From Invoicing to Anchoring: How RMB Swap Lines Shape Exchange Rate Anchoring in Small Open Economies *

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Abstract

This paper studies whether and how policies that promote a currency's use in trade invoicing can also strengthen its role as an anchor currency in other economies' exchange rate baskets. We exploit the establishment of RMB swap lines by the People's Bank of China as a natural setting to examine this mechanism. We first estimate countries' implicit currency baskets and the weights assigned to the RMB, and then use a staggered difference-in-differences design to assess the effect of initiating swap line agreements on the RMB's weights in these baskets. Our results indicate that RMB weights increase by approximately 5% about nine months after a swap line is introduced and remain persistently higher thereafter. Finally, we develop a three-country DSGE model to interpret these findings, showing that by promoting RMB invoicing, swap lines reinforce the RMB's role as an anchor currency for exchange rate stabilization.

JEL classification: F15; F31; F36; F41; O24

Keywords: Exchange Rate Anchoring; Invoicing Currency; RMB Swap Lines; Exchange Rate Basket Weight

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1 Introduction

One defining feature of international currency status is that it entails not only widespread use in cross-border transactions, but also a role as an anchor currency for other economies. The choice of an anchor currency—whether as a base currency in pegged regimes or as a dominant component in (implicit) exchange rate baskets for floating regimes—carries significant consequences for the economies adopting the anchor, shaping exchange rate pass-through, macroeconomic stability, and international monetary transmission. Despite its importance, the determinants of a currency's role as an anchor currency remain surprisingly understudied. In this paper, we seek to shed light on this question by examining whether policies aimed at promoting an international currency's use as an invoicing or settlement currency can also strengthen its role as an anchor currency.

Historically, the currencies that dominated international transactions have also tended to serve as the principal anchor currencies in the international monetary system. In the nineteenth and early twentieth centuries, when international payments were settled either directly in gold or indirectly through gold-linked arrangements, major economies operated under some form of the Gold Standard, fixing their currencies to gold (e.g., the United Kingdom, Germany, and the United States). Following World War II, as the US dollar emerged as the dominant currency in international transactions, most countries either pegged their currencies directly to the dollar or, under more flexible exchange rate arrangements, assigned a dominant weight to the dollar in their (implicit) currency baskets.[1] In contrast, as the British pound declined in importance as an international transaction currency, its role as an anchor currency has also diminished (Ilzetzki, Reinhart and Rogoff, 2019). These historical

[1]Under the Bretton Woods system, most currencies were formally pegged to the US dollar. Following its collapse, many economies transitioned toward more flexible exchange rate regimes. Nevertheless, even countries that do not maintain formal pegs often attempt to limit excessive exchange rate fluctuations against major international currencies through foreign exchange intervention or monetary policy adjustments. In practice, many economies therefore continue to manage their exchange rates relative to one or several major currencies, either explicitly through announced exchange rate arrangements or implicitly through policy behavior. An implicit currency basket refers to a de facto exchange rate arrangement in which a central bank stabilizes its currency against a weighted combination of foreign currencies without formally announcing the basket composition or weights. Empirical evidence suggests that the US dollar has remained the dominant currency in such de facto arrangements, typically carrying the largest weight in implicit currency baskets (Frankel and Wei, 1994, 2008; Ilzetzki, Reinhart and Rogoff, 2019).

episodes suggest that expanding a currency's international usage may, in turn, strengthen its role as an anchor currency. We study this mechanism through the lens of China's bilateral central bank swap lines, which provide a contemporary case setting for analyzing how policies that expand cross-border currency usage may affect exchange rate anchoring behavior.

Since 2008, China has actively promoted the internationalization of the Renminbi (RMB) as an invoicing or settlement currency through a range of policy initiatives.[2] Among these initiatives, bilateral RMB swap line agreements signed by the People's Bank of China (PBoC) have become one of the central pillars of China's internationalization strategy. Between 2008 and 2024, the PBoC signed swap line agreements with foreign central banks to provide RMB liquidity either as trade finance for firms engaged in trade with China or as a lender-of-last-resort facility for foreign central banks. Official PBoC statements characterize these agreements as instruments to facilitate bilateral trade and investment, support local-currency settlement, provide RMB liquidity abroad, and stabilize financial markets during periods of stress.[3] By the end of 2024, the People's Bank of China (PBoC) had signed 41 standing swap line agreements—more than any other central bank at any point in history.[4]

Existing literature on RMB swap lines finds that the establishment of such agreements indeed significantly increases a country's use of the RMB for international payments (Bahaj and Reis, 2026; Jiao et al., 2024; Benguria and Novy, 2025). As outlined by Eichengreen (2011), the historical pattern of currency internationalization typically follows a sequence that starts with increased use in trade invoicing and settlement.[5] Against the backdrop of rising geoeconomic fragmentation and intensifying currency competition, this paper offers a new perspective on the role of RMB swap lines in advancing the RMB's status as an international currency in addition to trade invoicing and settlement. Specifically, we focus

[2]These measures include the introduction of the PBoC's RMB swap line agreements, the establishment of overseas RMB clearing banks, and the launch of the Cross-Border Interbank Payment System (CIPS), among others.

[3]For example, official PBoC announcements on the initiation and renewal of bilateral currency swap agreements state that these arrangements are intended to facilitate bilateral trade and investment, promote the use of local currencies, and support the stability of financial markets. See the PBoC's official announcement at https://www.pbc.gov.cn/en/3688241/3688636/3688657/index.html.

[4]At their respective peaks, the Federal Reserve System issued 14 U.S. dollar swap lines, compared with 11 for the European Central Bank and 6 for the Bank of England.

[5]The historical pattern of currency internationalization typically follows a sequence: beginning with trade invoicing and settlement, followed by private financial transactions, and ultimately culminating in its use as official reserves held by central banks and governments (Eichengreen, 2011).

on RMB's role as a nominal anchor currency in countries' currency baskets of (implicit) exchange rate target. In particular, we investigate whether providing RMB liquidity through swap lines increases the RMB's weight as an anchor for exchange rate stabilization and how this influences the distribution of exchange rate anchoring across currencies.

This paper proceeds in four steps. We begin by estimating each economy's implicit currency basket and the corresponding weights assigned to its components. Our approach builds on the seminal framework of Frankel (1993), which regresses changes in the local currency's value on changes in major candidate anchor currencies such as the US dollar and the euro. Our focus is on identifying the weight of the RMB within these baskets. A central econometric challenge arises from the strong collinearity between RMB and US dollar movements, which complicates their joint inclusion in Frankel–Wei regression (Frankel and Wei, 1994) . To address this, we adopt the two-step method of Kawai and Pontines (2016). In the first step, we purge RMB movements of the component explained by fluctuations in major international currencies. In the second step, we use the residuals as a proxy for RMB movements in the Frankel–Wei specification, while imposing the restriction that the weights of the major currencies sum to one.

Second, we examine how access to an RMB swap line affects the RMB weight in a country's (implicit) exchange-rate basket using a staggered difference-in-differences design. An RMB swap line is a bilateral agreement between the PBoC and a foreign central bank, allowing the latter to access RMB liquidity and extend RMB-denominated credit to domestic financial institutions. These agreements typically have a renewable three-year term, during which the foreign central bank can choose to activate the line.[6] Like other central bank lending programs, swap lines place a ceiling on interest rates, thereby reducing the interest rate risk faced by commercial banks and thus encouraging a broader expansion of RMB business. In addition, the PBoC swap lines are often accompanied by trade finance programs that support the use of RMB. These RMB swap line arrangements have been found to increase the use of RMB in trade invoicing and settlement (Bahaj and Reis, 2026; Jiao et al., 2024).

Two features of RMB swap lines are particularly relevant for our empirical strategy. First,

[6]In recent years, some agreements have adopted a five-year validity period-for example, the agreement between China and South Korea.

swap lines are initiated at different points in time across countries. Second, most countries renew their agreements upon expiration. To account for these characteristics, we adopt a staggered difference-in-differences design with absorbing treatment: countries receive treatment at different points in time, and once a country obtains a swap line, it is considered treated in all subsequent periods. Thus, our analysis focuses on the effect of the initial activation of an RMB swap line with the PBoC on the RMB's weight in partner countries' official currency baskets. Our sample comprises 34 countries over the period from August 2005 to December 2023, of which 18 signed swap line agreements with China and 16 did not. The sample excludes major international anchor currencies, economies operating under hard pegs or currency unions, and countries experiencing episodes of high and persistent inflation (defined as annual inflation exceeding 10 percent at any point during the sample period), where exchange rate movements may primarily reflect macroeconomic instability than exchange rate policy objectives.

In the baseline estimation, we employ the estimator proposed by (Borusyak, Jaravel and Spiess, 2024), which belongs to the class of imputation-based approaches. Imputation methods follow a two-step logic: first, they recover the unit and time components of untreated outcomes using only never-treated or not-yet-treated observations; second, they estimate the treatment effect using residualized outcomes that have been purged of unit- and time-invariant variation. This approach is appealing for its transparency and computational simplicity. Our estimation results show that, following the establishment of a swap line, the RMB weight rises by approximately 5% within nine months of signing and remains persistently elevated thereafter. This represents a quantitatively meaningful shift over a short period of time in the context of the international monetary system, where exchange rate anchoring patterns are typically highly persistent and dominated by the US dollar. Prior to the launch of the first RMB swap line in 2008, the US dollar accounted for an average exchange rate weight of 57% across the countries in our sample, while the implied RMB weight was close to zero for most economies.

We conduct a series of robustness checks to assess the stability of our empirical findings. First, we consider alternative estimators for our staggered difference-in-differences design under the absorbing-treatment framework to verify that the results are not sensitive to the

choice of estimator. Second, we explore alternative definitions of the control group to test whether our estimates depend on specific criteria for classifying treated and untreated units. Third, we replace the onshore RMB exchange rate with the offshore rate to ensure that our estimated RMB weights are not driven by the choice of exchange-rate measure. Fourth, we change the numeraire currency from NZD to AUD to confirm that our results are robust to the selection of base currency. Finally, we vary the width of the rolling window, using both wider and narrower windows, to examine whether the estimated RMB weights are sensitive to the time-series smoothing procedure. Overall, our results remain robust across these alternative specifications.

Third, we interpret our empirical findings as a "jumpstarting effect" of RMB swap lines, whereby enhanced RMB liquidity increases the share of RMB invoicing in bilateral trade. We provide two pieces of evidence linking access to RMB swap lines, RMB invoicing in bilateral trade and RMB's weight in currency baskets, highlighting the central role of invoicing in this mechanism. First, combining invoicing data from Boz et al. (2025) with swap line signing dates, we show that access to an RMB swap line raises the share of bilateral trade invoiced in RMB. Second, we document a positive relationship between RMB invoicing shares and RMB weights in trading partners' exchange rate baskets.

Fourth, to rationalize our empirical findings and to shed light on the underlying channels through which the establishment of RMB swap lines incentivizes an increase in the RMB weight within recipient countries' (implicit) currency baskets, we develop a three-country DSGE model with exogenous invoicing share based on Georgiadis and Schumann (2021) and approximate swap line recipient country as a small open economy following the method proposed by De Paoli (2009a,b). The framework extends De Paoli (2009a,b)'s two-country setup to a three-country environment comprising a small open economy (SOE), China, and the United States. In the model, access to RMB swap lines is introduced as an exogenous change in the share of imports and exports invoiced in RMB in the SOE, consistent with the empirical evidence in Bahaj and Reis (2026) and Jiao et al. (2024) and supported by our empirical observations.

Within this framework, the optimal adjustment of a central bank's exchange rate basket weights in response to swap line access is equivalent to setting the parameters of a simple

exchange rate policy rule that reacts to shifts in invoicing shares. The SOE has an incentive to stabilize its terms of trade as in De Paoli (2009a). With nominal price rigidities in invoicing currencies, a higher share of RMB-invoiced imports strengthens the SOE's incentive to peg more closely to the RMB in order to better stabilize its terms of trade.

Our paper contributes to four strands of literature. First, we contribute to the literature on the international monetary system and dominant currencies. While the existing literature primarily focuses on the implications of the dominant currency paradigm (Gopinath et al., 2020) and the endogenous emergence of international currencies in trade invoicing, financial asset denomination, and foreign reserve holdings (Gopinath and Stein, 2021; Gopinath, Kim and Stein, 2022; Mukhin, 2022; Coppola, Krishnamurthy and Xu, 2023; Bahaj and Reis, 2022a), we instead focus on the choice of anchor currencies.

Second, we add to the literature on central bank swap lines. Recent studies find that US swap lines have been highly effective in providing dollar liquidity, reducing CIP deviations and exchange rate volatility, and stabilizing financial markets during periods of stress (Bahaj and Reis, 2022a; Goldberg and Ravazzolo, 2022; Kekre and Lenel, 2025). Studies on RMB swap lines find that countries with access to RMB swap lines are better insulated from RMB liquidity shocks and that these facilities help strengthen the RMB as an invoicing or settlement currency (Bahaj and Reis, 2026; Jiao et al., 2024; Benguria and Novy, 2025). Unlike the Federal Reserve's swap lines, which serve as a global liquidity backstop, China's swap lines are more targeted, often directed toward indebted BRI countries (Horn et al., 2023). Our paper contributes to the literature by providing a new perspective on RMB swap lines, examining how they shape exchange rate anchoring in small open economies.

Third, we contribute to the literature on RMB internationalization. China has pursued a distinctive policy-driven path to currency internationalization, actively promoting RMB use through deliberate measures. One strand of research examines whether policies such as RMB swap lines can effectively jumpstart an international currency. For example, Bahaj and Reis (2026) find that swap lines reduce the tail risk of RMB borrowing costs, thereby encouraging firms to invoice and finance in RMB and significantly increasing a country's use of RMB for payments in both bilateral trade with China and third-party trade. A broader literature investigates whether a renminbi bloc is emerging in Asia—whether other currencies

peg to or shadow the RMB—and concludes that the RMB has thus far gained only modest influence (Subramanian and Kessler, 2013; Kawai and Pontines, 2016). Our paper seeks to bridge these two strands of the literature on RMB internationalization by examining how RMB swap lines shape exchange rate anchoring in small open economies and the underlying channels through which this occurs.

Fourth, we contribute to the literature on optimal exchange rate policy in New Keynesian open-economy (NKOE) models by incorporating heterogeneous currency invoicing and terms-of-trade externalities into a three-country setting. While previous studies (e.g., Devereux and Engel, 2003; Engel, 2011; De Paoli, 2009b; Gopinath et al., 2020; Zhang, 2022; Georgiadis and Schumann, 2021; Itskhoki and Mukhin, 2023) have examined the implications of local, producer, and dominant currency pricing for optimal monetary policy and real exchange rate stabilization, they primarily focus on two-country setups or static exposure to foreign currency risk. We extend this framework to a three-country environment—comprising a small open economy, China, and the United States—and introduce access to RMB swap lines as an exogenous increase in the share of imports invoiced in RMB, thereby reinforcing the RMB's role as an anchor for exchange rate stabilization.

The remainder of the paper is organized as follows. Section 2 describes the swap line and exchange rate data used in the analysis. Section 3 estimates RMB weights in the implicit currency basket of an economy, and Section 4 examines the impact of access to RMB swap lines on RMB weights. Section 5 provides additional empirical evidence on the effects of RMB swap lines on currency invoicing, and documents the positive correlation between RMB invoicing and RMB weights. Section 6 presents a theoretical model to rationalize our empirical findings, and Section 7 conducts quantitative analysis to shed light on how currency weighs respond to access to RMB swap lines. Section 8 concludes.

2 Data

Our empirical analysis draws on two main datasets. The first consists of daily spot exchange rate data, which we use to estimate the currency weights in each country's exchange rate policy basket. The second is a dataset of RMB swap lines, detailing the signing dates of

bilateral agreements with the PBoC, which we use to capture policy shocks. In addition, we assemble a set of control variables reflecting institutional, economic, and geopolitical factors that may affect countries' currency linkages with China.

2.1 Daily Spot Exchange Rate

Following Du, Tepper and Verdelhan (2018), the daily spot exchange rate data are primarily obtained from Bloomberg whenever available. For exchange rates not covered by Bloomberg, we supplement the dataset with Datastream.[7] The sample covers the period from August 1, 2005, to December 31, 2023.[8] A detailed summary of exchange rate sources is provided in the Appendix A.1.

In total, we collect 60 bilateral exchange rates against the US dollar. To ensure data consistency and reliability, we implement a systematic screening procedure to exclude currencies subject to structural distortions or institutional constraints that may confound the analysis of exchange rate dynamics. The construction of the final dataset proceeds in three steps.

First, we exclude currencies that serve as benchmark pegs or numeraires in international markets. These include the British Pound (GBP), Japanese Yen (JPY), Euro (EUR), and New Zealand Dollar (NZD).

Second, we exclude currencies that are part of a fixed peg or currency union. Specifically, we remove the Gulf Cooperation Council currencies (AED, BHD, KWD, QAR, SAR, OMR) as well as the Hong Kong Dollar (HKD) and the Jordanian Dinar (JOD), which are strictly pegged to the US dollar. We also exclude currencies in the European Exchange Rate Mechanism II (ERM II), including the Bulgarian Lev (BGN), Danish Krone (DKK), and Croatian Kuna (HRK). In addition, legacy EU currencies that were replaced by the euro (e.g., CYP, GRD, LVT, SIT, SKK) are dropped to maintain dataset consistency.

Third, we discard high-inflation or persistently depreciating currencies to mitigate noise from macroeconomic instability. We exclude currencies issued by economies whose annual

[7] We use the same tickers as in Du, Tepper and Verdelhan (2018) when downloading daily spot exchange rate data.

[8] China abandoned its US dollar peg on 21 July 2005 and shifted to a more flexible exchange-rate arrangement. Accordingly, we begin our sample after the peg's termination to ensure that China's exchange rate is not mechanically fixed during the period we study.

inflation exceeded 10 percent at any point during our sample period, including the Argentine Peso (ARS), Russian Ruble (RUB), Turkish Lira (TRY), Egyptian Pound (EGP), Ukrainian Hryvnia (UAH), and Zambian Kwacha (ZMW).

The final sample comprises 34 currencies. Among them, 18 currencies have active swap line agreements with the PBoC, while 16 currencies do not have access to the PBoC swap lines.

2.2 RMB Swap Lines

Swap line data are obtained from the Global Network of Liquidity Lines Database (Bahaj, Fuchs and Reis, 2024), which provides detailed information on swap agreements, including the signing (or renewal) date, currency denomination, and participating parties.[9]

Our analysis leverages detailed information on the signing dates of bilateral agreements between the PBoC and other central banks. Each signature date corresponds to one of three events: (i) *activation*, when two central banks establish a swap line for the first time; (ii) *renewal*, when a previous agreement is extended after expiring within the past month or superseded before its expiration; and (iii) *reactivation*, when an agreement is reinstated following a lapse of more than one month. Our final sample includes 18 countries that signed RMB swap lines with the PBoC. During our sample period, nearly all countries renewed their RMB swap line agreements with the PBoC, with the exceptions of Indonesia, Sri Lanka, and Morocco.

2.3 Other Factors Shaping Currency Linkages with China

We also assemble a set of control variables to capture institutional, economic, and geopolitical factors that may shape countries' currency linkages with China. Specifically, these variables include: (i) China's official outward investment in other countries, sourced from the China Global Investment Tracker; (ii) the presence of an RMB clearing bank, collected from the PBoC official website; (iii) membership in the Asian Infrastructure Investment Bank (AIIB);

[9]In practice, multiple swap lines may exist between the same pair of countries under different initiatives or in different currencies. Moreover, not all swap lines are reciprocal: some are multilateral in nature (e.g., CMI, NAFTA), while others are unilateral, such as the standing facilities offered by the Federal Reserve to its partner central banks.

(iv) the existence of a bilateral trade agreement with China, sourced from the WTO Regional Trade Agreement Database; (v) the existence of a USD swap line with China under the CMI framework, as reported in Bahaj, Fuchs and Reis (2024); and (vi) the volume of imports from China, sourced from the IMF International Trade in Goods database.

