colombia: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

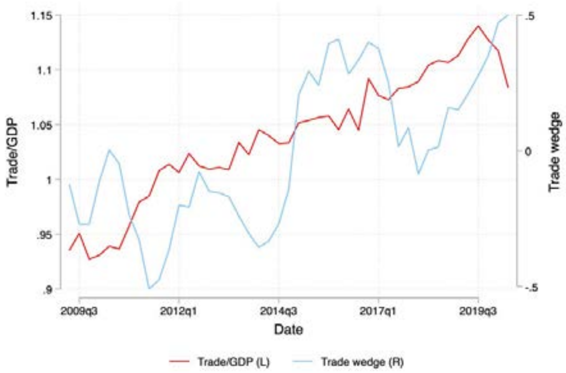


(a) Trade/GDP

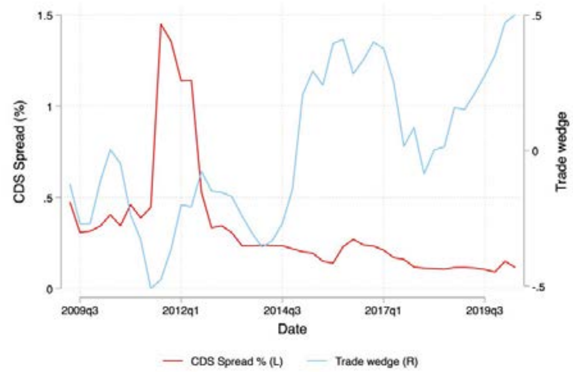
(b) CDS spread

Figure A.10: Czech Republic: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