3 Estimating the RMB Weight in Currency Baskets

We begin by econometrically estimating the implicit currency basket of an economy and the corresponding weights of its components. Our approach follows the seminal framework of Frankel (1993), which estimates the relationship by regressing changes in the value of the local currency on changes in the values of major candidate currencies for the anchor role, such as the US dollar, the euro, and others. This method has been further developed in subsequent studies, including Frankel and Wei (1994), Frankel and Xie (2010), and McCauley and Shu (2018).

For our purposes, we aim to estimate the weight of the RMB in a country's implicit currency basket, which in turn allows us to assess how the establishment of a swap line affects the RMB share in the country's exchange rate basket. A key econometric challenge is the high collinearity between movements in the RMB and the US dollar, which complicates the inclusion of RMB movements as a regressor in the Frankel–Wei regression (Frankel and Wei, 1994). To address this issue, we adopt the two-step approach proposed by Kawai and Pontines (2016).

In the first step, we remove the component of RMB movements that is explained by movements in major international currencies—namely, the US dollar (USD), euro (EUR), Japanese yen (JPY), and British pound (GBP)—by estimating the following first-stage regression within a 260-day window, obtaining the residuals.

$$\Delta \log\left(e_t^{RMB}\right) = \varphi_0 + \varphi_1 \Delta \log\left(e_t^{\text{USD}}\right) + \varphi_2 \Delta \log\left(e_t^{\text{EUR}}\right) + \varphi_3 \Delta \log\left(e_t^{\text{JPY}}\right) + \varphi_4 \Delta \log\left(e_t^{\text{GBP}}\right) + \omega_t, \tag{1}$$

where $\Delta \log\left(e_t^k\right)$, with $k \in \{\text{USD}, \text{EUR}, \text{JPY}, \text{GBP}, \text{RMB}\}$, denotes the logarithmic change in

the exchange rate of currency k against the New Zealand dollar (NZD). The NZD is chosen as the numeraire for two main reasons. First, New Zealand maintains no capital controls and operates a fully free-floating exchange rate regime. Second, the NZD is not an anchor currency for most countries,[10] which makes its movements largely independent of other major currencies. As a robustness check, we also use the Australian Dollar (AUD) as an alternative numeraire in Section 4.2 and our findings remain robust. For the RMB, we use the onshore exchange rate (CNY) in our baseline estimation, as the offshore exchange rate (CNH) is available only from October 2010 onward.[11]

Equation (1) can be interpreted as revealing the weights assigned by the Chinese authorities to major international currencies in constructing their own exchange rate basket. Once the residuals from equation (1) are obtained, we include them on the right-hand side of the Frankel–Wei specification as a proxy for the actual RMB movements in the second step for each currency, as follows,

$$\begin{aligned}\Delta \log (e_{it}) =& \gamma_0 + \gamma_1 \Delta \log \left(e_t^{\text{USD}}\right) + \gamma_2 \Delta \log \left(e_t^{\text{EUR}}\right) + \gamma_3 \Delta \log \left(e_t^{\text{JPY}}\right) + \gamma_4 \Delta \log \left(e_t^{\text{GBP}}\right) \\ &+ \gamma_5 \hat{\omega}_t + \nu_{it} \end{aligned} \tag{2}$$

where $\gamma_1, \gamma_2, \gamma_3$, and γ_4 denote the weights of the USD, EUR, JPY, and GBP, respectively, in the exchange rate basket of currency i, while γ_5 denotes the weight of the RMB. Following Kawai and Pontines (2016), we impose the restriction that the coefficients of the explanatory variables sum to one, $\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 + \gamma_5 = 1$, which makes the second stage a restricted OLS regression. In practice, we estimate the implied RMB weight γ_5 through the following reparameterization.

[10] The NZD is generally regarded as having little importance in the implicit currency baskets of developing economies.

[11] To address the concern that the offshore rate may better reflect market-determined pricing prior to China's exchange rate reform, we conduct a robustness check using the CNH rate in Section 4.2.

$$\Delta \log (e_{it}) - \widehat{\omega}_t = \gamma_0 + \gamma_1 \left[\Delta \log \left(e_t^{\text{USD}}\right) - \widehat{\omega}_t\right] + \gamma_2 \left[\Delta \log \left(e_t^{\text{EUR}}\right) - \widehat{\omega}_t\right] + \gamma_3 \left[\Delta \log \left(e_t^{\text{JPY}}\right) - \widehat{\omega}_t\right] + \gamma_4 \left[\Delta \log \left(e_t^{\text{GBP}}\right) - \widehat{\omega}_t\right] + \nu_{it} \quad (3)$$

Equation 3 is estimated at a daily frequency over the sample period from August 1, 2005, to August 18, 2024. To capture changes in the RMB's role within a country's currency basket, we implement a rolling regression with a 260-day window, which approximately corresponds to the number of business days in a calendar year.[12] Alternatively, we use 130-day and 390-day rolling windows as robustness checks. The results remain robust under these alternative specifications, as presented in Online Appendix Section B.5.

Notably, in the absence of the linear constraint on currency basket weights, $\sum_i^5 \phi_i = 1$, the Frisch-Waugh-Lovell (FWL) theorem for multivariate linear regression ensures that a one-step ordinary least squares (OLS) estimation can directly yield unbiased estimates by purging synchronized exchange rate fluctuations arising from the RMB's peg to other currencies. However, the presence of this linear constraint invalidates the applicability of the FWL theorem, as it no longer guarantees that the partial regression coefficients from the one-step procedure unbiasedly reflect the RMB's exchange rate weight. Furthermore, given the high degree of linear correlation between the RMB and USD exchange rates, the one-step estimation would also lead to biased standard errors. Consequently, decomposing the estimation into a two-step procedure is necessary to generate statistically accurate results.

To account for serial correlation in daily exchange rates and thus in the estimated RMB weights within each country's currency basket, we aggregate the daily RMB weight estimates to the monthly level by taking their simple average within each calendar month. Our subsequent analysis focuses on monthly RMB weights within each country's currency basket.

[12] Following An, Kim and Park (2024), the estimation of the RMB weight is based on a 260-day rolling window, which reflects the approximate number of trading days in a year.

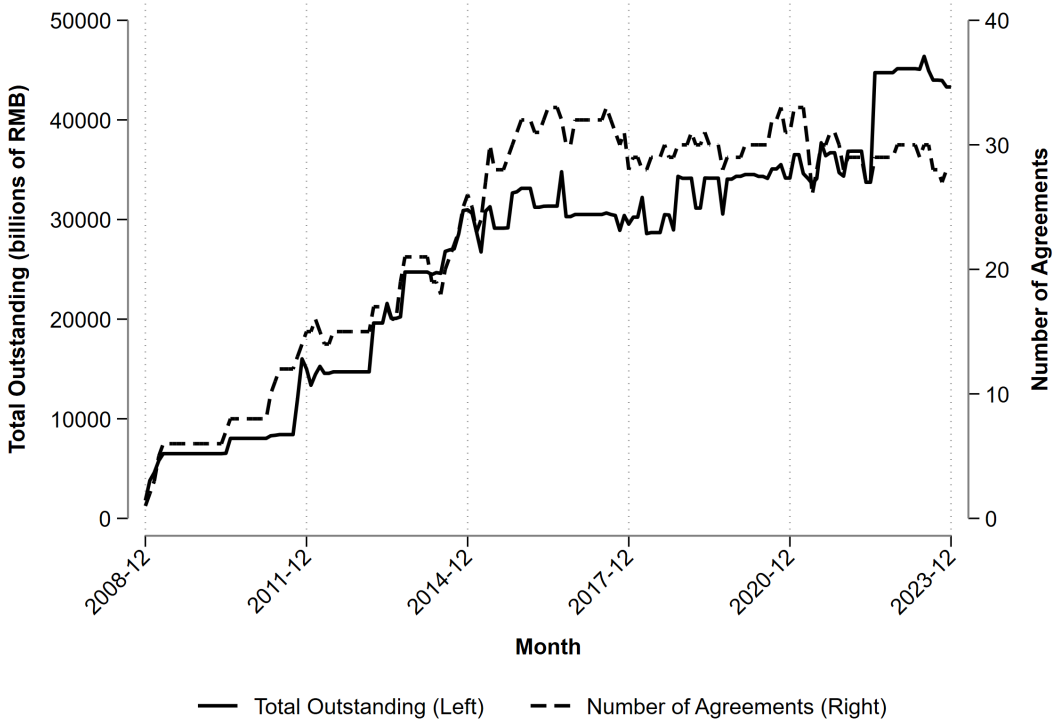
4 The Impact of RMB Swap Lines on RMB Weights

Beginning in 2008, the People's Bank of China (PBoC) started signing currency swap agreements with foreign central banks. Figure 1 illustrates the historical expansion of the RMB swap line network, tracking both the total outstanding amount (solid line, left axis) and the number of active agreements (dashed line, right axis) from 2008 to 2023. The first bilateral RMB swap line agreement was signed with the Bank of Korea in December 2008. The expansion of the RMB swap line network accelerated markedly thereafter, especially between 2013 and 2020. By the end of 2023, the PBoC had signed a total of 41 RMB swap line agreements with foreign central banks, 29 of which were still active. The rapid expansion of RMB swap lines appears to have been driven primarily by the PBoC's strategic objective of promoting RMB internationalization and reducing the dominance of the dollar-centric global financial system, rather than by pre-existing market demand for RMB liquidity arising from deeper trade integration with China or widespread RMB use in cross-border transactions. In many cases, swap line agreements were established with countries where RMB invoicing and settlement activity had previously remained limited.

Since their inception, bilateral RMB swap line agreements have become a central component of China's strategy to promote the international use of the RMB. Beyond facilitating trade settlement, these swap lines are widely viewed as backstop liquidity facilities for offshore RMB markets, helping provide liquidity support and stabilize offshore RMB trading. Unlike the U.S. dollar swap lines established during the global financial crisis, which were primarily designed as emergency liquidity facilities, China's RMB swap lines serve a broader and more structural purpose. They form part of a long-term strategy to integrate the RMB and China's financial system more deeply into global financial markets. In this sense, the RMB swap line network reflects China's broader vision for expanding its role in the international monetary system (Lin, Zhan and Cheung, 2016).

The typical RMB swap line agreement sets out a renewable 3-year period during which the foreign central bank can choose to activate the line (Bahaj, Fuchs and Reis, 2024). While many agreements historically remained largely undrawn, recent evidence suggests that several emerging-market economies have actively drawn on RMB swap facilities during periods of

Figure 1: Expansion of RMB Swap Lines



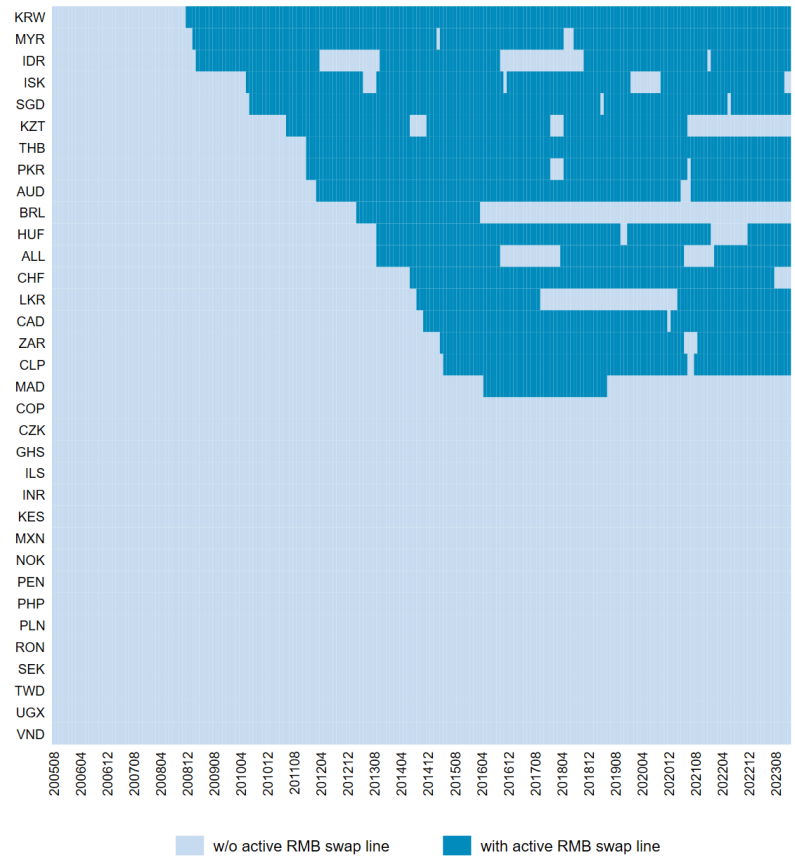
Notes: The figure plots the total maximum drawing limit of RMB swap lines (solid line, left axis) and number of active RMB swap line agreements (dashed line, right axis) signed by the PBoC with foreign central banks from the signing of the first RMB swap line in December 2008 through December 2023.

external stress and dollar funding shortages (Horn et al., 2023). More broadly, even when not formally activated, the availability of swap lines may still support RMB internationalization by alleviating concerns about future RMB liquidity and encouraging firms and financial institutions to invoice and settle trade in RMB.

Figure 2 illustrates the timelines of active bilateral Chinese RMB swap line agreements between the PBoC and other central banks in our sample. In total, our sample covers 34 countries over the period from August 2005 to December 2023, of which 16 never signed swap line agreements with China and 18 did. Among the latter, 2 countries renewed their agreements either before or immediately upon expiration, while 16 renewed them after a lapse. On average, the renewal gap was modest, with the longest reaching 15 months. Only 3 countries had not renewed their swap lines by the end of the sample period, with lapses

exceeding 15 months.

Figure 2: Status of RMB Swap Lines



Notes: This figure shows the status of RMB swap lines for the 34 currencies in our sample from August 2005 to December 2023 with light blue indicating periods without an active RMB swap line and dark blue indicating periods with an active swap line.

4.1 Empirical Strategy

To evaluate the impact of initiating an RMB swap line on the RMB weight in recipient countries' implicit currency baskets, we account for two key features of the swap lines. First, swap lines are initiated at different times across countries. Second, most countries renew their swap line agreements upon expiration. Accordingly, we adopt a staggered difference-in-differences design with absorbing treatment: countries receive treatment at different points in time, and once a country obtains a swap line, it is considered treated in all subsequent

periods.[13] Our main empirical specification is

$$y_{it} = \alpha_i + \nu_t + \sum \beta^h \mathbf{1}\left(\text{months since swap line activation}_{it} = h\right) + \mathbf{X}_{it}\boldsymbol{\gamma} + e_{it}, \tag{4}$$

where $h = -12, \ldots, -1, 0, 1, \ldots, 24$. The estimation examines the effect of RMB swap lines over a 36-month window, covering the 12 months preceding and the 24 months following their initial establishment. α_i and ν_t are country and time fixed effects. The dependent variable y_{it} measures the RMB weight within country i's policy currency basket at time period t. The indicator $\mathbf{1}\left(\text{months since swap line activation}_{it} = h\right)$ equals one in period t if the number of months since country i first activated an RMB swap line is exactly h, and zero otherwise. The parameter of interest, β^h, traces the dynamic response of RMB weights to swap line initiation. X_{it} denotes a set of country-time specific control variables capturing institutional, economic, and geopolitical factors that may affect currency linkages or comovements. Specifically, following Bahaj and Reis (2026), we include: (i) share of China's official investment in country i's GDP, capturing capital flows that may directly promote RMB usage in cross-border transactions;[14] (ii) a binary indicator for the presence of an *RMB clearing bank* in country i, reflecting institutional infrastructure that can facilitate RMB-denominated settlements; (iii) a dummy for membership in the *Asian Infrastructure Investment Bank* as a proxy for alignment with China-led financial initiatives; and (iv) a binary indicator for the existence of a *bilateral trade agreement* between China and country i, accounting for trade-driven demand for RMB liquidity. Additionally, to address potential confounding from pre-existing financial linkages, we include an additional control indicating whether the PBoC has established *USD swap lines* with country i under the Chiang Mai Initiative framework. This allows us to isolate the incremental impact of RMB swap lines, recognizing that countries with prior USD swap arrangements may exhibit systematically different trajectories in currency market behavior. Lastly, given that high import dependence on China may si-

[13] We implement a pseudo-absorbing treatment framework, defining treatment as the first instance a country gains access to an RMB swap line. This reflects the assumption that initiating a swap line can induce structural and persistent changes in liquidity, risk-sharing, or market integration. As a robustness check, Section 4.2 excludes the five currencies whose swap lines were either not renewed or renewed only after a prolonged lapse (KZT, MAD, RSD, IDR, and LKR); the results remain robust.

[14] China's official investment in country i is measured as the ratio of China's investment in country i to that country's GDP.

multaneously increase the likelihood of establishing RMB swap lines (Koosakul, 2024) and also drive the comovement in the exchange rates of swap line-linked currencies in foreign exchange markets (Jiang and Richmond, 2023), we control for the share of imports from China in country i's total imports to mitigate the potential important confounding factor.

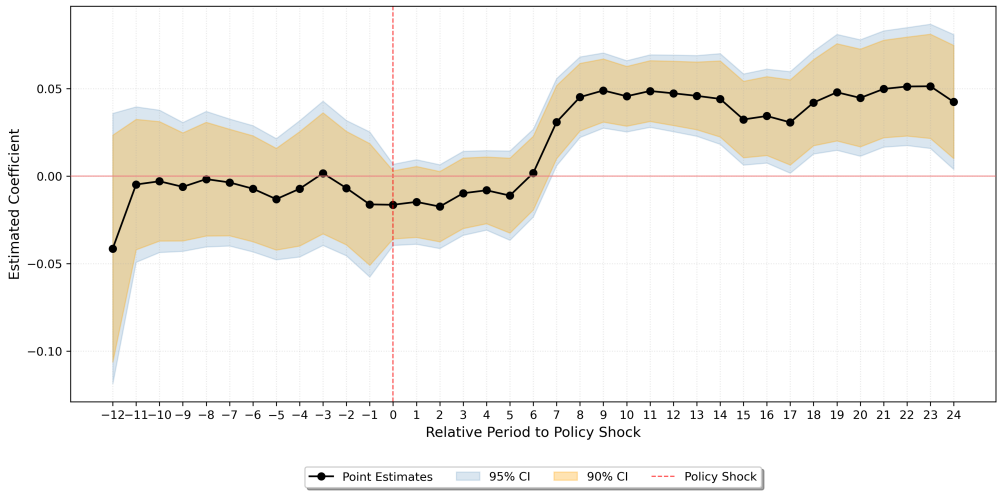
It is now well recognized that OLS estimation of a two-way fixed effects (TWFE) model like equation 4 can produce biased estimates when treatment occurs at different times across units (De Chaisemartin and d'Haultfoeuille, 2020; Callaway and SantAnna, 2021; Borusyak, Jaravel and Spiess, 2024). As more units become treated, there are fewer untreated observations available for comparison, causing the TWFE estimator to rely heavily on comparisons that use previously treated units as controls. In addition, if treatment effects grow with exposure length, this time-varying heterogeneity can create apparent but spurious violations of the parallel-trends assumption that DiD models require for causal interpretation (Sun and Abraham, 2021).

Several bias-robust estimators have been developed to address the limitations of TWFE under staggered treatment timing. In our baseline analysis, we employ the estimator proposed by Borusyak, Jaravel and Spiess (2024), which belongs to the class of imputation-based approaches. Imputation methods follow a two-step logic: in the first step, they recover the unit and time components of untreated outcomes using only never-treated or not-yet-treated observations; in the second step, they estimate the treatment effect using residualized outcomes that have been purged of unit- and time-invariant variation. This procedure is attractive for its transparency and computational simplicity. Although bias-robust estimators can yield meaningful differences relative to a naive and generally invalid TWFE regression, our findings remain stable across alternative estimators including the local-projection difference-in-differences estimator of Dube et al. (2023) and the double-robust inverse-probability weighting estimator of Callaway and SantAnna (2021) as shown in the robustness checks in Section 4.2.

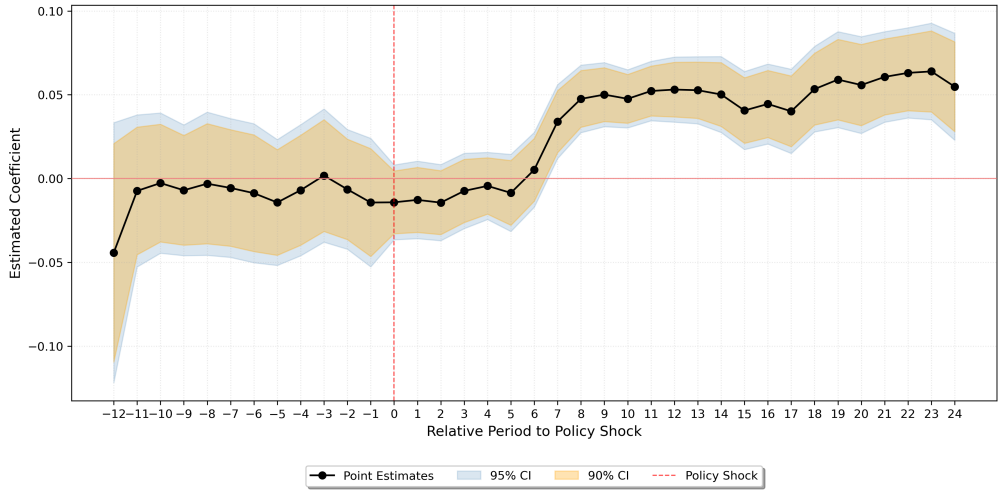
Figure 3 presents the estimated dynamic effects of RMB swap lines on the RMB weights in countries' currency baskets following the establishment of a swap line with the PBoC. Panel (a) reports estimates without controls, while Panel (b) shows results including the full set of controls. Confidence intervals are set at the 95% level. The results indicate no evidence

Figure 3: The Impact of RMB Swap Lines On RMB Weights in Currency Baskets

(a) no controls



(b) with controls



Notes: This figure reports the estimated impact of establishing an RMB swap line on the RMB's weight in the implicit currency basket at horizons $h = -12, \ldots, 24$ months. The blue shaded area denotes the 95% confidence interval, and the light orange shaded area denotes the 90% confidence interval.

of a pre-trend in RMB basket weights prior to swap line establishment, suggesting that the timing of swap line agreements is not driven by pre-existing increases in RMB anchoring.[15] After a swap line is established, however, the RMB weight rises by approximately 5% around nine months after signing and remains elevated thereafter. The dynamic response suggests that RMB swap lines have a lasting effect on the role of the renminbi in partner countries' exchange rate arrangements rather than merely generating short-lived fluctuations.

This magnitude is economically meaningful in the context of the international monetary system, where exchange rate anchoring patterns are typically highly persistent and heavily dominated by the US dollar. Changes in implicit basket weights are generally gradual and infrequent, reflecting deep-rooted invoicing practices, financial linkages, reserve compositions, and policy credibility accumulated over decades. Against this backdrop, a 5 percentage point increase in RMB weight over less than a year represents a substantial shift in the currency orientation of partner economies. To put the magnitude into perspective, prior to the launch of the first RMB swap line in 2008, the US dollar accounted for an average implicit exchange rate weight of 57 percent across the countries in our sample, while the implied RMB weight was close to zero for most economies. The post-swap-line increase therefore reflects the emergence of the RMB as a non-negligible component of exchange rate stabilization policies in a number of partner countries.

4.2 Robustness Checks

In this section, we conduct a series of robustness checks to assess the stability of our empirical findings. First, we consider alternative estimators for our staggered difference-in-differences design under the absorbing-treatment framework to verify that the results are not sensitive to the choice of estimator. Second, we explore alternative definitions of the control group to test whether our estimates depend on specific criteria for classifying treated and untreated units. Third, we replace the onshore RMB exchange rate with the offshore rate to ensure that our estimated RMB weights are not driven by the choice of exchange-rate measure. Fourth, we change the numeraire currency from NZD to AUD to confirm that our results are robust to

[15] For the pre-trend tests, we follow Borusyak, Jaravel and Spiess (2024) and define the reference group as all observations with $t < -12$.

the selection of base currency. Finally, we vary the width of the rolling window, using both wider and narrower windows, to examine whether the estimated RMB weights are sensitive to the time-series smoothing procedure.

4.2.1 Alternative Estimator

To address treatment-effect heterogeneity, our baseline estimation employs the imputation estimator proposed by Borusyak, Jaravel and Spiess (2024). As robustness checks, we also estimate the effect of gaining access to RMB swap lines on RMB basket weights using two alternative approaches: (i) the local-projection difference-in-differences estimator of Dube et al. (2023), and (ii) the double-robust inverse-probability weighting estimator of Callaway and SantAnna (2021). The results are reported in Appendix Section B.1. Our findings are robust across these alternative estimators.

4.2.2 Alternative Treatment Group

In our baseline estimation, we adopt a pseudo-absorbing treatment framework, defining treatment as the first instance a country obtains access to an RMB swap line. This approach rests on the assumption that initiating such a swap line can induce structural and persistent changes in liquidity, risk-sharing, or market integration. To address potential concerns arising from the temporary or discontinuous nature of certain swap arrangements, we conduct a robustness check by excluding currencies whose swap lines were either not renewed or were renewed only after a substantial gap. Specifically, we remove KZT, MAD, RSD, IDR, and LKR from the sample. Appendix Figure B.3 reports the estimated effects after excluding these five currencies.

4.2.3 Alternative RMB exchange rate

China's capital controls in the foreign exchange market have resulted in a dual exchange rate regime, characterized by the coexistence of onshore and offshore RMB rates. Although the deviation between onshore and offshore rates narrowed following the RMB exchange rate reform on August 18, 2015, significant differences in currency basket weight performance persist, and the relative weight rankings reversed notably after the reform (McCauley and

Shu, 2018). To examine the sensitivity of our results to the choice of exchange rate, we replace the onshore RMB rate with the offshore rate. As shown in Appendix Figure B.4, the estimated effects remain robust to alternative RMB exchange rate measure.

4.2.4 Alternative Numeraire Currency

In our baseline estimates of RMB weights, we use the New Zealand dollar as the numeraire currency. As a robustness check, we replace it with the Australian dollar, given that Australia imposes no capital controls, operates a fully free-floating exchange rate regime, and the Australian dollar is not an anchor currency for most countries—making its movements largely independent of other major currencies. This allows us to verify that our RMB weight estimates are not sensitive to the choice of numeraire currency. Appendix Figure B.5 presents the dynamic effects of RMB swap lines on RMB weights when using the Australian dollar as the numeraire currency. The results are robust to this alternative numeraire, showing that signing an RMB swap line increases the RMB weight in the partner countries' currency baskets.

4.2.5 Alternative Rolling Window

When estimating RMB weights, we use a 260-day rolling window as the benchmark, reflecting the approximate number of trading days in a calendar year. To assess robustness, we also consider shorter and longer windows, specifically 130-day and 390-day periods. The corresponding results are presented in Appendix Figure B.6.

5 RMB Swap Lines, Currency Weights and RMB Invoicing

The empirical results in Section 4 suggest that access to an RMB swap line increases the RMB weight in partner countries' currency baskets. This finding can be explained by a "jumpstarting effect" of RMB swap lines, whereby swap lines increase the RMB's share in bilateral trade invoicing. In this section, we provide two pieces of empirical evidence on

the relationship among access to RMB swap lines, RMB invoicing in bilateral trade, and the RMB's weight in currency baskets, highlighting the role of invoicing in this relationship. First, using invoicing shares from Boz et al. (2025) and swap line signing dates, we show that access to an RMB swap line, and hence RMB liquidity, raises the share of bilateral trade invoiced in RMB. Second, we document a positive correlation between RMB weights in the trading partners' exchange rate baskets and RMB invoicing shares.

First, we show that access to an RMB swap line raises the share of bilateral trade invoiced in RMB. To examine the impact of access to RMB swap line on RMB invoicing shares, we combine country-level invoicing share data from Boz et al. (2025) with data on RMB swap line signing dates. While the country-level data report RMB invoicing as a share of each country's total exports (or imports), our empirical analysis requires constructing a bilateral measure of RMB invoicing in trade with China.[16] To do so, we adopt a simplifying assumption that all RMB invoicing recorded at the country level occurs exclusively in trade with China. This assumption is reasonable, as the use of RMB in transactions not involving China remained limited over our sample period. Additionally, we make two adjustments to ensure consistency with the sample used in our empirical analysis in Section 4. First, we exclude large open economies whose currencies serve as major invoicing currencies or are widely used as anchor currencies, including euro area economies, the United States, Japan, and the United Kingdom. Second, we trim observations above the 99th percentile to remove extreme values, given that RMB invoicing shares can be exceptionally high in some cases due to idiosyncratic geopolitical events or strong trade linkages. For example, Russia's post-2022 surge in RMB invoicing reflects a sharp increase in RMB-denominated oil trade, while Mongolia exhibits persistently elevated RMB usage due to its close economic ties with China.

We adopt the same empirical strategy as in Section 4, with the empirical specification given by:

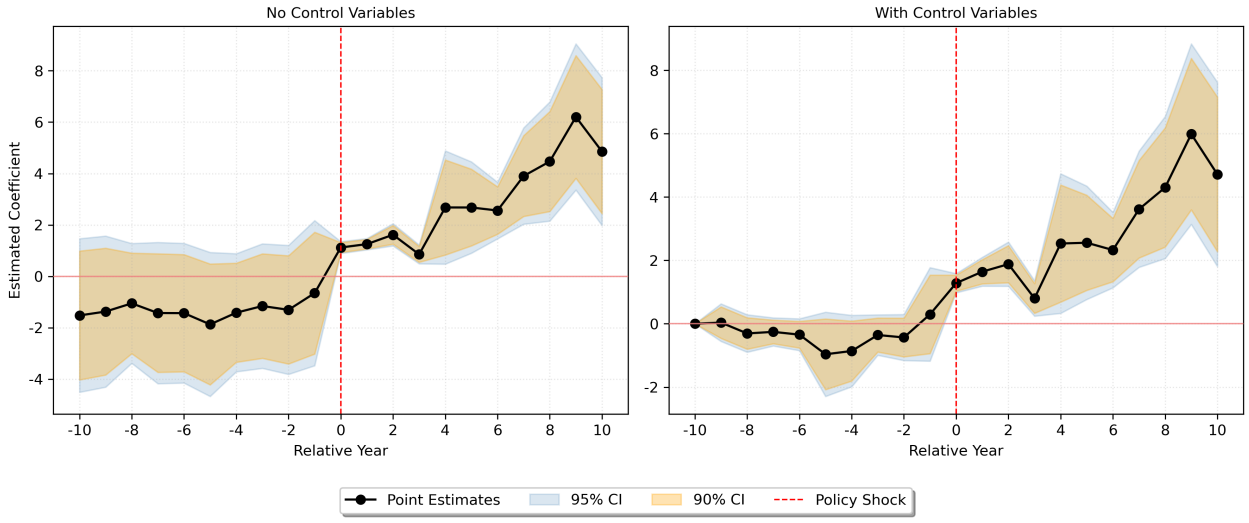
$$y_{it} = \alpha_i + \nu_t + \sum \beta^h \mathbf{1}\left(\text{years since swap line activation}_{it} = h\right) + \mathbf{X}_{it}\boldsymbol{\gamma} + e_{it}, \tag{5}$$

[16] Our empirical analysis below uses the aggregate RMB invoicing share in bilateral trade between China and country i, defined as the sum of RMB invoicing in exports to and imports from country i, divided by total exports and imports with country i.

where $h = -10, \ldots, -1, 0, 1, \ldots, 10$. α_i and ν_t are country and time fixed effects. The dependent variable y_{it} measures RMB invoicing share in the bilateral trade between country i and China. The indicator $\mathbb{1}$ (years since swap line activation$_{it} = h$) equals one in period t if the number of years since country i first activated an RMB swap line is exactly h, and zero otherwise. The parameter of interest, β^h, traces the dynamic response of RMB invoicing share in bilateral trade to swap line initiation. X_{it} denotes country-time-specific controls capturing institutional, economic, and geopolitical factors affecting currency comovements. We include the same controls as in Equation (4), except the dummy indicating whether the People's Bank of China has established USD swap lines with country i under the Chiang Mai Initiative, as it exhibits no variation in our sample. As discussed in Section 4, the recent literature has noted that there might be a bias if the treatment effect is heterogeneous across time, we use the imputation methodology from Borusyak, Jaravel and Spiess (2024), clustering standard errors at the country level and averaging treatment effects by cohort.

As shown in Figure 4, the signing of an RMB swap line significantly increases the RMB invoicing share by up to around 5.7%. The jumpstarting effect is consistent with existing findings in the literature.

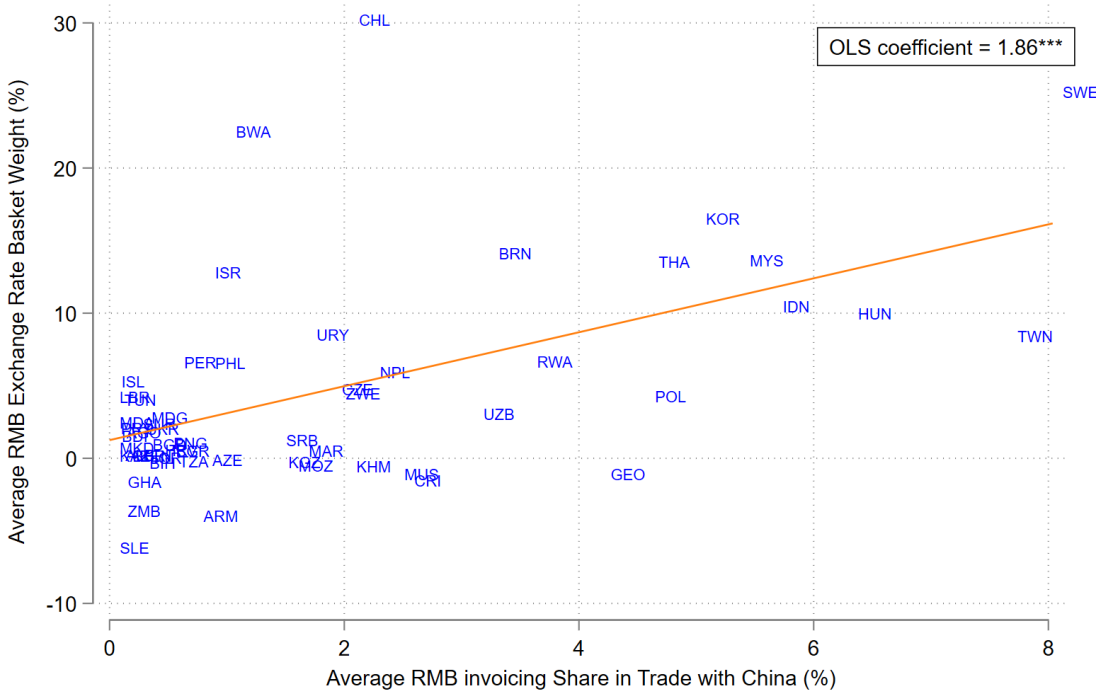
Figure 4: The Effect of RMB Swap Line on RMB Invoicing Shares in Bilateral Trade



Notes: This figure reports the estimated impact of establishing an RMB swap line on the RMB invoicing shares in bilateral trade with China at horizons $h = -10, \ldots, 10$ years. The blue shaded area denotes the 95% confidence interval, and the light orange shaded area denotes the 90% confidence interval.

Second, we document that RMB weights in exchange-rate baskets are positively correlated with RMB invoicing shares, both across countries and over time. Across countries, there is a clear positive correlation between the RMB weight in a partner country's currency basket and its RMB invoicing share, as shown in Figure 5.[17] This positive correlation holds despite the distribution of invoicing shares is heavily right-skewed, with many countries recording zero RMB invoicing.

Figure 5: RMB Invoicing Share and RMB Basket Weight



Notes: The figure plots the average RMB basket weight against average RMB invoicing shares in total trade for each country over the sample period 2012-2024. Each dot represents a country, with its RMB invoicing share on the x-axis and the corresponding RMB weight in its implicit currency basket on the y-axis. *** indicates $p < 0.01$.

Along the time dimension, we use data on the RMB's share in international payments from the SWIFT RMB Tracker and correlate it with RMB weights in exchange-rate baskets over the sample period from August 2012 to December 2024. While Boz et al. (2025) measure RMB invoicing shares in trade, the SWIFT RMB Tracker reports the RMB's aggregate share

[17] The country-level RMB invoicing shares are from Boz et al. (2025), and the RMB weights in exchange-rate baskets are from the estimates in Section 3. Both measures are averaged over the sample period 2012-2024.

in international payments based on SWIFT messages, including both customer-initiated and institutional payments.

To obtain a time series of RMB weights, we average RMB weights across countries, constructing measures at both monthly and quarterly frequencies. Table 1 reports the correlation between RMB invoicing shares and the average RMB weights at these frequencies, after controlling for the RMB's effective exchange rate. A 10% increase in the RMB invoicing share is associated with increases of about 1.1% and 2.4% in the RMB basket weight at the monthly and quarterly frequencies, respectively.

Table 1: RMB Invoicing Share and RMB Exchange Rate Basket Weight

	Monthly RMB Weight	Quarterly RMB Weight
RMB Invoicing Share (Lagged)	0.105*	0.239*
	(0.059)	(0.120)
RMB Effective FX Index (Lagged)	-0.200***	-0.243*
	(0.062)	(0.127)
Observations	135	45

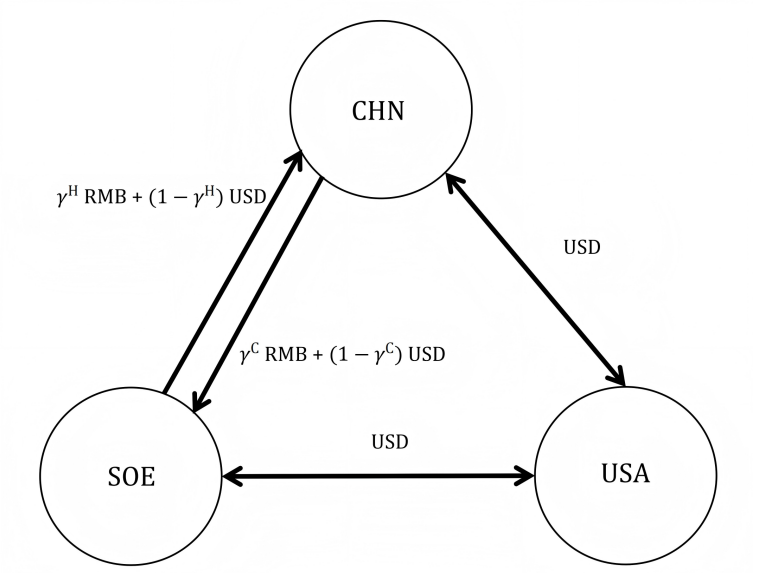
Notes: The table reports the correlation between RMB invoicing shares and the average RMB weights at these frequencies, after controlling for the RMB's effective exchange rate. Monthly (quarterly) RMB weights are the average RMB weights in trading partners' currency baskets in each month (quarter). Robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Model

In Section 4, we find that access to an RMB swap line increases the RMB weight in partner countries' currency baskets, and in Section 5, we further show that it raises the share of bilateral trade invoiced in RMB and is positively associated with RMB weights in exchange rate baskets. In this section, we develop a quantitative model to account for these empirical findings. We model swap lines as operating through their effect on RMB invoicing, which provides a microfoundation for how swap lines translate into higher RMB weights in currency baskets and motivates the analysis of an optimal exchange rate policy rule responding to invoicing shares.

Extending the three-country DSGE model with exogenous invoicing share based on Geor-

Figure 6: Currency Invoicing Paradigm



Notes: Trade between the SOE and the United States, as well as between China and the United States, is assumed to be invoiced exclusively in the dominant currency (USD). In contrast, trade between the SOE and China features asymmetric currency invoicing: a fraction γ^C of imports from China and a fraction γ^H of exports to China are invoiced in RMB.

giadis and Schumann (2021) and approximate swap line recipient country as a small open economy following De Paoli (2009a,b), we construct a three-country model consisting of a small open economy (SOE), China, and the United States. In this setup, the SOE represents the swap line recipient, China serves as the RMB swap line provider, and the United States acts as the dominant-currency issuer. Trade between the SOE and the United States, as well as between China and the United States, is assumed to be invoiced exclusively in the dominant currency (USD). In contrast, trade between the SOE and China can be invoiced in either USD or RMB.