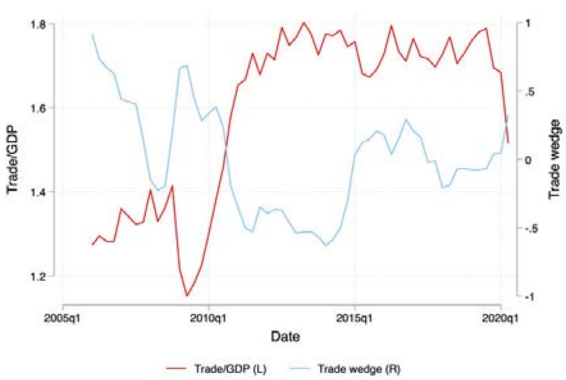
(a) Trade/GDP



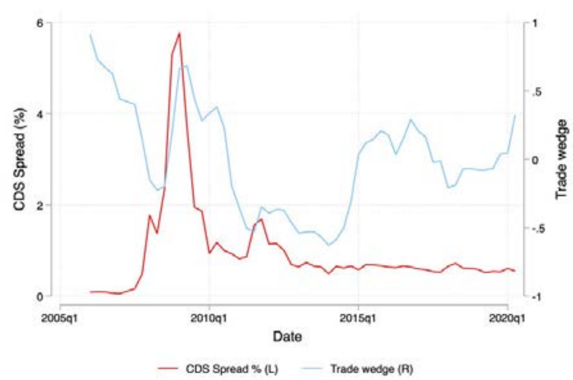
(b) CDS spread

Figure A.11: Denmark: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



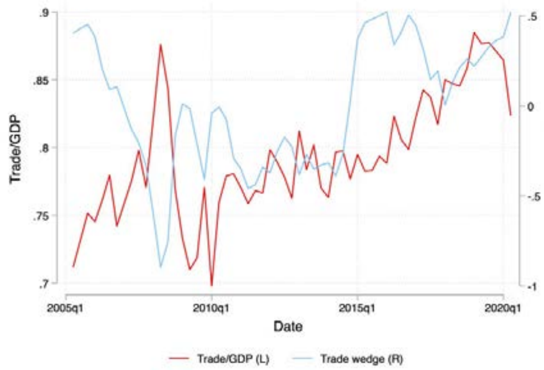
(a) Trade/GDP



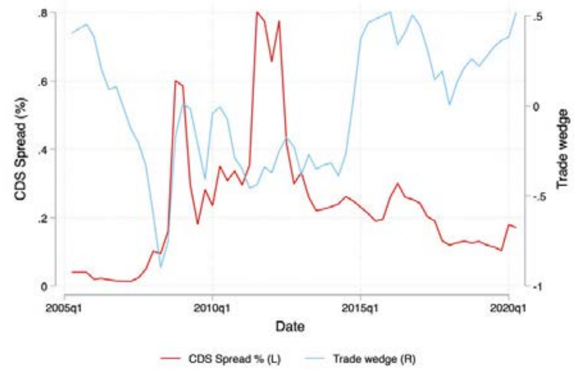
(b) CDS spread

Figure A.12: Estonia: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



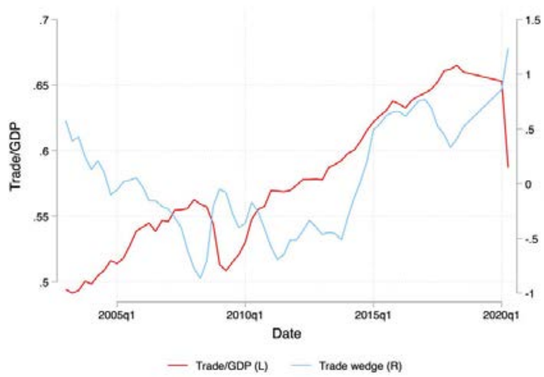
(a) Trade/GDP



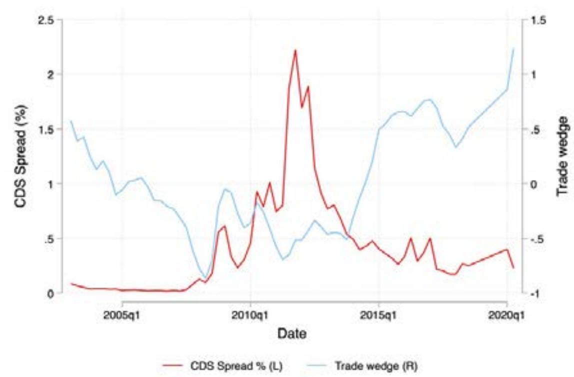
(b) CDS spread

Figure A.13: Finland: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



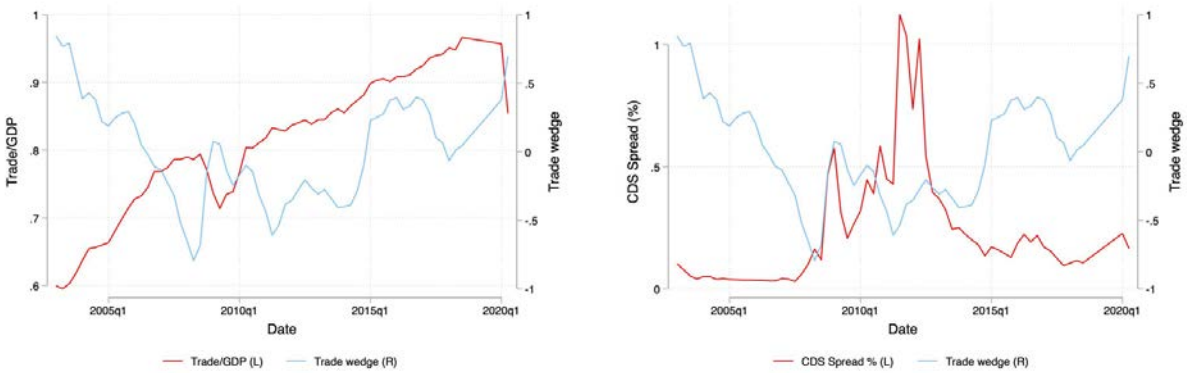
(a) Trade/GDP



(b) CDS spread

Figure A.14: France: trade wedge, trade/GDP and CDS spread

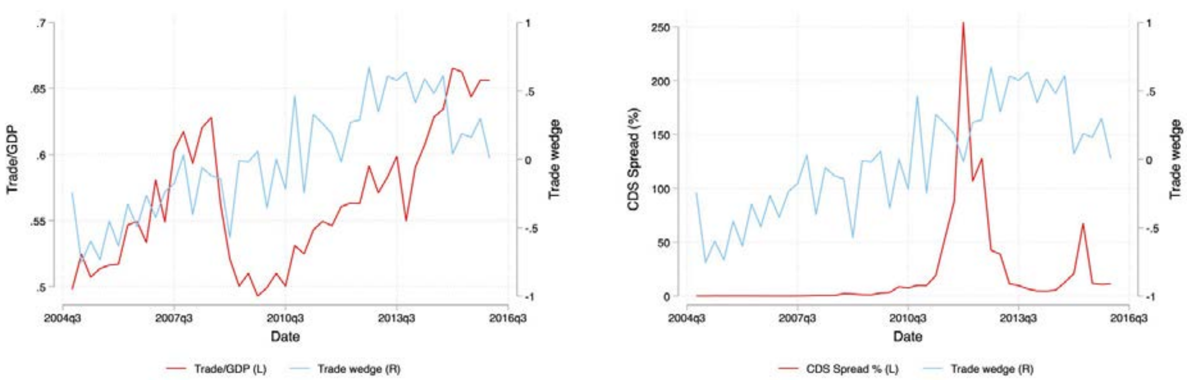
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.15: Germany: trade wedge, trade/GDP and CDS spread

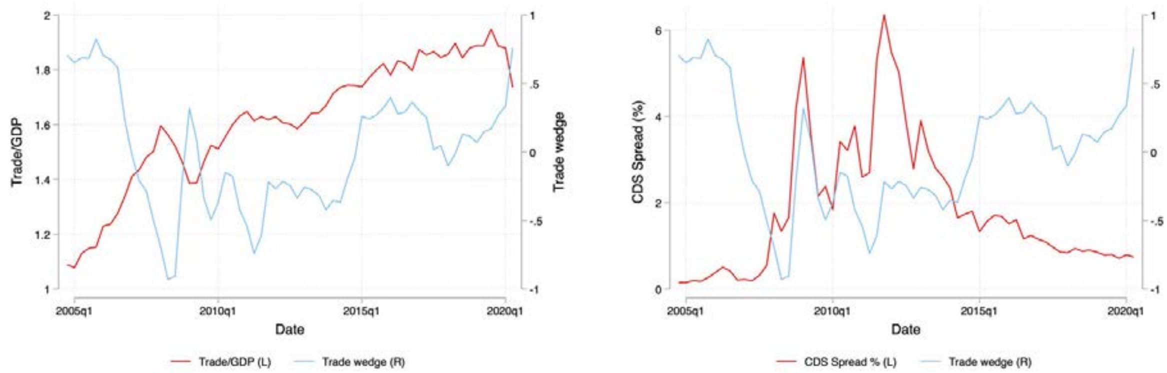
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.16: Greece: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

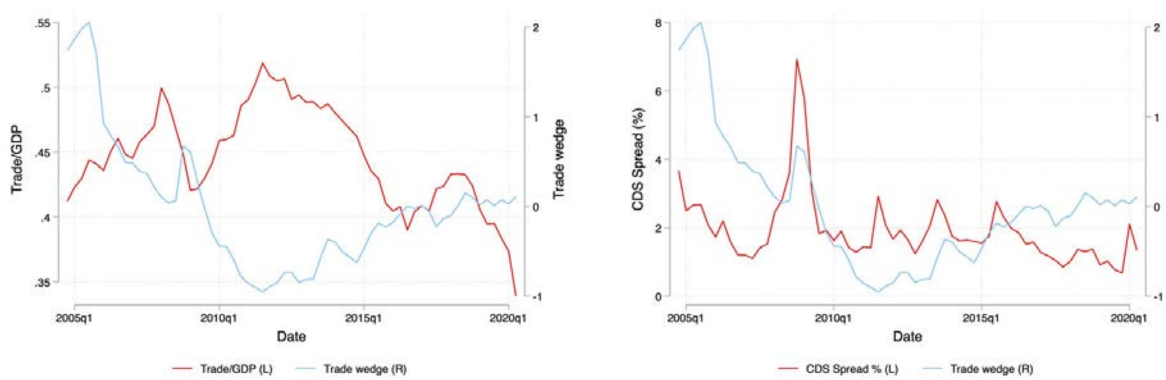


(a) Trade/GDP

(b) CDS spread

Figure A.17: Hungary: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

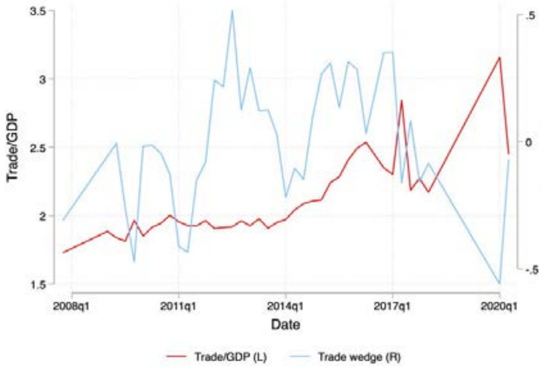


(a) Trade/GDP

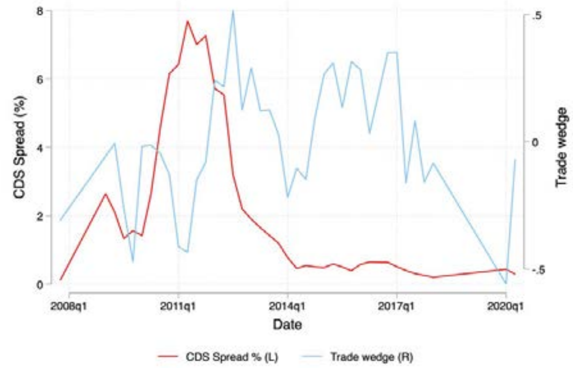
(b) CDS spread

Figure A.18: Indonesia: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



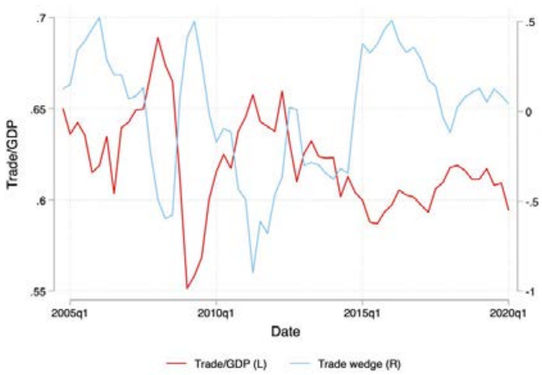
(a) Trade/GDP



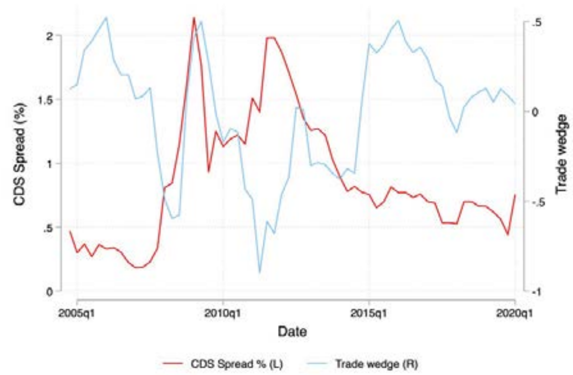
(b) CDS spread

Figure A.19: Ireland: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



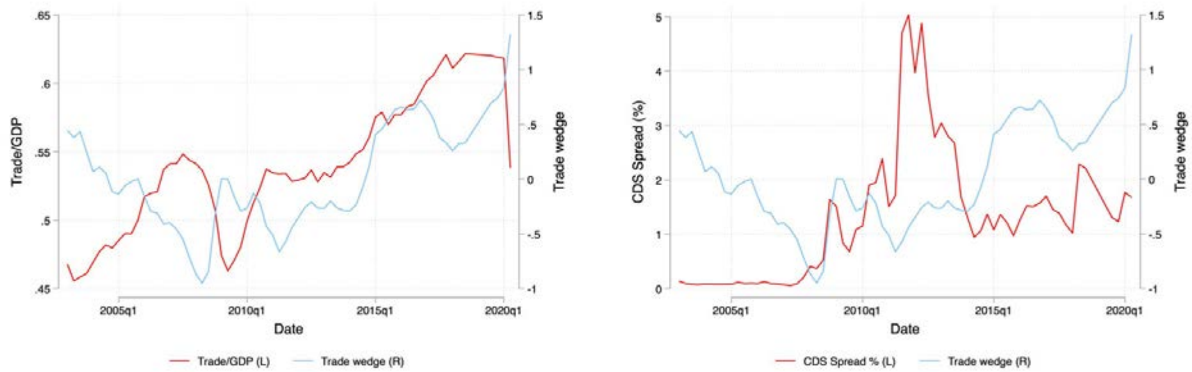
(a) Trade/GDP



(b) CDS spread