For bilateral trade between SOE and China, we allow for asymmetric currency invoicing: a fraction γ^C of the SOE's imports from China and a fraction γ^H of the SOE's exports to China are invoiced in RMB. These fractions are treated as exogenous parameters rather than being endogenously determined within the model. Figure 6 presents a schematic representation of the model's bilateral currency-invoicing structure.

6.1 Households

Home country consists of a continuum of households with total mass n, where $n < 1$. China and the US together account for the remaining mass $1 - n$. At equilibrium, we will take the limit $n \to 0$ so that the home country is infinitesimally small and behaves as a small open economy. Within this group, China represents a share α, and the US accounts for the remaining $1-\alpha$. Households' preferences over consumption and labor supply are represented by a constant relative risk aversion (CRRA) utility function.

$$U(C_t^j, N_t^j) = \frac{\left(C_t^j\right)^{1-\rho}}{1-\rho} - \kappa \frac{\left(N_t^j\right)^{1+\eta}}{1+\eta} \tag{6}$$

where $j \in \{H, C, D\}$ indexes the country. H denotes the SOE, C China, and D the US. C_t^j and N_t^j denote household consumption and labor supply, respectively.

Households have access to both domestic and international bond markets. US households trade USD-denominated bonds in both domestic and international markets, while households in the SOE and China trade local-currency-denominated bonds in domestic markets and USD-denominated bonds in international markets. Households' bond holdings are denoted as follows: B_{t-1}^j denotes holdings of local-currency-denominated bonds in country $j \in \{H, C, D\}$, while $B_{D,t-1}^j$ denotes holdings of USD-denominated bonds in the international market by households in country j. [18]

In equilibrium, the net supply of domestic bonds in both the SOE and China is zero.[19] In addition, firms' monopolistic profits are rebated to households. The resulting budget constraints faced by SOE, China and USA are given by,

$$P_t^j C_t^j + (1 + r_{t-1}^j) B_{t-1}^j + E_{jD,t}(1 + r_{t-1}^{jD}) B_{D,t-1}^j = B_t^j + E_{jD,t} B_{D,t}^j + W_t^j N_t^H + P_t^j \Gamma_t^j. \tag{7}$$

where P_t^j and W_t^j denote the price index for final consumption and the wage rate in country j, respectively, both denominated in local currency. $P_t^j \Gamma_t^j$ denotes firms' profits rebated to

[18] For notational simplicity, we set $B_{D,t}^D = 0$, so that the budget constraint for the United States reduces to $P_t^D C_t^D + (1 + r_{t-1}^D) B_{t-1}^D = B_t^D + W_t^D N_t^D + P_t^D \Gamma_t^D$.

[19] Alternatively, in Appendix Figure F.9, we extend the framework to allow for complete financial markets. This modification does not alter the model's key qualitative predictions.

households in country j, denominated in local currency.

E_{jDt}, for $j \in \{H, C, D\}$, denotes the nominal exchange rate of the currency issued by country j against the USD. r^j_{t-1}, for $j \in \{H, C, D\}$, denotes the interest rate on domestic-currency-denominated bonds in country j. Households in the SOE and China that borrow in USD face effective interest rates r^{HD}_{t-1} and r^{CD}_{t-1}.

To ensure the stationarity of net foreign assets, we introduce an external debt-elastic interest rate premium following Schmitt-Grohé and Uribe (2003). Under this mechanism, the effective interest rate for each country is defined as a premium over the US rate that increases with the country's real debt holdings. The effective interest rate is specified as follows,

$$r^{HD}_t = r^D_t + \psi^H \exp\left(\left(b^h_{d,t} - \bar{b}^h_d\right) - 1\right) + \eta^{H,UIP}_t \tag{8}$$

$$r^{CD}_t = r^D_t + \psi^C \exp\left(\left(b^c_{d,t} - \bar{b}^c_d\right) - 1\right) + \eta^{C,UIP}_t \tag{9}$$

where $\psi^H, \psi^C > 0$ are the elasticities of the interest rate premium with respect to external dollar-denominated debt positions, and $b^h_{d,t} \equiv B^H_{D,t}/P^D_t$ and $b^c_{d,t} \equiv B^C_{D,t}/P^D_t$ denote the real holdings of USD-denominated bonds by the households in SOE and China. $\bar{b}^h_{d,t}$ and $\bar{b}^c_d$ denote steady state values. $\eta^{H,UIP}_t(\eta^{C,UIP}_t)$ stands for the foreign interest rate premium shock or UIP shock.

Given that the US interest rate r^D_t serves as the benchmark risk-free rate, the relevant interest rate for the United States is the domestic interest rate set by US monetary policy, to be discussed in Section 6.4.

Households' Problem Households in SOE, China and USA choose labor supply N^i_t, consumption C^i_t, domestic bonds B^i_t, and USD-denominated bonds $B^i_{D,t}$ to maximize their discounted utility in Equation (6), subject to budget constraint in Equation (7), respectively.

6.2 Final Consumption Good Producers in the SOE

We now introduce the consumption good producers. To avoid lengthy and repetitive descriptions for each country, we provide detailed exposition for the SOE, while relegating the

specifics for China and the US to the Online Appendix Section C.

Final consumption good producers in the SOE combine the domestically produced bundle ($Y_{H,t}^H$) with imported bundles $Y_{C,t}^H$ from China and $Y_{D,t}^H$ from the US to form the final consumption good bundle using the following CES technology:

$$Y_t^H = \left[(\nu_H^H)^{\frac{1}{\theta}} (Y_{H,t}^H)^{\frac{\theta-1}{\theta}} + (\nu_C^H)^{\frac{1}{\theta}} (Y_{C,t}^H)^{\frac{\theta-1}{\theta}} + (\nu_D^H)^{\frac{1}{\theta}} \left(Y_{D,t}^H\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{10}$$

where ν_H^H captures the home bias of the SOE in consumption, and the weights satisfy $\nu_H^H + \nu_C^H + \nu_D^H = 1$. Following De Paoli (2009a), we model the SOE as a small open economy by setting the home bias parameters as follows,

$$\nu_H^H = 1 - (1 - n)\lambda \tag{11}$$

where λ captures the degree of trade openness.

Final consumption good producers operate under perfect competition. Accordingly, the demand for input bundle from country $j \in \{H, C, D\}$ is given by:

$$Y_{j,t}^H = \nu_j^H \left(\frac{P_{j,t}^H}{P_t^H} \right)^{-\theta} Y_t^H \tag{12}$$

where $P_{j,t}^H$ denotes the price index of the input bundle from country j, denominated in the SOE currency. The aggregate consumer price index in country H is given by a CES aggregator over the price indices of goods sourced from H, C, and D:

$$P_t^H = \left(\nu_H^H \left(P_{H,t}^H\right)^{1-\theta} + \nu_C^H \left(P_{C,t}^H\right)^{1-\theta} + \nu_D^H \left(P_{D,t}^H\right)^{1-\theta} \right)^{\frac{1}{1-\theta}}. \tag{13}$$

6.3 Domestic and Imported Input Bundles in the SOE

The domestic input bundle $Y_{H,t}^H$ and imported input bundles ($Y_{C,t}^H$ from China and $Y_{D,t}^H$ from the US) are aggregations of differentiated goods $y_{j,t}^H(i)$ from each origin $j \in \{H, C, D\}$,

$$Y_{H,t}^H = \left(\left(\frac{1}{n} \right)^{\frac{1}{\sigma}} \int_0^n y_{H,t}^H(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{14}$$

$$Y_{C,t}^H = \left(\left(\frac{1}{\alpha(1-n)} \right)^{\frac{1}{\sigma}} \int_n^{n+\alpha(1-n)} y_{C,t}^H(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{15}$$

$$Y_{D,t}^H = \left(\left(\frac{1}{(1-\alpha)(1-n)} \right)^{\frac{1}{\sigma}} \int_{n+\alpha(1-n)}^1 y_{D,t}^H(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{16}$$

where σ denotes the elasticity of substitution between differentiated intermediate goods and is allowed to vary over time to capture the markup shocks.

In addition, input bundles from China can be invoiced in either USD or RMB. We assume that the SOE imports from China, with a fraction $1-\gamma^C$ invoiced in the dominant currency (USD) and a fraction γ^C invoiced in RMB. Accordingly, the SOE's imported bundle from China in Equation (16) can be rewritten as a combination of RMB-invoiced and USD-invoiced input bundles,[20]

$$Y_{C,t}^H = \left[\left(\gamma^C\right)^{\frac{1}{\sigma}} \left(\hat{Y}_{C,t}^H\right)^{\frac{\sigma-1}{\sigma}} + \left(1-\gamma^C\right)^{\frac{1}{\sigma}} \left(\tilde{Y}_{C,t}^H\right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{17}$$

where imported input bundles from China invoiced in RMB and USD are defined as follows:

$$\hat{Y}_{C,t}^H = \left(\left(\frac{1}{\gamma^C \alpha(1-n)} \right)^{\frac{1}{\sigma}} \int_n^{n+\gamma^C\alpha(1-n)} y_{C,t}^H(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{18}$$

$$\tilde{Y}_{C,t}^H = \left(\left(\frac{1}{(1-\gamma^C)\alpha(1-n)} \right)^{\frac{1}{\sigma}} \int_{n+\gamma^C\alpha(1-n)}^{n+\alpha(1-n)} y_{C,t}^H(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}. \tag{19}$$

[20] For simplicity, goods invoiced in RMB are denoted with a hat, while those invoiced in USD are denoted with a tilde.

Therefore, the aggregate price index of SOE imports from China can be expressed as:

$$P_{C,t}^{H} = \left(\gamma^{C}\left(E_{HC,t}\hat{P}_{C,t}^{H}\right)^{1-\sigma} + (1-\gamma^{C})\left(E_{HD,t}\tilde{P}_{C,t}^{H}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \tag{20}$$

where $\tilde{P}_{C,t}^{H}$ denotes the USD-denominated price for imports from China and $\hat{P}_{C,t}^{H}$ denotes the RMB-denominated price for imports from China.

Each differentiated good i is produced using a constant-returns-to-scale technology with labor as the sole input:

$$y_t^j(i) = A_t^j n_t^j(i), \tag{21}$$

where $j \in \{H, C, D\}$. The marginal cost of production depends on domestic wages, and firms are price takers in the labor market. Wages adjust flexibly each period. As a result, marginal costs evolve in line with local labor market conditions,

$$mc_t^j = \frac{\partial w_t^j n_t^j}{\partial Y_t^j} = \frac{w_t^j}{A_t^j}. \tag{22}$$

Producers of differentiated goods face price rigidities when setting prices in both domestic and foreign markets. Given constant marginal costs, pricing decisions across the two markets are independent and can therefore be analyzed separately. Following Calvo (1983), in each period firms keep their prices unchanged with probability θ_p, while with probability $1-\theta_p$ they are allowed to reset prices.

The domestic firms' optimal pricing problem in the SOE's domestic market is given by:

$$\max_{p_{H,t}^{H}(i)} \ \mathbb{E}_t\left\{\sum_{s=0}^{\infty}(\theta_p\beta)^s \frac{\Lambda_{t+s}^{H}}{P_{t+s}^{H}}\left[p_{H,t}^{H}(i)y_{H,t+s}^{H}(i) - mc_t^{H}y_{H,t+s}^{H}(i)\right]\right\}, \tag{23}$$

where Λ_{t+s}^{H} represents the marginal utility of consumption for households in the SOE at time $t+s$.

Correspondingly, the producer currency pricing for Chinese exporters is specified as,

$$\max_{p_{Ct}^{H}(i)} \ \mathbb{E}_t\left\{\sum_{s=0}^{\infty}(\theta_p\beta)^s \frac{\Lambda_{t+s}^{C}}{P_{t+s}^{C}}\left[p_{C,t}^{H}(i)y_{C,t+s}^{H}(i) - mc_t^{C}y_{C,t+s}^{H}(i)\right]\right\}, \tag{24}$$

where $p_{C,t}^{H}(i) = \hat{p}_{C,t}^{H}(i)$ if the differentiated good is invoiced in RMB. The pricing problems

of exporters using USD, as well as those of US exporters, are analogous and are omitted for brevity.

The formal description of consumption aggregation and differentiated goods producers in the US and China is provided in the Online Appendix Section C to avoid repetition. Their problems are similar to, but often simpler than, those of the SOE, reflecting simpler currency invoicing decisions. Both Chinese and US imports are assumed to be invoiced in US dollars, as we consider the limiting case in which home-country's mass n approaches zero.

6.4 Monetary Policy

The monetary policy of the SOE is assumed to take the form of an exchange rate policy pegged to a basket of currencies: USD and RMB. We follow the specification of Shi and Xu (2008) and Xu (2011):

$$\left(\frac{E_{HC,t}}{\bar{E}_{HC}}\right)^{\xi}\left(\frac{E_{HD,t}}{\bar{E}_{HD}}\right)^{(1-\xi)}=1 \tag{25}$$

where $E_{HC,t}$ denotes the nominal exchange rate of SOE currency vis-à-vis RMB and $\bar{E}_{HC}$ denotes its steady state level. ξ is the RMB weight parameter optimally chosen by the SOE.[21]

When solving for the optimal monetary (exchange rate) policy of the SOE, we consider each value of $\gamma \in [0,1]$, the share of RMB invoicing in bilateral trade between China and the SOE, jointly determined by the import and export invoicing shares γ^C and γ^H. For each γ, we solve for the optimal RMB weight $\xi \in [0,1]$ that maximizes the second-order approximation of SOE welfare. This procedure yields a policy mapping between the share of RMB invoicing and the optimal RMB weight, $\xi = f(\gamma)$. If this function is increasing in γ, it suggests that the theoretical predictions are consistent with our empirical findings and that the empirical results can be interpreted as the monetary authority's optimal response to changes in the share of bilateral trade invoiced in RMB.

For the monetary policies of China and the United States, Miranda-Agrippino, Nenova and Rey (2026) show that the PBoC places greater emphasis on the output gap than on the inflation gap, in contrast to the U.S. Federal Reserve. In addition, the PBoC assigns a

[21] Rewriting Equation (25) using a base currency N yields: $\Delta \ln E_{HN,t} = \xi \Delta \ln E_{CN,t} + (1-\xi)\Delta \ln E_{DN,t}$. This expression parallels Equation (2) when the New Zealand dollar is used as the base currency, with ξ corresponding to the RMB weight.

positive weight to exchange rate movements to keep the exchange rate within a relatively narrow band. As a result, China's Taylor rule includes an exchange rate target, unlike that of the US. To ensure consistently with the data and the literature, we assume the following Taylor rules:

$$\text{CHN: } \frac{1+r_t^C}{1+\bar{r}^C} = \left(\frac{1+r_{t-1}^C}{1+\bar{r}^C}\right)^{\rho_{R,C}} \left[\left(\frac{Y_t^C}{\bar{Y}^C}\right)^{\rho_{Y,C}} \left(\frac{1+\Pi_t^C}{1+\bar{\Pi}^C}\right)^{\rho_{\pi,C}} \left(\frac{E_{CD,t}}{\bar{E}_{CD}}\right)^{\rho_S}\right]^{1-\rho_{R,C}} \exp(\eta_t^{C,MP}) \tag{26}$$

$$\text{USA: } \frac{1+r_t^D}{1+\bar{r}^D} = \left(\frac{1+r_{t-1}^D}{1+\bar{r}^D}\right)^{\rho_{R,D}} \left[\left(\frac{Y_t^D}{\bar{Y}^D}\right)^{\rho_{Y,D}} \left(\frac{1+\Pi_t^D}{1+\bar{\Pi}^D}\right)^{\rho_{\pi,D}}\right]^{1-\rho_{R,D}} \exp(\eta_t^{D,MP}) \tag{27}$$

where r^j denotes the interest rate on home bond and $\bar{r}^j$ denotes its steady state. Y^j and $\bar{Y}^j$ denote the aggregate output and associated steady state. Π^j and $\bar{\Pi}^j$ denotes the CPI inflation and its steady-state level, respectively. CPI inflation refers to inflation in the final consumption price index P^j in the model. $\eta^{j,MP}$ are the monetary policy shocks follows the AR(1) process.

$$\eta_t^{j,MP} = \rho^{j,MP}\eta_{t-1}^{j,MP} + \epsilon_t^{j,MP}. \tag{28}$$

7 Quantitative Analysis

In this section, we conduct a quantitative analysis to shed light on the optimal exchange rate policy and how currency weights respond to access to RMB swap lines. The analysis proceeds in three steps. Section 7.1 outlines the calibration strategy for key parameters and shocks. Section 7.2 characterizes the relationship between RMB invoicing shares and the optimal RMB weight, highlighting the channel through which swap line access affects currency basket weights. Section 7.3 examines the robustness of the results through a series of sensitivity analyses.

7.1 Calibration

The calibration adopts standard parameter values in the macroeconomic literature. Table 2 reports the calibrated parameters, their values, and sources. Each model period corresponds to one quarter. Parameter α, the relative country size of China, is set to 0.5, implying that the United States also has a size of 0.5, while the SOE is infinitesimally small. This symmetric assumption for USA and China, together with the infinitesimal size of the SOE, allows us to focus on the impact of the United States and China on the SOE.

The openness measure λ is calibrated to 0.4 following De Paoli (2009a). We set discount factor to $\beta = 0.99$, implying an annual steady-state real interest rate of approximately 4%. The intra-temporal elasticity of substitution across consumption bundles from different origin (the trade elasticity) θ is set to 3 following De Paoli (2009b). The elasticity of substitution across differentiated goods σ is set to 6, implying a markup of 20%. The coefficient of relative risk aversion (ρ) and the inverse Frisch elasticity of labor supply (η) are both set to 2, following Georgiadis and Schumann (2021). The Calvo parameter is calibrated to 0.75, implying that prices are reset once every four quarters on average.

We consider a steady state around zero net foreign debt position.[22] The sensitivity of the foreign interest rate premium on USD bond positions, ψ_C and ψ_H, are calibrated to be 0.001, following Gopinath et al. (2020).

Monetary policy parameters, including interest rate inertia ρ_R, output gap response ρ_Y, inflation response ρ_π, and exchange rate response ρ_S, are calibrated as follows. For China, we calibrate monetary policy parameters using reduced-form Taylor rule estimates from Miranda-Agrippino, Nenova and Rey (2026), converting monthly estimates to quarterly frequency. For the United States, we adopt Bayesian estimates from Smets and Wouters (2007).

External shocks—arising from productivity, markups, interest rate premia and monetary policy—make exchange rate management a key stabilization tool in small open economies. The magnitude and volatility of these shocks vary across countries and, in turn, shape optimal currency basket weights in SOEs. We calibrate the volatilities of markup, UIP, and monetary

[22] Our main results are robust to alternative levels of foreign debt. We show the optimal response of RMB policy weight to RMB invoicing share under 10% foreign debt-to-GDP ratio in Online Appendix Section F Figure F.8.

policy shocks symmetrically for China and the United States. The standard deviation of the markup shock is set to 0.13 following Dong, Jiao and Wang (2024) and that of the UIP shock is calibrated to 0.01 following Gopinath et al. (2020). The standard deviation of the monetary policy shock is set to 0.0025 following Georgiadis and Schumann (2021), implying quarterly policy rate volatility of about 100 basis points (annualized).

For TFP shocks, we allow for asymmetric volatility across China and the United States to reflect differences between emerging and advanced economies. Assuming a constant-returns-to-scale production function with labor as the only input, TFP can be measured as GDP per capita. To calibrate the TFP volatility, we use quarterly GDP and population data constructed by Chen, Higgins and Zha (2024) for China, and the quarterly GDP and population data from FRED for the United States. We estimate a quadratic trend in log GDP per capita and use the standard deviation of the residuals as a measure of TFP volatility. The estimates imply quarterly standard deviations of approximately 2.1% for China and 1.3% for the United States. For the stylized small open economy, we set the standard deviation of TFP to 4.6%, following Dong, Jiao and Wang (2024).