Figure A.20: Israel: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

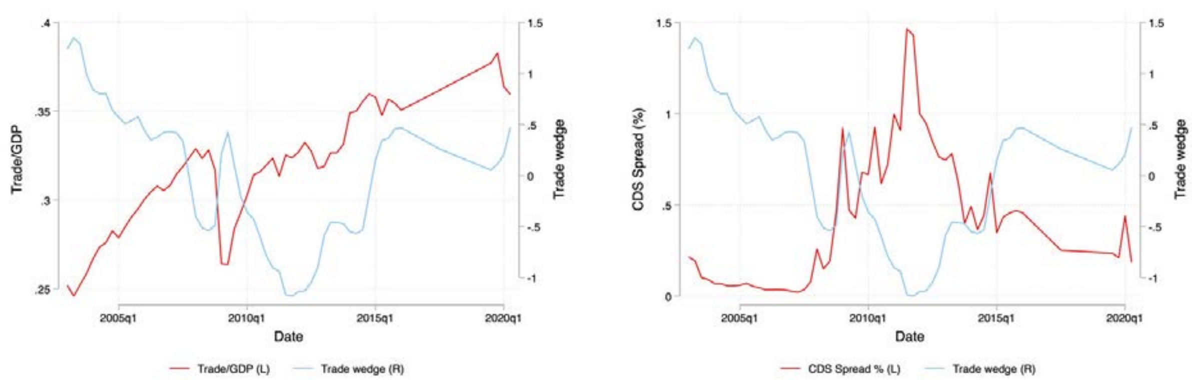


(a) Trade/GDP

(b) CDS spread

Figure A.21: Italy: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

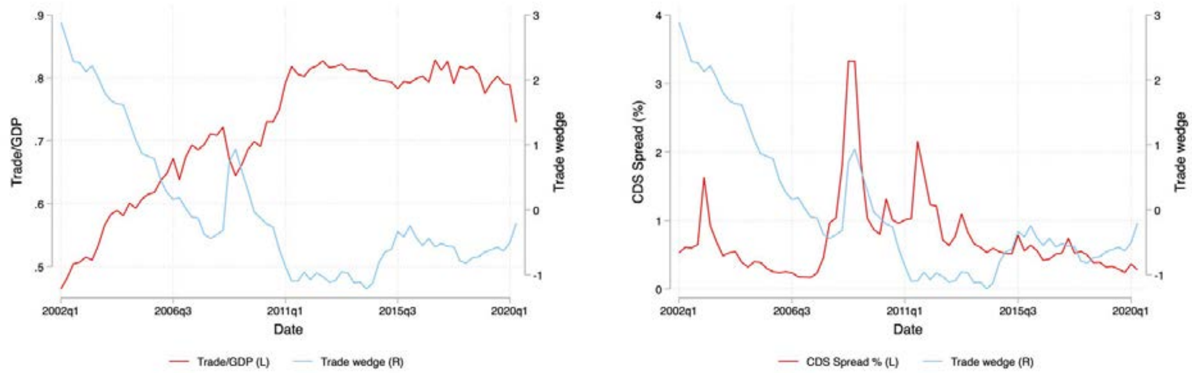


(a) Trade/GDP

(b) CDS spread

Figure A.22: Japan: trade wedge, trade/GDP and CDS spread

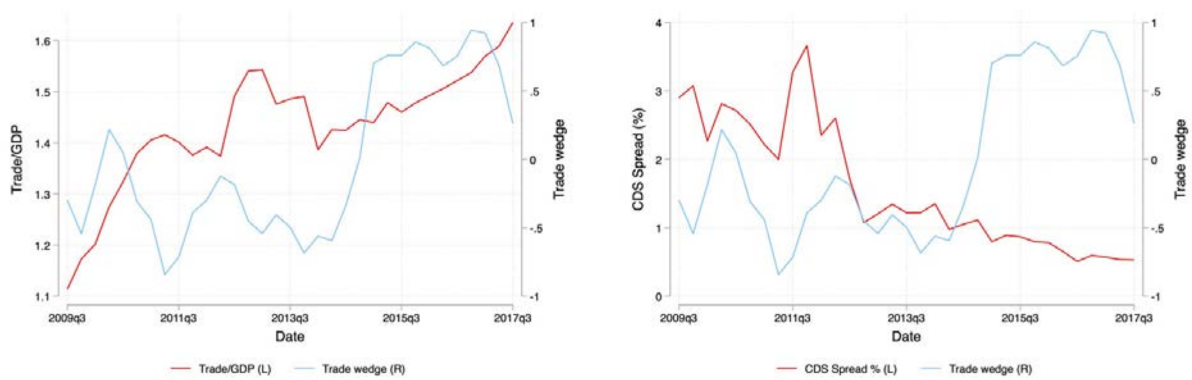
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.23: South Korea: trade wedge, trade/GDP and CDS spread

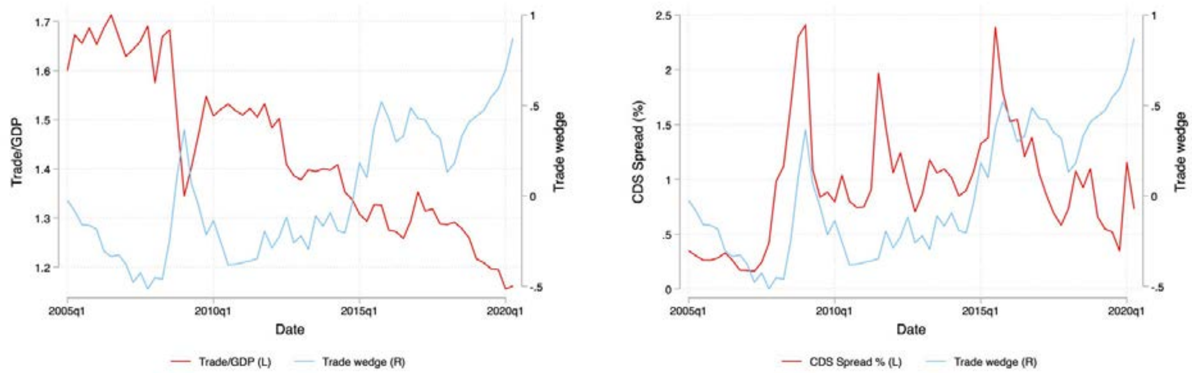
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.24: Lithuania: trade wedge, trade/GDP and CDS spread

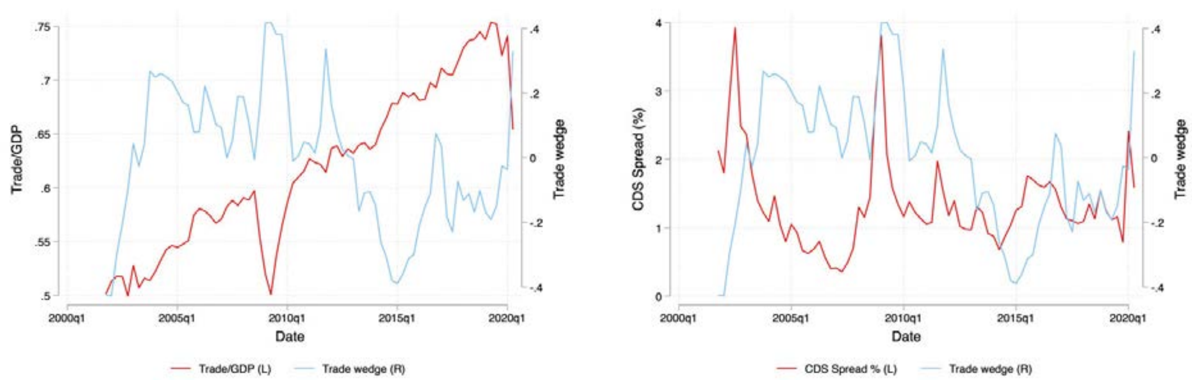
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.25: Malaysia: trade wedge, trade/GDP and CDS spread

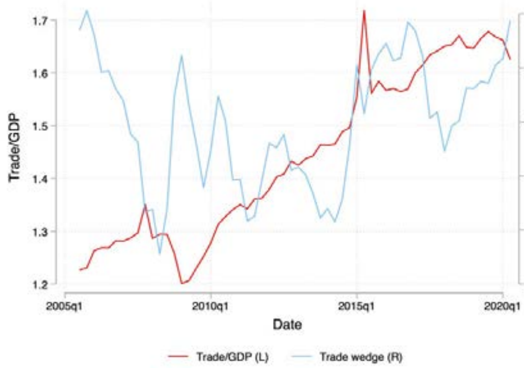
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