To solve the model, one of the key moments we target is the import-to-export invoicing share ratio γ^C/γ^H. This approach allows us to trace the optimal exchange rate basket weight (ξ) across a continuum of RMB invoicing shares in imports (γ^C) in a comparative statics exercise, while keeping the asymmetry in SOE RMB trade invoicing between imports and exports as observed in the data.[23] The import-to-export invoicing share ratio is calibrated using cross-country trade invoicing data from Boz et al. (2025). We restrict the sample to the baseline estimation sample in Section 4 and compute, for each country, the average RMB invoicing shares for exports and imports over the sample period. We then take the median values across countries for import and export invoicing shares. The results indicate that import invoicing in RMB is about four times export invoicing for a typical small open economy. Accordingly, we set $\gamma^C/\gamma^H = 4$ in the quantitative analysis.

[23]Empirically, Bahaj and Reis (2022b) also document asymmetric changes in RMB use across imports and exports in response to access to RMB swap lines. In particular, access to a swap line leads to a larger increase in RMB use in imports than in exports.

Table 2: Calibration of Parameters

Parameters	Description	Sources	Values
α	relative country size of CHN	symmetric assumption	0.5
λ	openness measure	De Paoli (2009a)	0.4
β	discount factor	Gali and Monacelli (2005)	0.99
θ	trade elasticity	De Paoli (2009b)	3
σ	elasticity of substitution	Gali and Monacelli (2005)	6
ρ	relative risk aversion	Georgiadis and Schumann (2021)	2
η	inverse Frisch elasticity	Georgiadis and Schumann (2021)	2
θ_p	Calvo price adjustment probability	Gali and Monacelli (2005)	0.75
γ^C/γ^H	import-to-export invoicing share ratio	estimated from data	4
$\rho_{R,D}$	interest rate inertia (USA)	Georgiadis and Schumann (2021)	0.81
$\rho_{R,C}$	interest rate inertia (CHN)	Georgiadis and Schumann (2021)	0.87
$\rho_{Y,D}$	output gap response (USA)	Smets and Wouters (2007)	0.08
$\rho_{Y,C}$	output gap response (CHN)	Miranda-Agrippino, Nenova and Rey (2026)	0.53
$\rho_{\pi,D}$	inflation response (USA)	Smets and Wouters (2007)	2.04
$\rho_{\pi,C}$	inflation response (CHN)	Miranda-Agrippino, Nenova and Rey (2026)	0.20
ρ_S	exchange rate response (CHN)	Miranda-Agrippino, Nenova and Rey (2026)	0.28
ψ_C	EDEIR coefficient of (CHN)	Gopinath et al. (2020)	0.001
ψ_H	EDEIR coefficient of (SOE)	Gopinath et al. (2020)	0.001
$\bar{b}_d^h$	s.s. of foreign debt-gdp ratio (SOE)	Gopinath et al. (2020)	0
$\bar{b}_d^c$	s.s. of foreign debt-gdp ratio (CHN)	Gopinath et al. (2020)	0
ρ_A^H	persistence of TFP shock (SOE)	Georgiadis and Schumann (2021)	0.9
ρ_A^C	persistence of TFP shock (CHN)	Georgiadis and Schumann (2021)	0.9
ρ_A^D	persistence of TFP shock (USA)	Georgiadis and Schumann (2021)	0.9
ρ_σ^H	persistence of markup shock (SOE)	Dong, Jiao and Wang (2024)	0.9
ρ_σ^C	persistence of markup shock (CHN)	Dong, Jiao and Wang (2024)	0.9
ρ_σ^D	persistence of markup shock (USA)	Dong, Jiao and Wang (2024)	0.9
ρ_η^C	persistence of MP shock (CHN)	Georgiadis and Schumann (2021)	0.5
ρ_η^D	persistence of MP shock (USA)	Georgiadis and Schumann (2021)	0.5
$\rho^{H,UIP}$	persistence of UIP shock (SOE)	Georgiadis and Schumann (2021)	0.9
$\rho^{C,UIP}$	persistence of UIP shock (CHN)	Georgiadis and Schumann (2021)	0.9
$\sigma^{A,H}$	std dev of productivity shock (SOE)	Dong, Jiao and Wang (2024)	0.046
$\sigma^{A,C}$	std dev of productivity shock (CHN)	estimated from data	0.021
$\sigma^{A,D}$	std dev of productivity shock (USA)	estimated from data	0.013
$\sigma^{R,C}$	std dev of MP shock (CHN)	Georgiadis and Schumann (2021)	0.0025
$\sigma^{R,D}$	std dev of MP shock (USA)	Georgiadis and Schumann (2021)	0.0025
$\sigma^{\sigma,H}$	std dev of markup shock (SOE)	Dong, Jiao and Wang (2024)	0.13
$\sigma^{\sigma,C}$	std dev of markup shock (CHN)	Dong, Jiao and Wang (2024)	0.13
$\sigma^{\sigma,D}$	std dev of markup shock (USA)	Dong, Jiao and Wang (2024)	0.13
$\sigma^{UIP,H}$	std dev of UIP shock (SOE)	Georgiadis and Schumann (2021)	0.01
$\sigma^{UIP,C}$	std dev of UIP shock (CHN)	Georgiadis and Schumann (2021)	0.01

7.2 Optimal Weights in Currency Basket

We conduct a quantitative analysis to characterize the relationship between the RMB invoicing share (γ) and the optimal RMB weight (ξ) in the exchange rate policy of a small open economy. The model is solved using a second-order approximation around the deterministic steady state. We consider a symmetric, zero inflation steady state and solve numerically for steady-state consumption and the real exchange rate. Given the small open economy framework, shocks originating in the SOE have negligible impact on the endogenous variables of China and the United States.

To explore the relationship between RMB weights and RMB invoicing shares, we proceed in two steps. First, we solve for the optimal RMB weight in the SOE's exchange rate policy ξ, for different values of RMB invoicing share of imports from China γ^C. The optimal simple rule maximizes conditional SOE welfare evaluated at the steady state:

$$\mathcal{W}_t^H = U(\bar{C}^H, \bar{N}^H) + \beta \mathcal{W}_{t+1}^H. \tag{29}$$

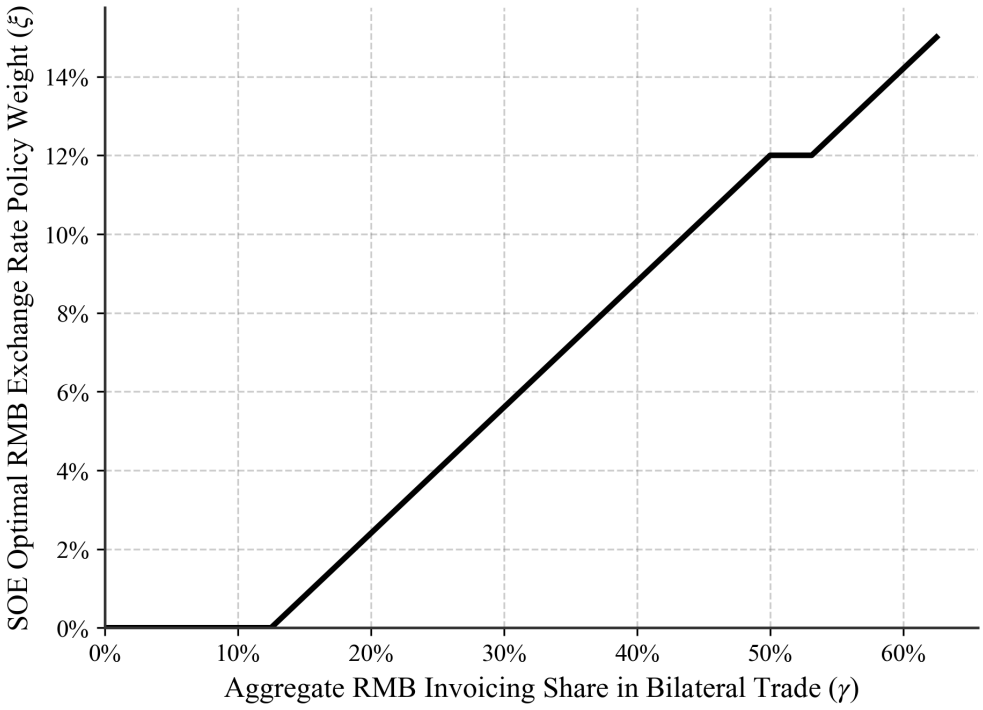
Second, given the calibrated import-to-export RMB invoicing share ratio γ^C/γ^H, each value of the import invoicing parameter γ^C implies a corresponding export invoicing share γ^H, yielding an aggregate measure of RMB invoicing in total bilateral trade. In the symmetric steady state, zero net foreign assets imply balanced trade between the SOE and China. Consequently, the aggregate RMB invoicing share γ is given by the arithmetic mean of the import and export shares: $\gamma = \frac{\gamma^C+\gamma^H}{2}$.[24] In Figure 7, we plot the optimal RMB basket weight (ξ) against this aggregate measure (γ), thereby aligning the model with the empirical measure of RMB exposure in Section 5.

As illustrated in Figure 7, the optimal RMB weight in the SOE's exchange rate policy responds positively to changes in the RMB invoicing share. On average, a 10% increase in the RMB invoicing share raises the RMB weight in the SOE's exchange rate basket by about 2.3%. This implies that an exogenous increase in the share of imports invoiced in RMB tend to raise the optimal weight placed on the RMB by the SOE's monetary authority. Notably,

[24]The proof of this steady-state trade balance and the derivation of the aggregate invoicing share are provided in Online Appendix E.1.

the relationship is nonlinear: the RMB does not enter the SOE's exchange rate basket until its invoicing share reaches approximately 12% of bilateral trade, suggesting a "jump-starting" effect. Consistent with this mechanism, our quarterly frequency empirical estimate as shown in Table 1 indicates that a 10% increase in the RMB invoicing share is associated with an increase of around 2.4% in the RMB basket weight, in line with the model's quantitative predictions.

Figure 7: Optimal RMB Weight in Response to RMB Invoicing Share (Incomplete Market)



Notes: This figure illustrates the quantitative relationship between the exogenous aggregate RMB invoicing share in bilateral trade γ (x-axis) and the optimal RMB exchange rate policy weight ξ (y-axis), where ξ maximizes household welfare.

In practice, the Chinese government has actively promoted the establishment of central bank swap lines as a key policy tool to support the internationalization of the RMB. These swap lines serve as a primary exogenous driver of higher RMB usage in trade invoicing. Therefore, the observed relationship between RMB swap line agreements and the increased RMB weight in the exchange rate baskets of recipient countries can be rationalized within the framework of our model.

The economic intuition for this result is that, in our model, the SOE has an incentive to

stabilize the real exchange rate, as in De Paoli (2009a,b), driven by terms-of-trade considerations. In our framework, "terms of trade" are defined as the relative price of imports to domestic sales:

$$\text{ToT}_t^{HC} = \frac{P_{c,t}^h}{P_{h,t}^h}. \tag{30}$$

Movements in the real exchange rate generate a wedge between the marginal utility of consumption and the disutility from labor supply. Shocks to monetary policy or productivity in China can spill over to the SOE through exchange rate adjustments, a mechanism we refer to as a terms-of-trade externality. Following Gopinath and Itskhoki (2022), the invoicing currency is a key determinant of exchange rate pass-through into import prices (P_{ct}^h). When γ^C is high, the bilateral terms of trade ToT_t^{HC} become endogenously sensitive to the nominal RMB exchange rate due to price stickiness in the invoicing currency. In this environment, the nominal exchange rate ceases to act as a pure shock absorber and instead propagates relative price distortions.

The second-order welfare approximation derived by De Paoli (2009a) shows that fluctuations in the terms-of-trade gap enter the social loss function as a quantitatively important source of welfare loss. A similar mechanism operates in our framework. The monetary authority therefore has a welfare-based incentive to increase its policy weight on the RMB (ξ) as the RMB invoicing share of imports rises, thereby internalizing the terms-of-trade externality. A higher value of ξ reduces nominal exchange rate volatility against the RMB and, in turn, stabilizes the terms of trade.

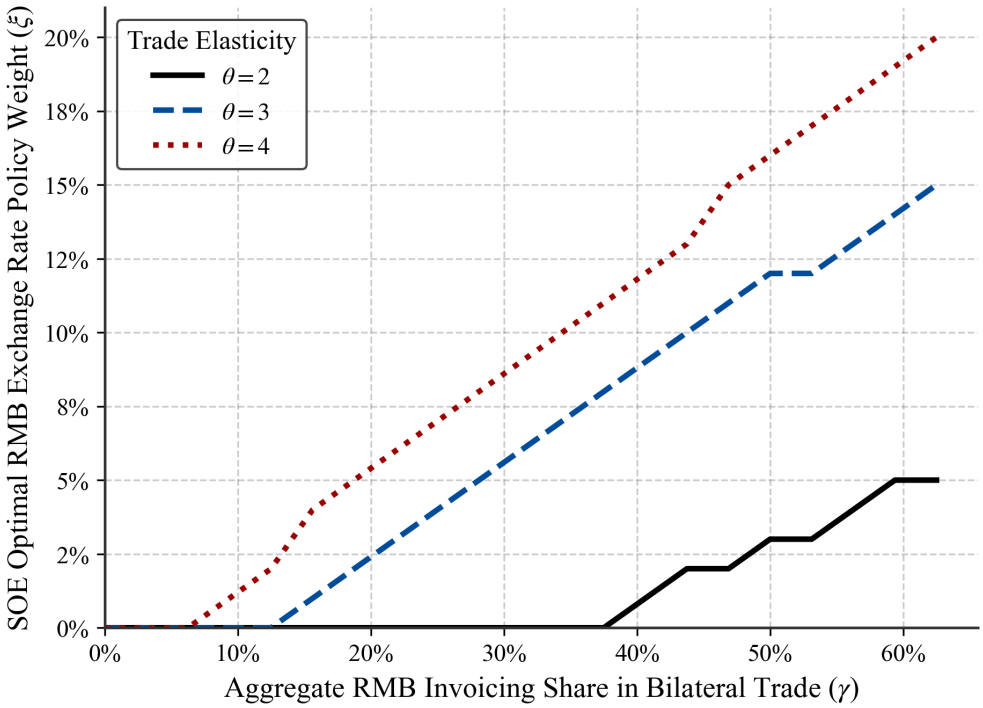
7.3 Sensitivity Analysis

We next examine how the results vary with different values of the intra-temporal elasticity, θ. A higher θ implies that domestic demand is more responsive to exchange rate movements. As a result, exchange rate fluctuations have a larger effect on the wedge between the marginal utility of consumption and the marginal disutility of production. This suggests that, holding the inter-temporal elasticity and the invoicing share constant, the optimal RMB basket weight responds more strongly to changes in the RMB invoicing share in order to stabilize the terms

of trade when intra-temporal elasticity increases.

Our findings are consistent with this theoretical prediction. Bajzik et al. (2020) show that existing estimates of the elasticity range from 2.5 to 5.1. Accordingly, we set $\theta = 3$ in our baseline specification and use 2 and 4 for robustness checks. As illustrated in Figure 8, an increase in RMB invoicing leads to a larger rise in the RMB weight when the intra-temporal elasticity θ is higher.

Figure 8: Optimal RMB Weight in Response to RMB Invoicing Share under Different Intra-temporal Elasticities



Notes: This figure illustrates the quantitative relationship between the exogenous aggregate RMB invoicing share in bilateral trade γ (x-axis) and the optimal RMB exchange rate policy weight ξ (y-axis), under different intra-temporal elasticity (trade elasticity).

8 Conclusion

Given the importance of anchor currency, this paper proposes that policies that aim to promote a currency as invoicing currency can also enhance its role as anchor currency. We examine how the People's Bank of China's bilateral swap lines reshape invoicing patterns

in international trade and, consequently, reconfigure the exchange rate policy calculus facing small open economies. On the empirical side, we find that access to RMB liquidity is associated with a substantial rise in the share of trade invoiced in RMB, accompanied by a simultaneous rebalancing of implied currency-basket weights. On the theoretical side, a three-country DSGE model demonstrates that greater RMB invoicing exposure amplifies the channel through which shocks originating in China transmit to the small open economy: import-price pass-through intensifies, terms-of-trade responses grow larger, and the welfare-maximizing weight assigned to the RMB within the domestic currency basket of the small open economy rises accordingly.

Our findings yield several policy implications. First, for recipient countries, access to foreign currency liquidity through swap lines may carry consequences that extend well beyond short-term liquidity insurance: by reshaping the currency composition of trade invoicing, these arrangements alter the degree to which domestic prices and real activity are exposed to foreign shocks. Second, for swap line providers, the endogenous shift in currency-anchoring weights may be negligible when the recipient economy is sufficiently small. Yet as recipient size grows, the increasing weight of the provider's currency in counterparties' currency baskets warrants attention, as it is likely to reinforce bilateral exchange rate co-movement and, in turn, reshape the patterns of bilateral trade and capital flows. Third, while this paper focuses on the impacts of invoicing currency on the anchor currency weights in exchange rate policy, it is also possible that anchor currency weights can affect firms' invoicing currency choice as well. A promising direction for future research is therefore to examine, within a unified framework, the joint determination of firms' invoicing choices and central banks' policy responses.

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Supplementary Online Appendix

From Invoicing to Anchoring: How RMB Swap Lines Shape Exchange Rate Anchoring in Small Open Economies

Rui Sun Ting Lan Yang Jiao

A Data

A.1 Exchange Rate Data

The table shows the data tickers in Bloomberg dataset.

A.2 Invoicing Data

We also provide the heterogeneous effect of swap line on invoicing share in both exports and imports.

Table A.2 reports the impact of access to RMB swap lines on the share of trade invoiced in RMB. Consistent with Bahaj and Reis (2026), our estimates indicate that access to an RMB swap line leads to a statistically significant increase in RMB invoicing shares. The effect is larger for import invoicing than for export invoicing.