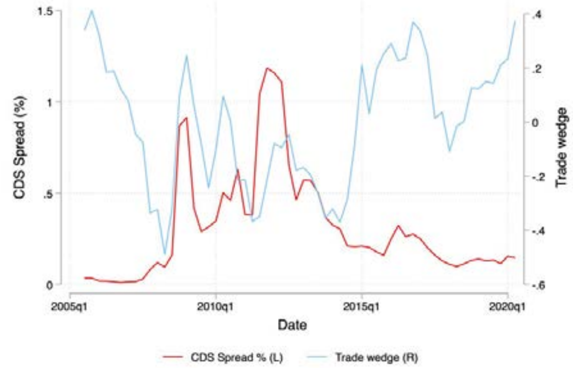
(a) Trade/GDP (b) CDS spread

Figure A.26: Mexico: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



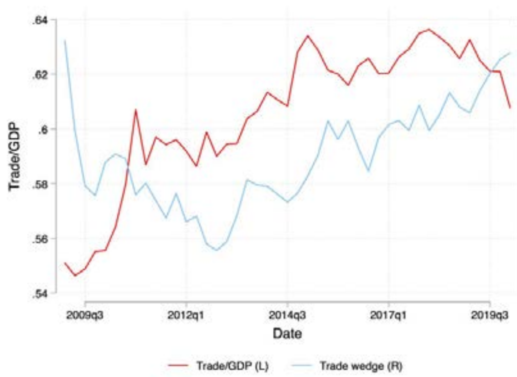
(a) Trade/GDP



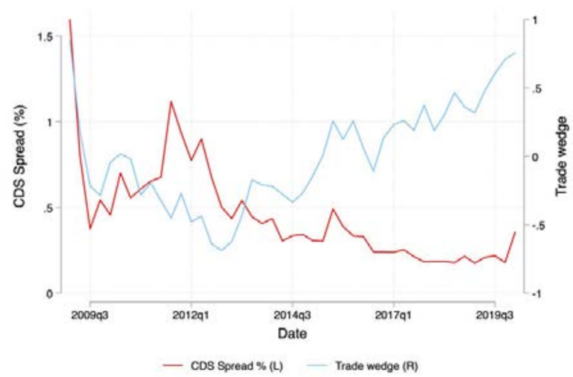
(b) CDS spread

Figure A.27: Netherlands: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



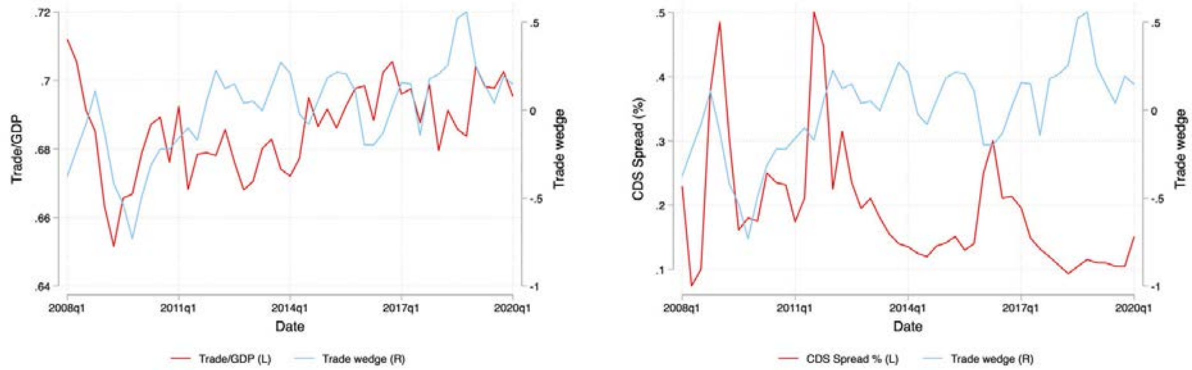
(a) Trade/GDP



(b) CDS spread

Figure A.28: New Zealand: trade wedge, trade/GDP and CDS spread

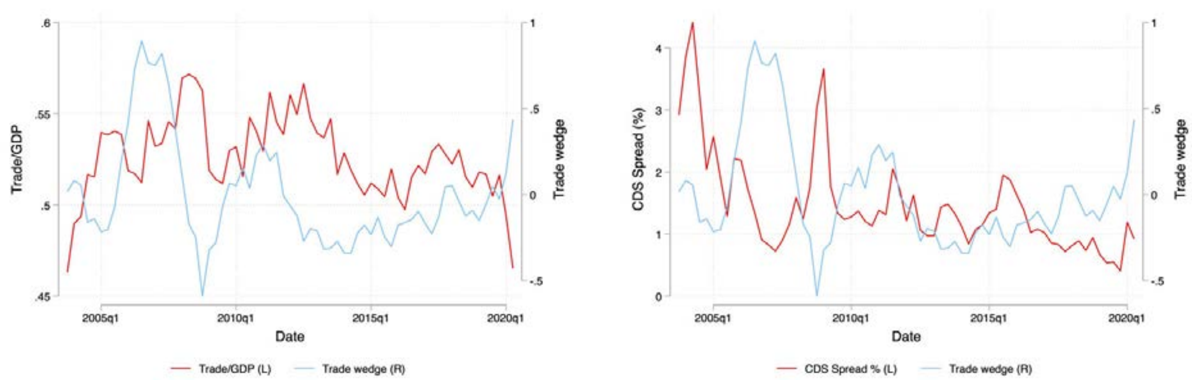
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.29: Norway: trade wedge, trade/GDP and CDS spread

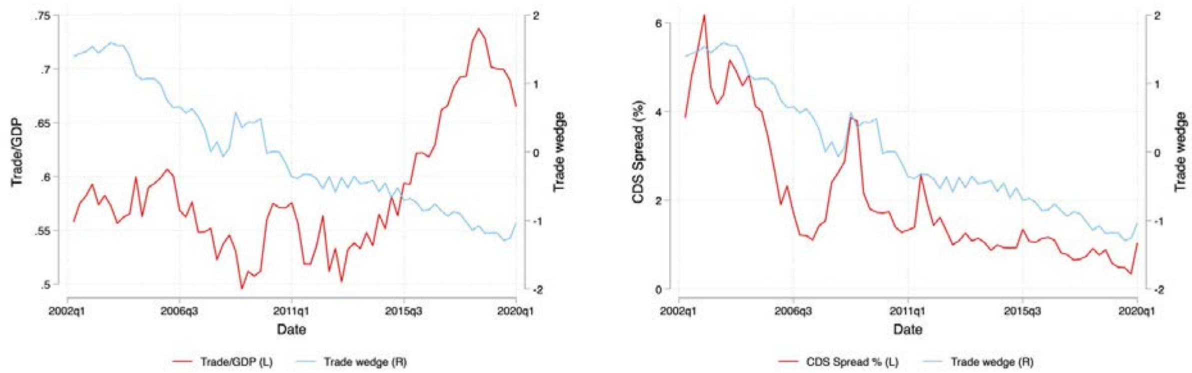
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.30: Peru: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

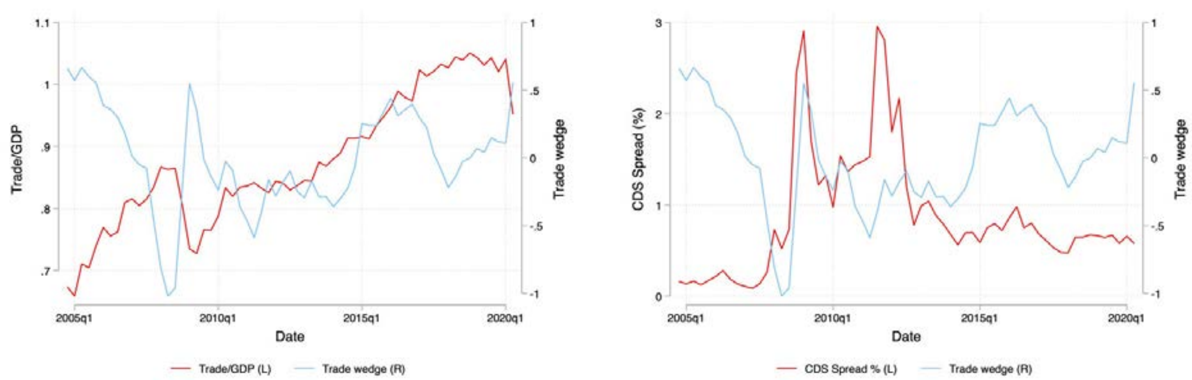


(a) Trade/GDP

(b) CDS spread

Figure A.31: Philippines: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

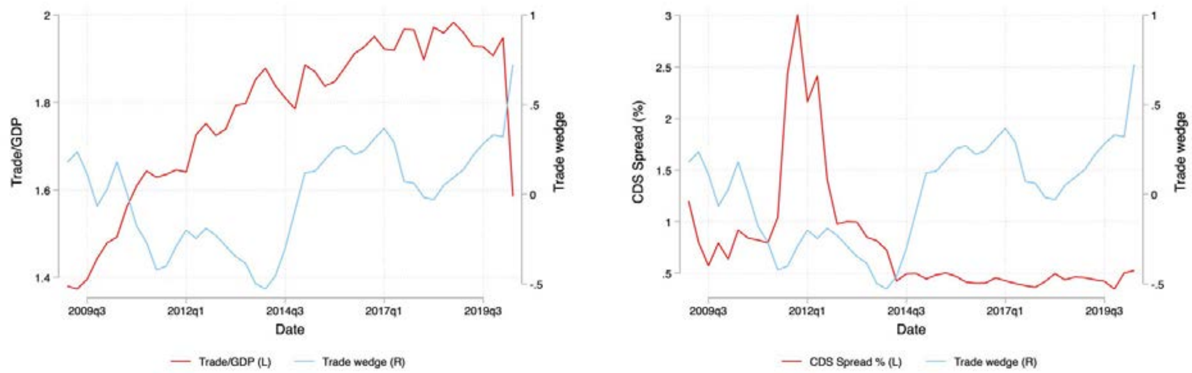


(a) Trade/GDP

(b) CDS spread

Figure A.32: Poland: trade wedge, trade/GDP and CDS spread

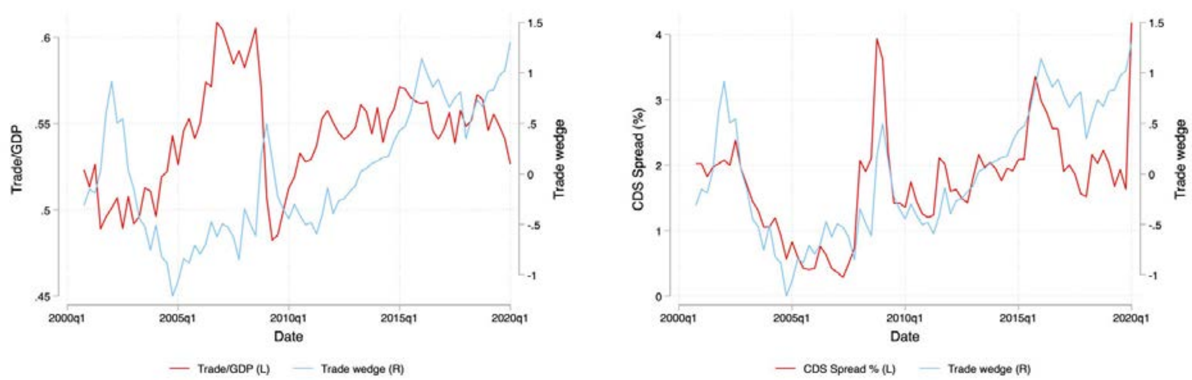
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.33: Slovak Republic: trade wedge, trade/GDP and CDS spread

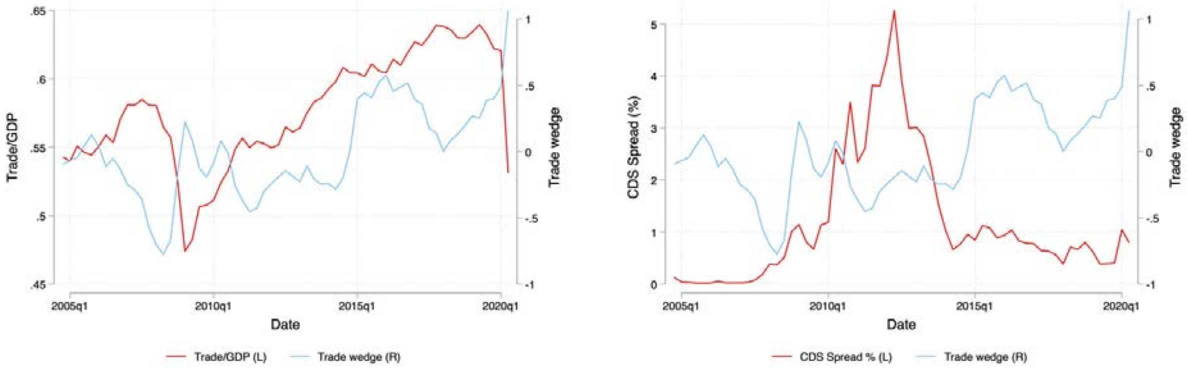
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.34: South Africa: trade wedge, trade/GDP and CDS spread

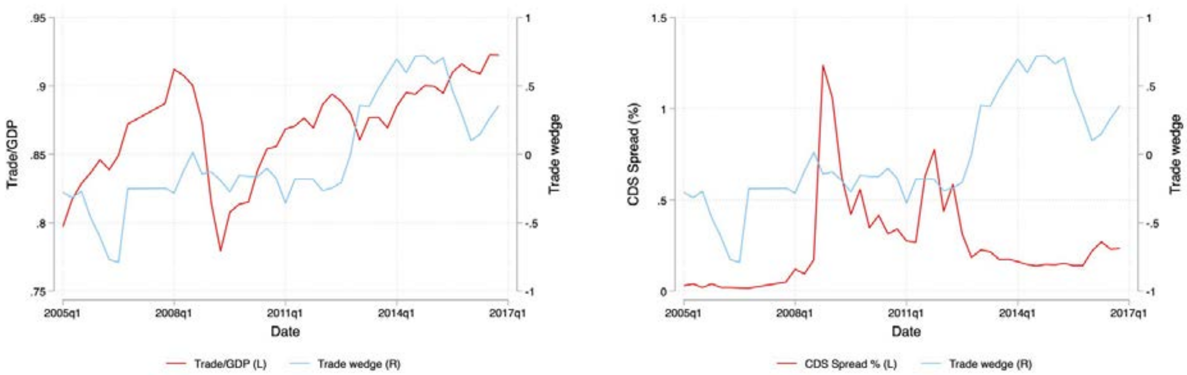
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.35: Spain: trade wedge, trade/GDP and CDS spread

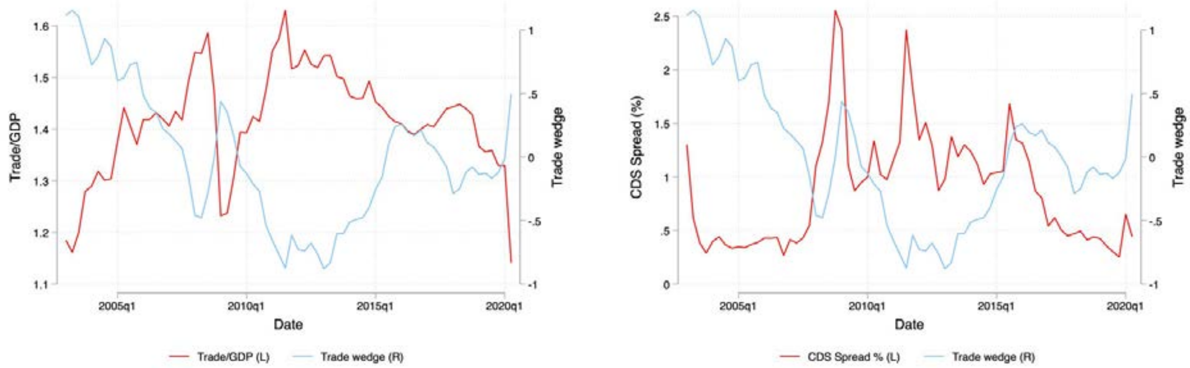
Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP (b) CDS spread