Table A.1: Bloomberg Tickers

Currency ID	Currency Name	Bloomberg Ticker
ALL	Albanian lek	USDALL
AUD	Australian dollar	AUDUSD
CAD	Canadian dollar	USDCAD
CHF	Swiss franc	USDCHF
CLP	Chilean peso	USDCLP
CZK	Czech koruna	USDCZK
EUR	Euro	EURUSD
GBP	Pound sterling	GBPUSD
GHS	Ghanaian cedi	USDGHS
HUF	Hungarian forint	USDHUF
IDR	Indonesian rupiah	USDIDR
ILS	Israeli new shekel	USDILS
INR	Indian rupee	USDINR
ISK	Icelandic króna	USDISK
JPY	Japanese yen	USDJPY
KES	Kenyan shilling	USDKES
KRW	South Korean won	USDKRW
KZT	Kazakhstani tenge	USDKZT
LKR	Sri-Lankan rupee	USDLKR
MAD	Moroccan dirham	USDMAD
MXN	Mexican peso	USDMXN
MYR	Malaysian ringgit	USDMYR
NOK	Norwegian krone	USDNOK
NZD	New Zealand dollar	NZDUSD
PEN	Peruvian sol	USDPEN
PHP	Philippine peso	USDPHP
PKR	Pakistani rupee	USDPKR
PLN	Polish zoty	USDPLN
RON	Romanian leu	USDRON
RSD	Serbian dinar	USDRSD
SEK	Swedish krona	USDSEK
SGD	Singapore dollar	USDSGD
THB	Thai baht	USDTHB
TWD	New Taiwan dollar	USDTWD
UGX	Ugandan shilling	USDUGX
VND	Vietnamese ng	USDVND
ZAR	South African rand	USDZAR

Table A.2: Effect of RMB Swap Lines on RMB Invoicing Share

	(1) RMB Invoicing Share of Import	(2) RMB Invoicing Share of Export
RMB Swap Lines	0.7013*	0.5859**
	[0.3596]	[0.2828]
Observations	1231	1546
Adjusted R^2	0.635	0.485
Currency FE	✓	✓
Month FE	✓	✓
Mean Value of RMB Invoicing Share	0.71%	0.26%

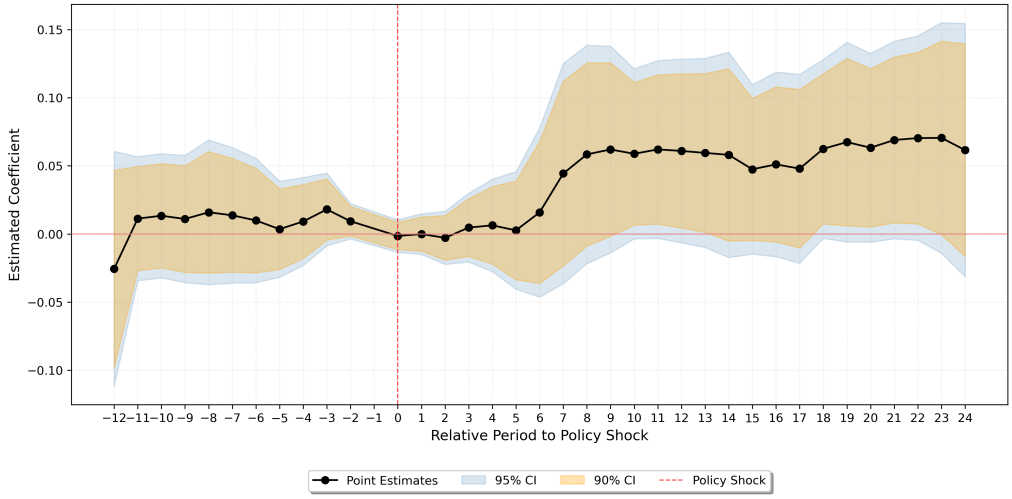
Note: Robust standard errors in brackets, clustered at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B Robustness Check

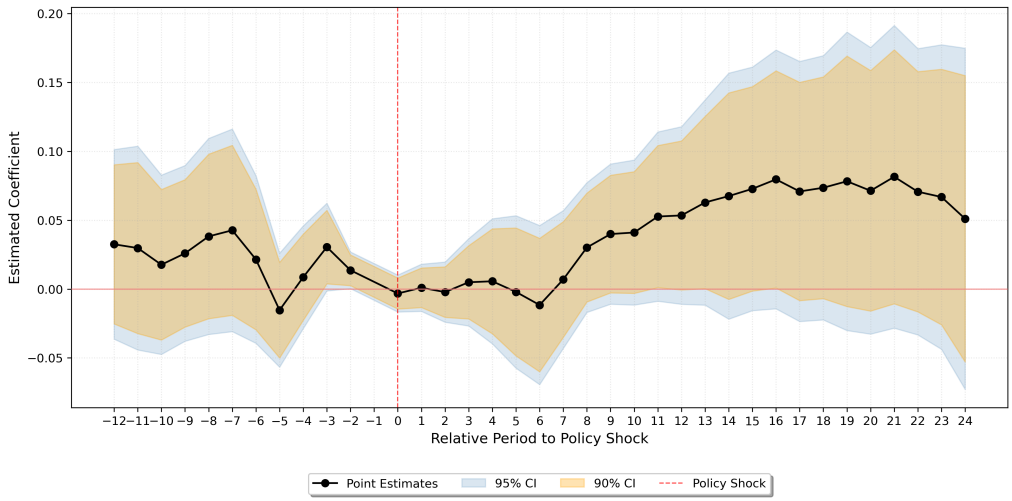
B.1 Alternative Estimator

Figure B.1: The Dynamic Effects of RMB Swap Lines: Double Robust Inverse Probability Weighting Estimator (Callaway and SantAnna, 2021)

(a) no controls



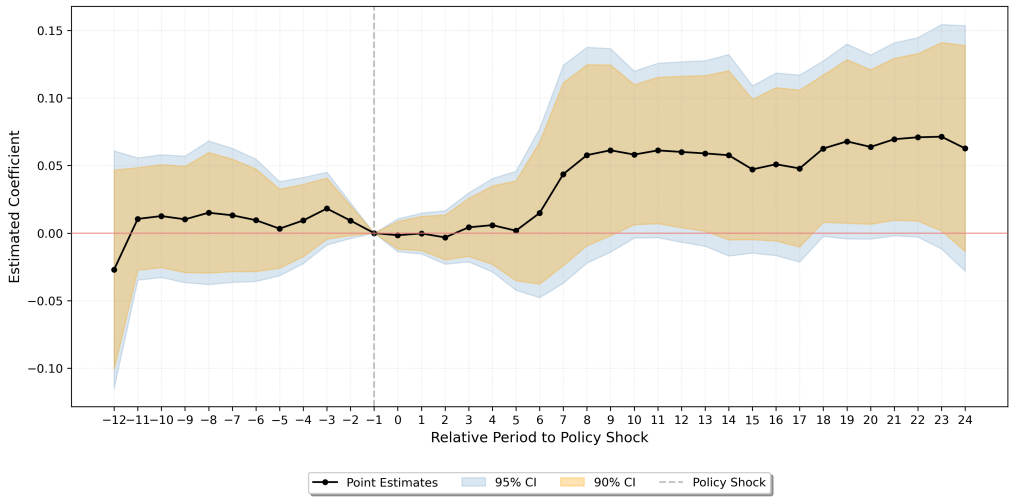
(b) with controls



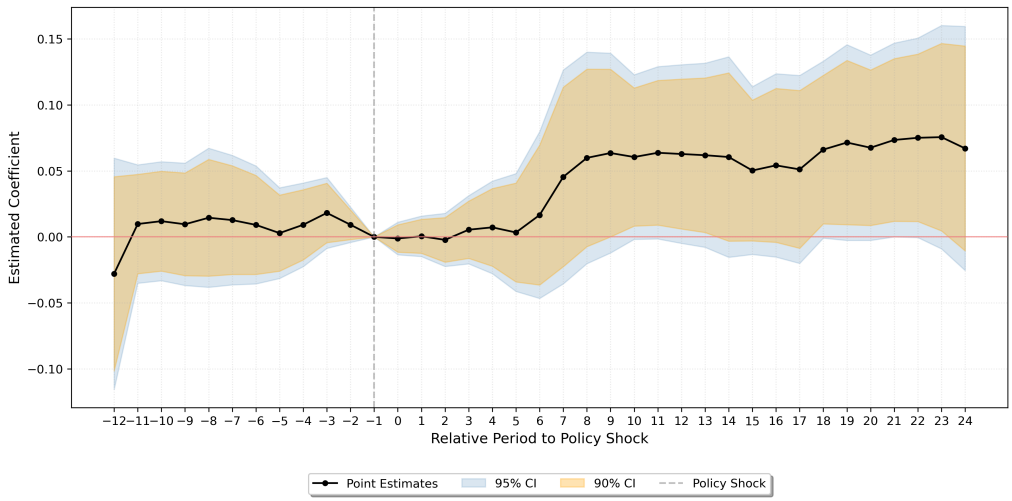
Note: This figure reports the estimated impact of establishing an RMB swap line on the RMB weight in the implicit currency basket at horizons, $h = -12, \ldots, 24$ months relative to the initiation of the swap line. The blue shaded area denotes the 95% confidence interval, while the light orange shaded area denotes the 90% confidence interval.

Figure B.2: The Dynamic Effects of RMB Swap Lines: Local Projection Difference-in-Difference Estimator (Dube et al., 2023)

(a) no controls



(b) with controls

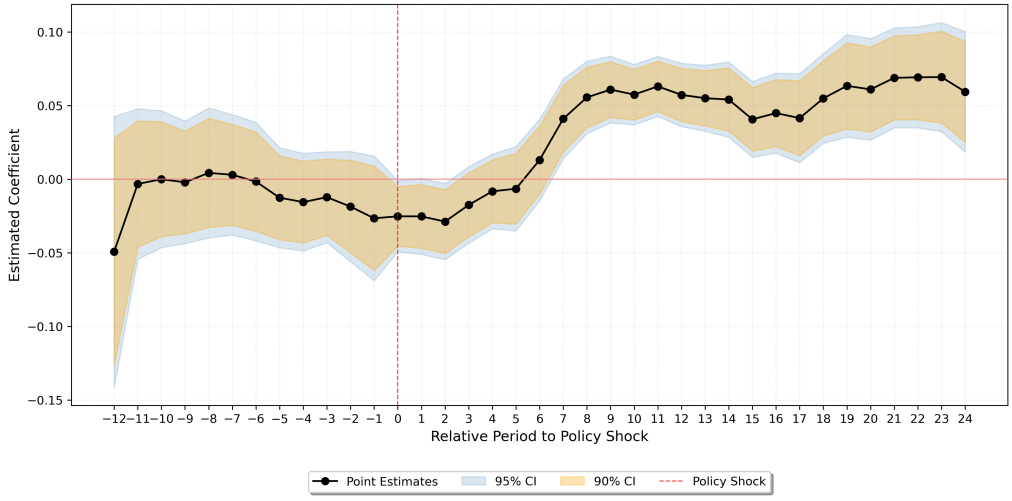


Note: This figure reports the estimated impact of establishing an RMB swap line on the RMB weight in the implicit currency basket at horizons, $h = -12, \ldots, 24$ months relative to the initiation of the swap line. The blue shaded area denotes the 95% confidence interval, while the light orange shaded area denotes the 90% confidence interval.

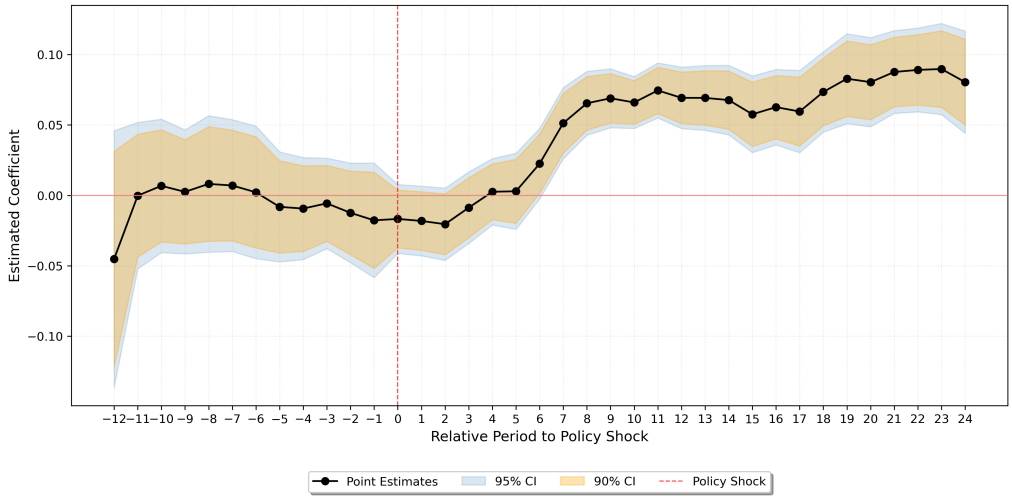
B.2 Alternative Treatment Group

Figure B.3: The Dynamic Effects of RMB Swap Lines: Drop certain currencies

(a) no controls



(b) with controls

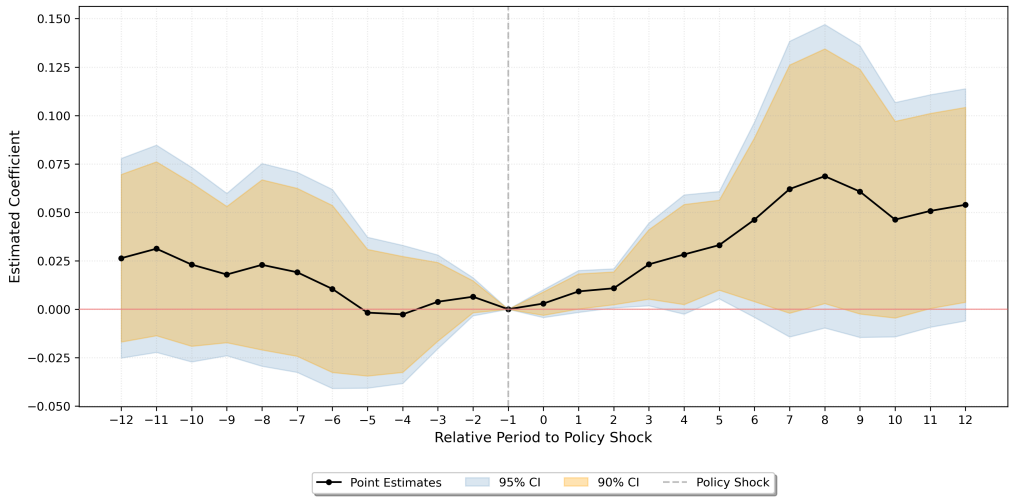


Note: This figure reports the estimated impact of establishing an RMB swap line on the RMB weight in the implicit currency basket at horizons, $h = -12, \ldots, 24$ months relative to the initiation of the swap line. The blue shaded area denotes the 95% confidence interval, while the light orange shaded area denotes the 90% confidence interval.

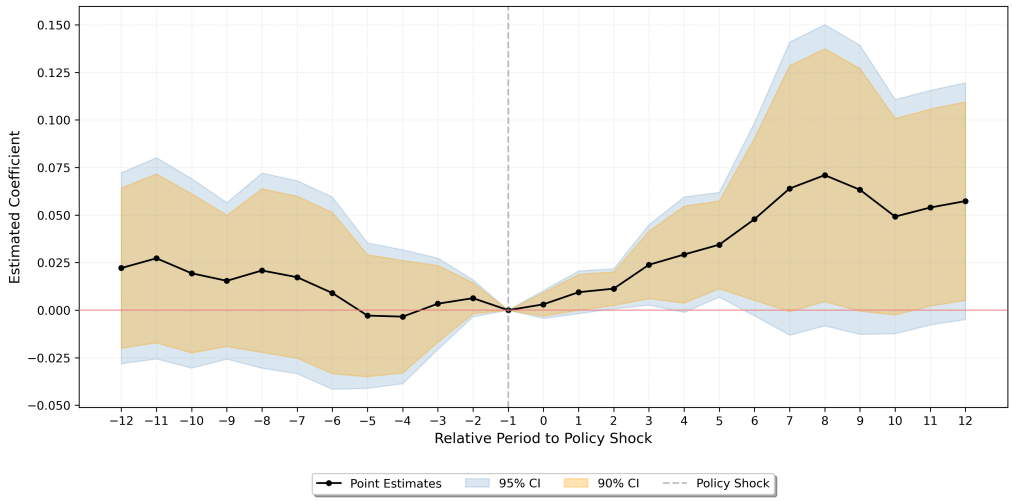
B.3 Alternative RMB exchange rate

Figure B.4: The Dynamic Effects of RMB Swap Lines: Onshore RMB Exchange Rate

(a) no controls

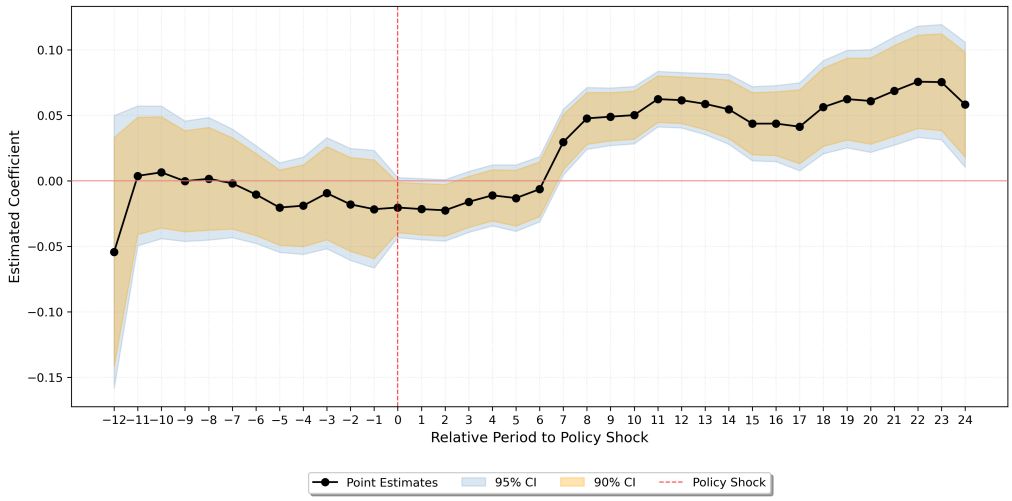


(b) with controls

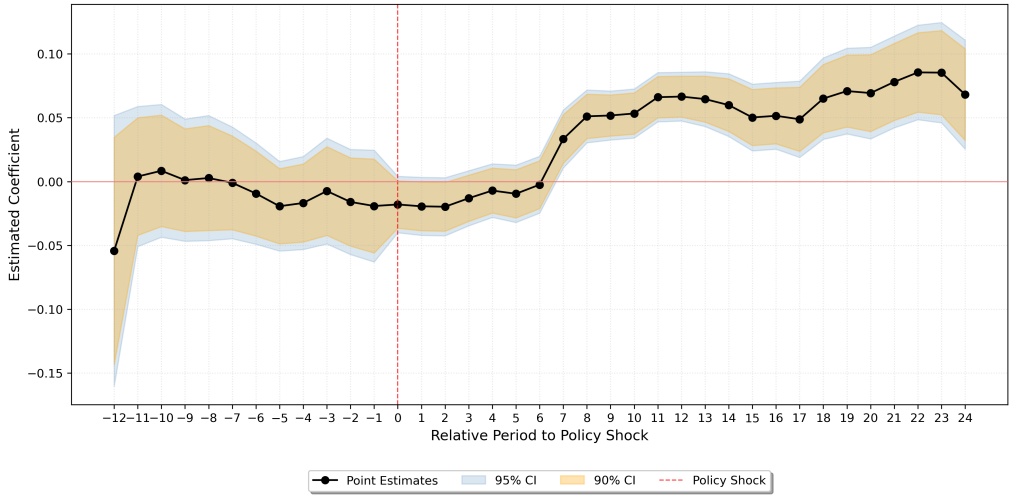


Note: This figure reports the estimated impact of establishing an RMB swap line on the RMB weight in the implicit currency basket at horizons, $h = -12, \ldots, 24$ months relative to the initiation of the swap line. The blue shaded area denotes the 95% confidence interval, while the light orange shaded area denotes the 90% confidence interval.

B.4 Alternative Numeraire Currency



(a) no controls

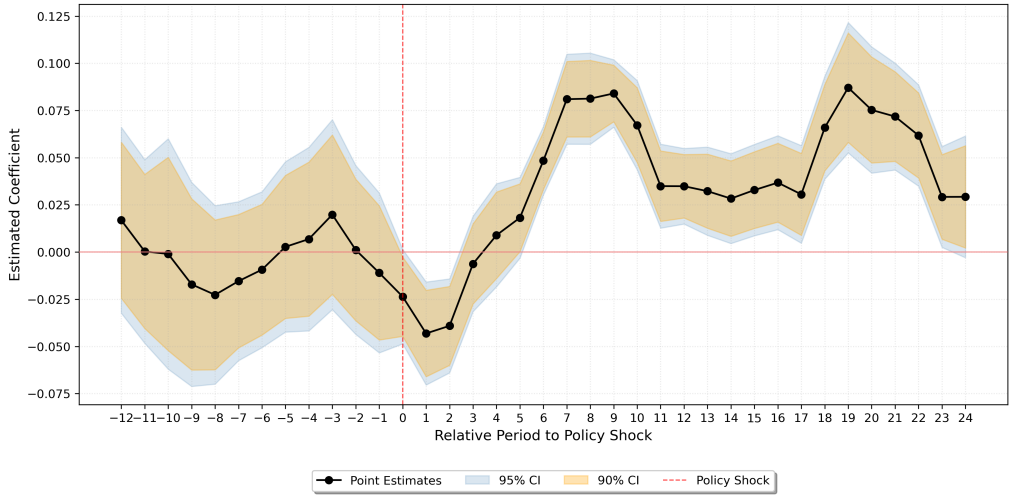


(b) with controls

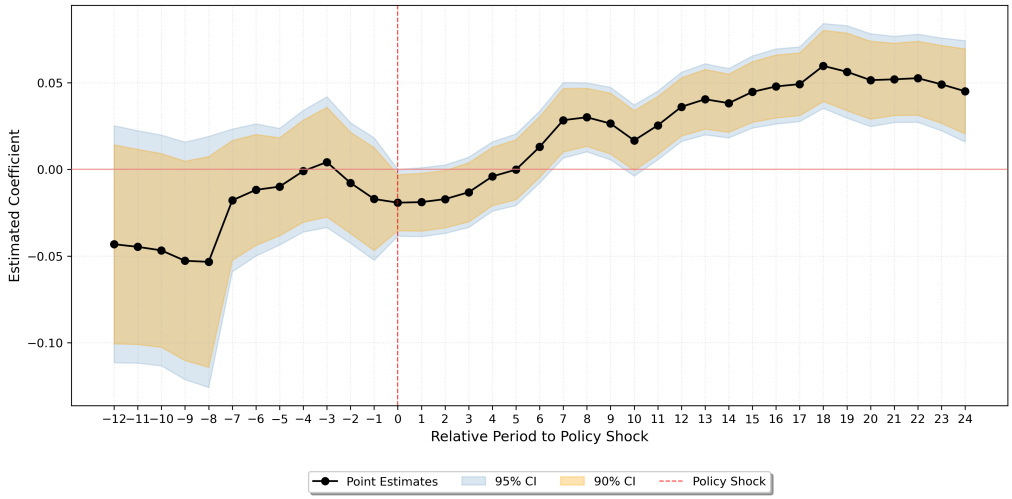
Figure B.5: The Dynamic Effects of RMB Swap Lines: AUD as basis currency

Note: This figure reports the estimated impact of establishing an RMB swap line on the RMB weight in the implicit currency basket at horizons, $h = -12, \ldots, 24$ months relative to the initiation of the swap line. The blue shaded area denotes the 95% confidence interval, while the light orange shaded area denotes the 90% confidence interval.