Figure A.36: Sweden: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

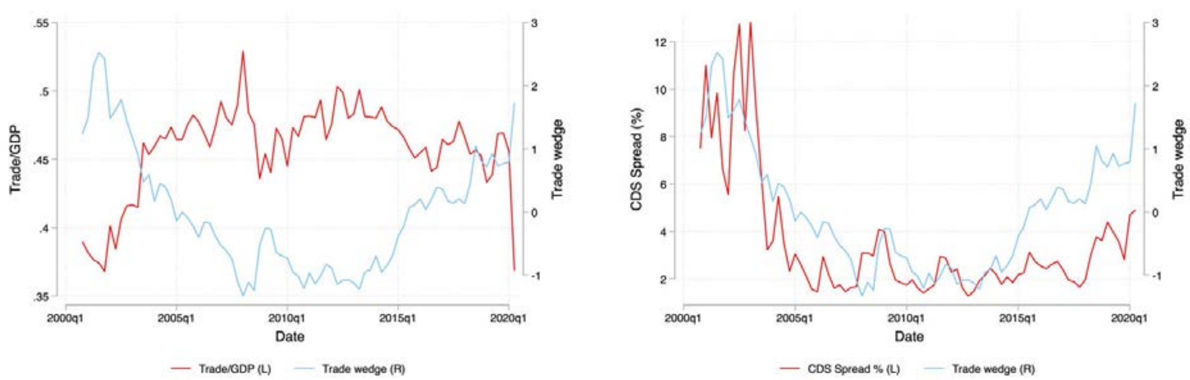


(a) Trade/GDP

(b) CDS spread

Figure A.37: Thailand: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

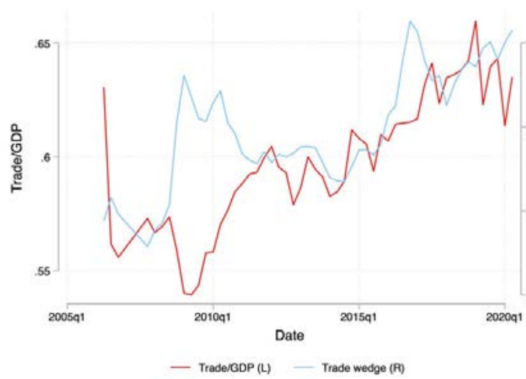


(a) Trade/GDP

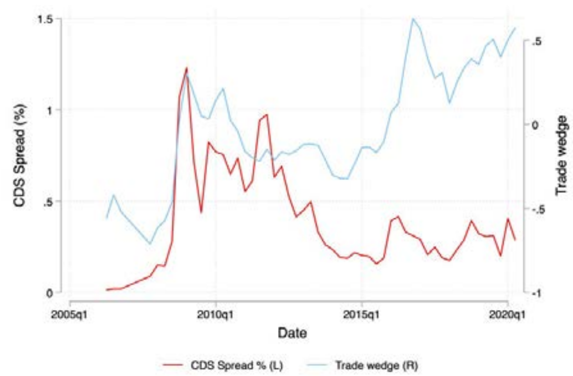
(b) CDS spread

Figure A.38: Turkey: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).



(a) Trade/GDP



(b) CDS spread

Figure A.39: United Kingdom: trade wedge, trade/GDP and CDS spread

Notes: The left panel plots the weighted average measured trade wedge (blue line) and the weighted average trade-to-GDP ratio (red line). The weight is the population of each economy in 2012. The right panel plots the weighted average measured trade wedge (blue line) and the weighted average CDS spread (red line).

A.4 Data moments

A.4.1 Targeted moments

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

Standard deviation of GDP First, we linearly detrend 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;

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

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

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 3.1%.

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 2.6%.

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. 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 meadian loans-to-sales ratio across countries as our targeted moments, which is 7.1%.

Correlation between spread and import-to-GDP ratio We first calculate the correlation between spread and import-to-GDP ratio for each economy. Then we take the median correlation across 16 economies.

A.4.2 Untargeted moments

This section describes untargeted moments used for evaluating the calibration.

Correlation between spread and debt-to-GDP ratio The debt-to-GDP ratio is measured as the ratio of external debt to GDP. We first calculate the correlation between CDS spread and debt-to-GDP ratio for each economy. Then we take the median correlation across 16 economies.

Correlation between spread and trade wedge We first calculate the correlation between spread and the measured trade wedge that derived using $\sigma = \rho = 3$ for each economy. Then we take the median correlation across 16 economies.

Correlation between trade balance-to-GDP ratio and GDP Trade balance is measured as net trade (export-import). We calculate the correlation between trade balance-to-GDP ratio and linearly detrended GDP. The moment is the median correlation across 16 economies, which is -0.4 in the data.

Correlation between trade balance-to-GDP ratio and CDS spread We calculate the correlation between trade balance-to-GDP ratio and CDS spread. Then we take the median correlation across 16 economies, which is 0.3.

Correlation between trade balance-to-GDP ratio and trade wedge The correlation between trade balance-to-GDP ratio and measured trade wedge is first calculated for each economy. Then we take the median correlation across 16 economies, which is 0.7.

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 GDP. The moment is the median correlation across 16 economies, which is 0.3 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 -0.6.

Correlation between trade-to-GDP ratio and trade wedge We first derive the correlation between trade-to-GDP ratio and measured trade wedge. The median correlation across 16 economies is -0.8.

B Computation Algorithm

We first solve the equilibrium in factor markets and production by solving the system of equations (3) - (9) 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 and iceberg cost shock τ. 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 $(z, \tau, r, b - qb')$, solve the private sector equilibrium by solving the system of equations (3) - (9), 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 $v_0(z, \tau, b)$ and a bond price function $q_0(z, \tau, b)$.

5. Given private sector equilibrium schedules and the value function and bond price in the previous step, update the repayment value $v^c(z, \tau, b)$ and the default value $v^d(z, \tau)$.

6. Compare $v^c(z, \tau, b)$ and $v^d(z, \tau)$, and update the defaulting rule, bond price, government optimal policy $b'(z, \tau, b)$ and the value function of the government $v(z, \tau, b)$.

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.