B.5 Alternative Rolling Window



(a) 130-days



(b) 390-days

Figure B.6: The Dynamic Effects of RMB Swap Lines: Alternative Rolling Windows

Note: This figure reports the estimated impact of establishing an RMB swap line on the RMB weight in the implicit currency basket at horizons, $h = -12, \ldots, 24$ months relative to the initiation of the swap line. The blue shaded area denotes the 95% confidence interval, while the light orange shaded area denotes the 90% confidence interval.

C Detailed Model Setup

C.1 Households

Households' preferences over consumption and labor supply are represented by a constant relative risk aversion (CRRA) utility function.

$$U(C_t^j, N_t^j) = \frac{\left(C_t^j\right)^{1-\rho}}{1-\rho} - \kappa \frac{\left(N_t^j\right)^{1+\eta}}{1+\eta} \tag{C.1}$$

where $j \in \{H, C, D\}$ indexes the country. H denotes the small open economy (SOE), C China, and D the US. C_t^j denotes household consumption, and N_t^j denotes labor supply.

Households in the SOE, China, and the United States face the following budget constraints, respectively:

$$\textbf{SOE}: \; P_t^H C_t^H + (1 + r_{t-1}^H) B_{t-1}^H + E_{HD,t}(1 + r_{t-1}^{HD}) B_{D,t-1}^H = B_t^H + E_{HD,t} B_{D,t}^H + W_t^H N_t^H + P_t^H \Gamma_t^H \tag{C.2}$$

$$\textbf{CHN}: \; P_t^C C_t^C + (1 + r_{t-1}^C) B_{t-1}^C + E_{CD,t}(1 + r_{t-1}^{CD}) B_{D,t-1}^C = B_t^C + E_{CD,t} B_{D,t}^C + W_t^C N_t^C + P_t^C \Gamma_t^C \tag{C.3}$$

$$\textbf{USA}: \; P_t^D C_t^D + (1 + r_{t-1}^D) B_{t-1}^D = B_t^D + W_t^D N_t^D + P_t^D \Gamma_t^D. \tag{C.4}$$

where P_t^j and W_t^j denote the price index for final consumption and the wage rate in country j, respectively, both denominated in local currency. $P_t^j \Gamma_t^j$ denotes firms' profits rebated to households in country j, denominated in local currency, where $j \in \{H, C, D\}$.

$E_{HD,t}$ and $E_{CD,t}$ denote the nominal exchange rates of the SOE currency and the RMB against the USD. r_{t-1}^H and r_{t-1}^C denote the interest rates on domestic-currency-denominated bonds in the SOE and China. The interest rate on USD-denominated bonds is denoted by r_{t-1}^D. Households in the SOE and China that borrow in USD face effective interest rates r_{t-1}^{HD} and r_{t-1}^{CD}.

The effective interest rate is specified as follows,

$$r_t^{HD} = r_t^D + \psi^H \exp\left(\left(b_{d,t}^h - \bar{b}_d^h\right) - 1\right) + \eta_t^{H,UIP} \tag{C.5}$$

$$r_t^{CD} = r_t^D + \psi^C \exp\left(\left(b_{d,t}^c - \bar{b}_d^c\right) - 1\right) + \eta_t^{C,UIP} \tag{C.6}$$

where $\psi^H, \psi^C > 0$ elasticity parameters, and $b_{dt}^h \equiv B_{D,t}^H / P_t^D$ and $b_{dt}^c \equiv B_{D,t}^C / P_t^D$ denote the real holdings of USD-denominated bonds by the households in SOE and China. $\eta_t^{H,UIP}$($\eta_t^{C,UIP}$) stands for the foreign interest rate premium shock or UIP shock.

C.2 Final Consumption Good Producers in the SOE

Final consumption good producers in the SOE combine the domestically produced bundle (Y_{Ht}^H) with imported bundles Y_{Ct}^H from China and Y_{Dt}^H from the US to form the final consumption good bundle using the following CES technology:

$$Y_t^H = \left[(\nu_H^H)^{\frac{1}{\theta}} (Y_{H,t}^H)^{\frac{\theta-1}{\theta}} + (\nu_C^H)^{\frac{1}{\theta}} (Y_{C,t}^H)^{\frac{\theta-1}{\theta}} + (\nu_D^H)^{\frac{1}{\theta}} \left(Y_{D,t}^H\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{C.7}$$

where ν_H^H captures the home-bias of country H in consumption, and the weights satisfy $\nu_H^H + \nu_C^H + \nu_D^H = 1$. The demand for input bundle is given by:

$$Y_{H,t}^H = \nu_H^H \left(\frac{P_{H,t}^H}{P_t^H} \right)^{-\theta} Y_t^H \tag{C.8}$$

$$Y_{C,t}^H = \nu_C^H \left(\frac{P_{C,t}^H}{P_t^H} \right)^{-\theta} Y_t^H \tag{C.9}$$

$$Y_{D,t}^H = \nu_D^H \left(\frac{P_{D,t}^H}{P_t^H} \right)^{-\theta} Y_t^H. \tag{C.10}$$

where P_{jt}^H denotes the price index of the input bundle from country j, denominated in the SOE currency. The aggregate consumer price index in country H is given by a CES aggregator over the price indices of goods sourced from H, C, and D:

$$P_t^H = \left(\nu_H^H \left(P_{H,t}^H\right)^{1-\theta} + \nu_C^H \left(P_{C,t}^H\right)^{1-\theta} + \nu_D^H \left(P_{D,t}^H\right)^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{C.11}$$

The SOE imports from China, with a fraction $1-\gamma^C$ invoiced in the dominant currency (USD) and a fraction γ^C invoiced in RMB. The SOE then aggregates imports from China invoiced in RMB ($\hat{Y}_{C,t}^H$) and USD ($\tilde{Y}_{C,t}^H$) using a CES aggregator.

$$Y_{C,t}^H = \left[\left(\gamma^C\right)^{\frac{1}{\sigma}} \left(\hat{Y}_{C,t}^H\right)^{\frac{\sigma-1}{\sigma}} + (1-\gamma^C)^{\frac{1}{\sigma}} \left(\tilde{Y}_{C,t}^H\right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{C.12}$$

Therefore, the aggregate price index of SOE imports from China can be expressed as:

$$P_{C,t}^H = \left(\gamma^C \left(E_{HC,t} \hat{P}_{C,t}^H\right)^{1-\sigma} + (1-\gamma^C) \left(E_{HD,t} \tilde{P}_{C,t}^H\right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{C.13}$$

where $\tilde{P}_{Ct}^H$ denotes the USD-denominated price for imports from China invoiced in USD and $\hat{P}_{Ct}^H$ denotes the RMB-denominated price for imports from China invoiced in RMB. The associated demand for different currency-invoiced imports

$$\hat{Y}^H_{C,t} = \gamma^C \left(\frac{E_{HC,t}\hat{P}^H_{C,t}}{P^H_{C,t}} \right)^{-\sigma} Y^H_{C,t} \tag{C.14}$$

$$\tilde{Y}^H_{C,t} = (1-\gamma^C) \left(\frac{E_{HD,t}\tilde{P}^H_{C,t}}{P^H_{C,t}} \right)^{-\sigma} Y^H_{C,t}. \tag{C.15}$$

Finally, we can rewrite Equation (C.13) as:

$$P^h_{c,t} = \left(\gamma^C \left(S_{HC,t} \frac{\hat{P}^H_{C,t}}{P^C_t} \right)^{1-\sigma} + (1-\gamma^C) \left(S_{HD,t} \frac{\tilde{P}^H_{C,t}}{P^D_t} \right)^{1-\sigma} \right)^{\frac{1}{(1-\sigma)}} \tag{C.16}$$

where $P^h_{c,t} = \frac{P^H_{C,t}}{P^H_t}$ denotes the relative price index of imports from China, and we have used two definitions of real exchange rates $S_{HD,t} = \frac{E_{HD,t}P^D_t}{P^H_t}$ and $S_{HC,t} = \frac{E_{HC,t}P^C_t}{P^H_t}$.

C.3 Domestic and Imported Input Bundles in the SOE

The domestic input bundle Y^H_{Ht} and imported input bundles (Y^H_{Ct} from China and Y^H_{Dt} from the US) are aggregations of differentiated goods $y^H_{Ht}(i)$ from each origin:

$$Y^H_{H,t} = \left(\left(\frac{1}{n} \right)^{\frac{1}{\sigma}} \int_0^n y^H_{H,t}(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{C.17}$$

$$Y^H_{C,t} = \left(\left(\frac{1}{\alpha(1-n)} \right)^{\frac{1}{\sigma}} \int_n^{n+\alpha(1-n)} y^H_{C,t}(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{C.18}$$

$$Y^H_{D,t} = \left(\left(\frac{1}{(1-\alpha)(1-n)} \right)^{\frac{1}{\sigma}} \int_{n+\alpha(1-n)}^1 y^H_{D,t}(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}. \tag{C.19}$$

The imported input bundle Y^H_{Ct} in Equation C.18 can be further decomposed into import bundles of the corresponding currency-invoiced goods as follows:

$$\hat{Y}^H_{C,t} = \left(\left(\frac{1}{\gamma^C\alpha(1-n)} \right)^{\frac{1}{\sigma}} \int_n^{n+\gamma^C\alpha(1-n)} y^H_{C,t}(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{C.20}$$

$$\tilde{Y}^H_{C,t} = \left(\left(\frac{1}{(1-\gamma^C)\alpha(1-n)} \right)^{\frac{1}{\sigma}} \int_{n+\gamma^C\alpha(1-n)}^{n+\alpha(1-n)} y^H_{C,t}(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}. \tag{C.21}$$

The price indices denominated in corresponding invoicing currencies are

$$P_{H,t}^H = \left(\frac{1}{n}\int_0^n p_{H,t}^H(i)^{1-\sigma}di\right)^{\frac{1}{1-\sigma}}, \tag{C.22}$$

$$\hat{P}_{C,t}^H = \left(\left(\frac{1}{\gamma\alpha(1-n)}\right)^{\frac{1}{\sigma}}\int_n^{n+\gamma\alpha(1-n)} \hat{p}_{C,t}^H(i)^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}}, \tag{C.23}$$

$$\tilde{P}_{C,t}^H = \left(\left(\frac{1}{(1-\gamma)\alpha(1-n)}\right)^{\frac{1}{\sigma}}\int_{n+\gamma\alpha(1-n)}^{n+\alpha(1-n)} \tilde{p}_{C,t}^H(i)^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}}, \tag{C.24}$$

$$\tilde{P}_{D,t}^H = \left(\frac{1}{(1-\alpha)(1-n)}\int_{n+\alpha(1-n)}^1 \tilde{p}_{D,t}^H(i)^{1-\sigma}di\right)^{\frac{1}{1-\sigma}}. \tag{C.25}$$

The SOE currency denominated price $P_{D,t}^H = E_{HD,t}\tilde{P}_{D,t}^H$.

The differentiated good producers operate under monopolistic competition, and thus each type of individual differentiated good producers face a downward-sloping demand

$$\text{Domestic}: y_{H,t}^H(i) = \frac{1}{n}\left(\frac{p_{H,t}^H(i)}{P_{H,t}^H}\right)^{-\sigma} Y_{Ht}^H$$

$$\text{RMB-invoicing imports from CHN}: \; y_{C,t}^H(i) = \frac{1}{\gamma\alpha(1-n)}\left(\frac{\hat{p}_{C,t}^H(i)}{\hat{P}_{Ct}^H}\right)^{-\sigma}\hat{Y}_{C,t}^H$$

$$\text{USD-invoicing imports from CHN}: \; y_{C,t}^H(i) = \frac{1}{(1-\gamma)\alpha(1-n)}\left(\frac{\tilde{p}_{C,t}^H(i)}{\tilde{P}_{C,t}^H}\right)^{-\sigma}\tilde{Y}_{C,t}^H$$

$$\text{USD-invoicing imports from USA}: \; y_{D,t}^H(i) = \frac{1}{(1-\alpha)(1-n)}\left(\frac{E_{HD,t}\tilde{p}_{D,t}^H(i)}{P_{D,t}^H}\right)^{-\sigma}Y_{D,t}^H.$$

Each differentiated good i is produced by one firm whose production features constant returns to scale with domestic labor as the sole input:

$$y_t^j(i) = A_t^j n_t^j(i) \tag{C.26}$$

where $j \in \{H, D, C\}$. The marginal cost of production depends solely on domestic wages, as labor is the only input. Firms are price takers in the labor market. Since wages are flexibly adjusted each period, marginal costs evolve in line with local labor market conditions.

$$mc_t^j = \frac{\partial w_t^j n_t^j}{\partial Y_t^j} = \frac{w_t^j}{A_t^j}. \tag{C.27}$$

Producers of differentiated goods face price rigidities when setting prices in both domestic and foreign markets. Due to constant marginal costs, pricing decisions in the two markets are independent and can therefore be analyzed separately. Following Calvo (1983), in each period, firms may retain the price as set previously with probability θ_p, while with probability $1-\theta_p$, they are allowed to reset their prices.

Domestic firm's optimal pricing problem in the domestic market for a small open economy (SOE) can be formulated as follows:

$$\max_{p^H_{Ht}(i)} \mathbb{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_p \beta)^s \frac{\Lambda^H_{t+s}}{P^H_{t+s}} \left[p^H_{H,t}(i) y^H_{H,t+s}(i) - mc^H_t y^H_{H,t+s}(i) \right] \right\} \tag{C.28}$$

where Λ^H_{t+s} represents the marginal utility of consumption for households in the small open economy (SOE) at time $t+s$.

For SOE import price from China, we need to consider the optimal pricing problem by China exporters. For SOE imports invoiced in RMB, which is producer currency pricing for China exporters, we have:

$$\max_{\hat{p}^H_{C,t}(i)} \mathbb{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_p \beta)^s \frac{\Lambda^C_{t+s}}{P^C_{t+s}} \left[\hat{p}^H_{C,t}(i) y^H_{C,t+s}(i) - mc^C_t y^H_{C,t+s}(i) \right] \right\} \tag{C.29}$$

where Λ^C_{t+s} represents the marginal utility of consumption for households in China at time $t+s$. For imports invoiced in USD which is dominant currency pricing for China exporters, we have:

$$\max_{\tilde{p}^H_{C,t}(i)} \mathbb{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_p \beta)^s \frac{\Lambda^C_{t+s}}{P^C_{t+s}} \left[E_{CD,t+s} \tilde{p}^H_{C,t}(i) y^H_{C,t+s}(i) - mc^C_t y^H_{C,t+s}(i) \right] \right\}. \tag{C.30}$$

Finally, for SOE imports from the US, we consider US exporters' USD pricing:

$$\max_{\tilde{p}^H_{Dt}(i)} \mathbb{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_p \beta)^s \frac{\Lambda^D_{t+s}}{P^D_{t+s}} \left[\tilde{p}^H_{D,t}(i) y^H_{D,t+s}(i) - mc^D_t y^H_{D,t+s}(i) \right] \right\}. \tag{C.31}$$

where Λ^D_{t+s} represents the marginal utility of consumption for households in the US at time $t+s$.

C.4 Monetary Policy

The monetary policy of SOE is assumed to be an exchange rate policy pegged to a basket of currencies: USD and RMB. We follow the specification by Shi and Xu (2008) and Xu (2011):

$$\left(\frac{E_{HC,t}}{\bar{E}_{HC}} \right)^{\xi} \left(\frac{E_{HD,t}}{\bar{E}_{HD}} \right)^{(1-\xi)} = 1 \tag{C.32}$$

where E_{HCt} nominal exchange rate of SOE currency versus RMB, $\bar{E}_{HC}$ is the steady state of nominal exchange rate of SOE currency versus RMB. ξ is the RMB weight parameter optimally selected by the SOE. One can re-write the above policy rule by introducing a basis currency N:

$$\Delta \ln E_{HN,t} = \xi \Delta \ln E_{CN,t} + (1-\xi) \Delta \ln E_{DN,t}. \tag{C.33}$$

Now it is clear that the weight parameter ξ corresponds to the RMB weight estimated in empirical section when using New Zealand Dollar as a basis currency.

For monetary policy of China and USA, we assume totally different Taylor rules to highlight the difference of monetary policy decision rules in two countries so that the implication of simulation results would be consistent with observed data.

$$\text{CHN: } \frac{1+r_t^C}{1+\bar{r}^C} = \left(\frac{1+r_{t-1}^C}{1+\bar{r}^C}\right)^{\rho_{R,C}} \left[\left(\frac{Y_t^C}{\bar{Y}^C}\right)^{\rho_{Y,C}} \left(\frac{1+\Pi_t^C}{1+\bar{\Pi}^C}\right)^{\rho_{\pi,C}} \left(\frac{E_{CD,t}}{\bar{E}_{CD}}\right)^{\rho_S}\right]^{1-\rho_{R,C}} \exp(\eta_t^{C,MP}), \tag{C.34}$$

$$\text{USA: } \frac{1+r_t^D}{1+\bar{r}^D} = \left(\frac{1+r_{t-1}^D}{1+\bar{r}^D}\right)^{\rho_{R,D}} \left[\left(\frac{Y_t^D}{\bar{Y}^D}\right)^{\rho_{Y,D}} \left(\frac{1+\Pi_t^D}{1+\bar{\Pi}^D}\right)^{\rho_{\pi,D}}\right]^{1-\rho_{R,D}} \exp(\eta_t^{D,MP}). \tag{C.35}$$

The monetary policy shock follows the following AR(1) process.

$$\eta_t^{C,MP} = \rho^{C,MP}\eta_{t-1}^{C,MP} + \epsilon_t^{C,MP} \tag{C.36}$$

$$\eta_t^{D,MP} = \rho^{D,MP}\eta_{t-1}^{D,MP} + \epsilon_t^{D,MP}. \tag{C.37}$$

C.5 Market Clearing

The final consumption good market clears in each country:

$$C_t^j = Y_t^j$$

where $j = H, C, D$.

The labor market clears for each country:

$$\begin{aligned}
\text{SOE}: N_t^H &= \int_0^n n_t^H(i)di = \frac{1}{A_t^H}\int_0^n y_t^H(i)di \\
&= \frac{1}{A_t^H}\left(D_{H,t}^H Y_{H,t}^H + \frac{\alpha(1-n)}{n} D_{H,t}^C Y_{H,t}^C + \frac{(1-\alpha)(1-n)}{n} D_{H,t}^D Y_{H,t}^D\right) \\
\text{CHN}: N_t^C &= \int_n^{n+\alpha(1-n)} n_t^C(i)di = \frac{1}{A_t^C}\int_n^{n+\alpha(1-n)} y_t^C(i)di \\
&= \frac{1}{A_t^C}\left(D_{C,t}^C Y_{C,t}^C + \frac{n}{\alpha(1-n)} D_{C,t}^H Y_{C,t}^H + \frac{1-\alpha}{\alpha} D_{C,t}^D Y_{C,t}^D\right) \\
\text{USA}: N_t^D &= \int_{n+\alpha(1-n)}^1 n_t^D(i)di = \frac{1}{A_t^D}\int_{n+\alpha(1-n)}^1 y_t^D(i)di \\
&= \frac{1}{A_t^D}\left(D_{D,t}^D Y_{D,t}^D + \frac{n}{(1-\alpha)(1-n)} D_{D,t}^H Y_{D,t}^H + \frac{\alpha}{1-\alpha} D_{D,t}^C Y_{D,t}^C\right)
\end{aligned}$$

where D_{jt}^{k} denotes the price dispersion associated with imports of country k from country j. It is important to note that, since the import price index for the small open economy (SOE) is a composite of two currency-invoiced price indices, the corresponding price dispersion must also be aggregated in a consistent manner:

$$D_{C,t}^{H}=\frac{(1-\gamma^{C})\left(S_{HD,t}\frac{\tilde{P}_{C,t}^{H}}{P_{t}^{D}}\right)^{-\sigma}\tilde{D}_{C,t}^{H}+\gamma^{C}\left(S_{HC,t}\frac{\hat{P}_{C,t}^{H}}{P_{t}^{C}}\right)^{-\sigma}\hat{D}_{C,t}^{H}}{\left(P_{ct}^{h}\right)^{-\sigma}}$$

where the import price dispersion for RMB-invoicing $\hat{D}_{Ct}^{H}$ is defined as:

$$\begin{aligned}\hat{D}_{C,t}^{H}&=\int_{n}^{n+\gamma\alpha(1-n)}\frac{1}{\gamma\alpha(1-n)}\left(\frac{\hat{p}_{C,t}^{H}(i)}{\hat{P}_{C,t}^{H}}\right)^{-\sigma}di\\&=(1-\theta_{p})\left(\frac{\hat{p}_{C,t}^{H}/P_{t}^{C}}{\hat{P}_{C,t}^{H}/P_{t}^{C}}\right)^{-\sigma}+\theta_{p}\hat{D}_{C,t-1}^{H}\left(1+\hat{\Pi}_{C,t}^{H}\right)^{\sigma}\end{aligned}$$

and the import price dispersion for USD-invoicing $\tilde{D}_{Ct}^{H}$ is defined as:

$$\begin{aligned}\tilde{D}_{C,t}^{H}&=\int_{n+\gamma\alpha(1-n)}^{n+\alpha(1-n)}\frac{1}{(1-\gamma)\alpha(1-n)}\left(\frac{\tilde{p}_{C,t}^{H}(i)}{\tilde{P}_{C,t}^{H}}\right)^{-\sigma}di\\&=(1-\theta_{p})\left(\frac{\tilde{p}_{C,t}^{H}/P_{t}^{D}}{\tilde{P}_{C,t}^{H}/P_{t}^{D}}\right)^{-\sigma}+\theta_{p}\tilde{D}_{C,t-1}^{H}\left(1+\tilde{\Pi}_{C,t}^{H}\right)^{\sigma}\end{aligned}$$

Analogously, the price dispersion for SOE's exports to China can be defined as:

$$D_{H,t}^{C}=\frac{(1-\gamma^{H})\left(S_{CD,t}\frac{\tilde{P}_{H,t}^{C}}{P_{t}^{D}}\right)^{-\sigma}\tilde{D}_{H,t}^{C}+\gamma^{H}\left(\frac{\hat{P}_{Ht}^{C}}{P_{t}^{C}}\right)^{-\sigma}\hat{D}_{H,t}^{C}}{\left(P_{h,t}^{c}\right)^{-\sigma}}$$

where the export price dispersion for RMB-invoicing $\hat{D}_{Ht}^{C}$ is defined as:

$$\begin{aligned}\hat{D}_{H,t}^{C}&\triangleq\int_{0}^{(1-\gamma^{H})n}\frac{1}{(1-\gamma^{H})n}\left(\frac{\hat{p}_{H,t}^{C}(i)}{\hat{P}_{H,t}^{C}}\right)^{-\sigma}di\\&=(1-\theta_{p})\left(\frac{\hat{p}_{H,t}^{C}/P_{t}^{C}}{\hat{P}_{H,t}^{C}/P_{t}^{C}}\right)^{-\sigma}+\theta_{p}\hat{D}_{H,t-1}^{C}\left(1+\hat{\Pi}_{H,t}^{C}\right)^{\sigma}\end{aligned}$$

and the export price dispersion for USD-invoicing $\tilde{D}^H_{Ct}$ is defined as:

$$\begin{aligned}\tilde{D}^C_{H,t} &\triangleq \int_{(1-\gamma^H)n}^{n} \frac{1}{\gamma^H n}\left(\frac{\tilde{p}^C_{H,t}(i)}{\tilde{P}^C_{H,t}}\right)^{-\sigma} di \\ &= (1-\theta_p)\left(\frac{\tilde{p}^C_{H,t}/P^D_t}{\tilde{P}^C_{H,t}/P^D_t}\right)^{-\sigma} + \theta_p \tilde{D}^C_{H,t-1}\left(1+\tilde{\Pi}^C_{H,t}\right)^{\sigma}\end{aligned}$$

The aggregated outputs are:

$$\begin{aligned}Z^H_t = A^H_t N^H_t &= \nu^H_H D^H_{H,t}\left(P^h_{h,t}\right)^{-\theta} Y^H_t \\ &+ \frac{\alpha(1-n)}{n}\nu^C_H D^C_{H,t}\left(P^c_{h,t}\right)^{-\theta} Y^C_t \\ &+ \frac{(1-\alpha)(1-n)}{n}\nu^D_H D^D_{H,t}\left(P^d_{h,t}\right)^{-\theta} Y^D_t \\ Z^C_t = A^C_t N^C_t &= \frac{n\nu^H_C}{\alpha(1-n)}\left(P^h_{c,t}\right)^{-\theta} D^H_{C,t} Y^H_t \\ &+ \nu^C_C\left(P^c_{c,t}\right)^{-\theta} D^C_{C,t} Y^C_t \\ &+ \frac{(1-\alpha)\nu^D_C}{\alpha}(P^d_{c,t})^{-\theta} D^D_{C,t} Y^D_t \\ Z^D_t = A^D_t N^D_t &= \frac{n\nu^H_D}{(1-\alpha)(1-n)}\left(P^h_{d,t}\right)^{-\theta} D^H_{D,t} Y^H_t \\ &+ \nu^D_D\left(P^d_{d,t}\right)^{-\theta} D^D_{D,t} Y^D_t \\ &+ \frac{\alpha\nu^C_D}{1-\alpha}(P^c_{d,t})^{-\theta} D^C_{D,t} Y^C_t\end{aligned}$$

where we have used the definition $P^k_{jt} = \frac{P^K_{Jt}}{P^K_t}$.

Our home bias parameters also follow De Paoli (2009a):

$$\begin{aligned}\nu^H_H &= 1-(1-n)\lambda \\ \nu^C_H &= \nu^D_H = n\lambda\end{aligned}$$

and we extend the parameterization of the other two home bias parameters to a three-country version:

$$\nu_C^H = \alpha(1-n)\lambda$$
$$\nu_D^H = (1-\alpha)(1-n)\lambda$$
$$\nu_C^C = \alpha(1-n\lambda)$$
$$\nu_D^C = (1-\alpha)(1-n\lambda)$$
$$\nu_D^D = (1-\alpha)(1-n\lambda)$$
$$\nu_C^D = \alpha(1-n\lambda).$$

The degree of openness, λ, can be interpreted as the share of imports in the overall consumption bundle. Then we take $n \to 0$ to approximate the SOE as a small open economy relative to CHN and USA, while China and US remain as the symmetric large open economies:

$$Z_t^H = (1-\lambda)D_{H,t}^H \left(P_{h,t}^h\right)^{-\theta} Y_t^H + \alpha\lambda D_{H,t}^C \left(P_{h,t}^c\right)^{-\theta} Y_t^C + (1-\alpha)\lambda D_{H,t}^D \left(P_{h,t}^d\right)^{-\theta} Y_t^D \quad \text{(C.38)}$$

$$Z_t^C = \alpha D_{C,t}^C \left(P_{c,t}^c\right)^{-\theta} Y_t^C + (1-\alpha) D_{C,t}^D \left(P_{c,t}^d\right)^{-\theta} Y_t^D \quad \text{(C.39)}$$

$$Z_t^D = (1-\alpha) D_{D,t}^D \left(P_{d,t}^d\right)^{-\theta} Y_t^D + \alpha D_{D,t}^C \left(P_{d,t}^c\right)^{-\theta} Y_t^C \quad \text{(C.40)}$$

where the relative price index P_{jt}^k satisfies following constraints:

$$1 = \left((1-\lambda)\left(P_{h,t}^h\right)^{1-\theta} + \alpha\lambda\left(P_{c,t}^h\right)^{1-\theta} + (1-\alpha)\lambda\left(S_{HD,t}\tilde{P}_{d,t}^h\right)^{1-\theta}\right)^{\frac{1}{1-\theta}}$$
$$1 = \left(\alpha\left(P_{c,t}^c\right)^{1-\theta} + (1-\alpha)\left(S_{CD,t}\tilde{P}_{d,t}^c\right)^{1-\theta}\right)^{\frac{1}{1-\theta}}$$
$$1 = \left((1-\alpha)\left(P_{d,t}^d\right)^{1-\theta} + \alpha\left(\tilde{P}_{c,t}^d\right)^{1-\theta}\right)^{\frac{1}{1-\theta}}.$$

The SOE currency and RMB bond markets clear: $B_t^j = 0$, $j \in \{H, C\}$. By Walras's law, the US dollar bond market clearing condition is automatically satisfied in equilibrium and can therefore be omitted.

D Equilibrium Conditions of the Model

D.1 SOE Household

- The definition of SOE nominal stochastic discount factor:

$$\Lambda_t^H = \left(C_t^H\right)^{-\rho}$$

- The SOE Euler equation for domestic-currency-denominated bond:

$$\Lambda_t^H = \beta(1+r_t^H)\mathbb{E}\left(\frac{\Lambda_{t+1}^H}{1+\pi_{t+1}^H}\right)$$

- The SOE Euler equation for USD-denominated bond:

$$\Lambda_t^H = \beta(1+r_t^{HD})\mathbb{E}_t\left(\frac{S_{HD,t+1}}{S_{HD,t}}\frac{\Lambda_{t+1}^H}{1+\pi_{t+1}^D}\right)$$

- The SOE Intra-temporal Condition:

$$w_t^H = \kappa\left(C_t^H\right)^{\rho}\left(N_t^H\right)^{\eta}$$

- SOE EDEIR condition:

$$r_t^{HD} = r_t^D + \psi^H\left(\exp\left(b_{dt}^h - \bar{b}_d^h\right) - 1\right) + \eta_t^{H,UIP}$$

- SOE budget constraint:

$$C_t^H + \frac{S_{HD,t}}{1+\pi_t^D}(1+r_{DH,t-1})b_{d,t-1}^h = S_{HD,t}b_{d,t}^h + w_t^H N_t^H + \Gamma_t^H$$

- The definition of SOE real dividend:

$$\Gamma_t^H = (1-\lambda)\left(P_{h,t}^h\right)^{1-\theta}C_t^H + \alpha\lambda S_{HC,t}\left(P_{h,t}^c\right)^{1-\theta}C_t^C + (1-\alpha)\lambda S_{HD,t}\left(P_{h,t}^d\right)^{1-\theta}C_t^D - w_t^H N_t^H$$

D.2 SOE Domestic Sales

The optimal price for SOE domestic sales is determined by:

$$\frac{p_{H,t}^H}{P_t^H} = \frac{\sigma}{\sigma-1}\frac{X_{1,t}^H}{X_{2,t}^H}$$

where

$$X_{1,t}^H = \Lambda_t^H mc_t^H y_{H,t}^H(i) + \theta_p\beta\mathbb{E}_t X_{1,t+1}^H$$
$$X_{2,t}^H = \Lambda_t^H y_{H,t}^H(i) + \theta_p\beta\mathbb{E}_t\left(\frac{X_{2,t+1}^H}{1+\Pi_{t+1}^H}\right)$$

and generic demand:

$$y_{H,t}^H(i) = \frac{\nu_H^H}{n}\left(\frac{p_{H,t}^H}{P_{H,t}^H}\right)^{-\sigma}\left(\frac{P_{H,t}^H}{P_t^H}\right)^{-\theta} Y_t^H$$
$$= \frac{\nu_H^H}{n}\left(\frac{p_{H,t}^H/P_t^H}{P_{h,t}^h}\right)^{-\sigma}\left(P_{h,t}^h\right)^{-\theta} Y_t^H$$

which further determines the aggregate inflation for domestic goods price according to Calvo price process:

$$\left(P_{H,t}^H\right)^{1-\sigma} = (1-\theta_p)\left(p_{H,t}^H\right)^{1-\sigma} + \theta_p\left(P_{H,t-1}^H\right)^{1-\sigma}$$
$$\Rightarrow \left(P_{h,t}^h\right)^{1-\sigma} = (1-\theta_p)\left(\frac{p_{H,t}^H}{P_t^H}\right)^{1-\sigma} + \theta_p\left(\frac{P_{h,t-1}^h}{1+\Pi_t^H}\right)^{1-\sigma}$$

and also the dynamics of price dispersion:

$$D_{H,t}^H \triangleq \int_0^n \frac{1}{n}\left(\frac{p_{H,t}^H(i)}{P_{Ht}^H}\right)^{-\sigma} di$$
$$= (1-\theta_p)\left(\frac{p_{H,t}^H/P_t^H}{P_{h,t}^h}\right)^{-\sigma} + \theta_p D_{H,t-1}^H\left(1+\Pi_{H,t}^H\right)^{\sigma}$$

where:

$$1+\Pi_{Ht}^H = \frac{P_{Ht}^H/P_t^H}{P_{H,t-1}^H/P_{t-1}^H}\left(1+\Pi_t^H\right)$$

D.3 SOE LCP Export to China (in RMB)

$$\frac{\hat{p}_{H,t}^C}{P_t^C} = \frac{\sigma}{\sigma-1}\frac{\hat{X}_{1,t}^{HC}}{\hat{X}_{2,t}^{HC}}$$

where

$$\hat{X}_{1,t}^{HC} = \Lambda_t^H mc_t^H y_{H,t}^C(i) + \theta_p\beta\mathbb{E}_t\hat{X}_{1,t+1}^{HC}$$
$$\hat{X}_{2,t}^{HC} = \Lambda_t^H S_{HC,t} y_{H,t}^C(i) + \theta_p\beta\mathbb{E}_t\left(\frac{\hat{X}_{2,t+1}^{HC}}{1+\Pi_{t+1}^C}\right)$$

and generic demand:

$$y_{H,t}^C(i) = \frac{\nu_H^C}{n}\left(\frac{\hat{p}_{H,t}^C(i)}{P_{H,t}^C}\right)^{-\sigma}\left(\frac{P_{H,t}^C}{P_t^C}\right)^{-\theta} Y_t^C$$
$$= \frac{\nu_H^C}{n}\left(\frac{\hat{p}_{H,t}^C/P_t^C}{P_{h,t}^c}\right)^{-\sigma}\left(P_{h,t}^c\right)^{-\theta} Y_t^C$$

which is subject to Calvo price process:

$$\begin{aligned}\left(\hat{P}_{H,t}^{C}\right)^{1-\sigma} &= (1-\theta_p)\left(\hat{p}_{H,t}^{C}\right)^{1-\sigma} + \theta_p\left(\hat{P}_{H,t-1}^{C}\right)^{1-\sigma} \\ \Rightarrow \left(\frac{\hat{P}_{H,t}^{C}}{P_t^C}\right)^{1-\sigma} &= (1-\theta_p)\left(\frac{\hat{p}_{H,t}^{C}}{P_t^C}\right)^{1-\sigma} + \theta_p\left(\frac{\hat{P}_{H,t-1}^{C}/P_{t-1}^{C}}{1+\Pi_t^C}\right)^{1-\sigma}\end{aligned}$$

and also the dynamics of price dispersion:

$$\begin{aligned}\hat{D}_{H,t}^{C} &\triangleq \int_0^{(1-\gamma^H)n} \frac{1}{(1-\gamma^H)n}\left(\frac{\hat{p}_{H,t}^{C}(i)}{\hat{P}_{H,t}^{C}}\right)^{-\sigma} di \\ &= (1-\theta_p)\left(\frac{\hat{p}_{H,t}^{C}/P_t^C}{\hat{P}_{H,t}^{C}/P_t^C}\right)^{-\sigma} + \theta_p \hat{D}_{H,t-1}^{C}\left(1+\hat{\Pi}_{H,t}^{C}\right)^{\sigma}\end{aligned}$$

where

$$1+\hat{\Pi}_{H,t}^{C} = \frac{\hat{P}_{H,t}^{C}/P_t^C}{\hat{P}_{H,t-1}^{C}/P_{t-1}^{C}}\left(1+\Pi_t^C\right)$$

D.4 SOE DCP Export to China (in USD)

$$\frac{\tilde{p}_{H,t}^{C}}{P_t^D} = \frac{\sigma}{\sigma-1}\frac{\tilde{X}_{1,t}^{HC}}{\tilde{X}_{2,t}^{HC}}$$

where:

$$\begin{aligned}\tilde{X}_{1,t}^{HC} &= \Lambda_t^H mc_t^H y_{H,t}^{C}(i) + \theta_p\beta\mathbb{E}_t\tilde{X}_{1,t+1}^{HC} \\ \tilde{X}_{2,t}^{HC} &= \Lambda_t^H S_{HDt} y_{H,t}^{C}(i) + \theta_p\beta\mathbb{E}_t\left(\frac{\tilde{X}_{2,t+1}^{HC}}{1+\Pi_{t+1}^D}\right)\end{aligned}$$

and generic demand:

$$\begin{aligned}y_{H,t}^{C}(i) &= \frac{\nu_H^C}{n}\left(\frac{E_{CD,t}\tilde{p}_{H,t}^{C}(i)}{P_{H,t}^{C}}\right)^{-\sigma}\left(\frac{P_{H,t}^{C}}{P_t^C}\right)^{-\theta} Y_t^C \\ &= \frac{\nu_H^C}{n}\left(S_{CD,t}\frac{\tilde{p}_{H,t}^{C}/P_t^D}{P_{h,t}^{c}}\right)^{-\sigma}\left(P_{h,t}^{c}\right)^{-\theta} Y_t^C\end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned}\left(\tilde{P}^C_{H,t}\right)^{1-\sigma} &= (1-\theta_p)\left(\tilde{p}^C_{H,t}\right)^{1-\sigma} + \theta_p\left(\tilde{P}^C_{H,t-1}\right)^{1-\sigma} \\ \Rightarrow \left(\frac{\tilde{P}^C_{H,t}}{P^D_t}\right)^{1-\sigma} &= (1-\theta_p)\left(\frac{\tilde{p}^C_{H,t}}{P^D_t}\right)^{1-\sigma} + \theta_p\left(\frac{\tilde{P}^C_{H,t-1}/P^D_{t-1}}{1+\Pi^D_t}\right)^{1-\sigma}\end{aligned}$$

and also the dynamics of price dispersion:

$$\begin{aligned}\tilde{D}^C_{H,t} &\triangleq \int_{(1-\gamma^H)n}^{n} \frac{1}{\gamma^H n}\left(\frac{\tilde{p}^C_{H,t}(i)}{\tilde{P}^C_{Ht}}\right)^{-\sigma} di \\ &= (1-\theta_p)\left(\frac{\tilde{p}^C_{H,t}/P^D_t}{\tilde{P}^C_{H,t}/P^D_t}\right)^{-\sigma} + \theta_p \tilde{D}^C_{H,t-1}\left(1+\tilde{\Pi}^C_{H,t}\right)^{\sigma}\end{aligned}$$

where

$$1+\tilde{\Pi}^C_{H,t} = \frac{\tilde{P}^C_{H,t}/P^D_t}{\tilde{P}^C_{H,t-1}/P^D_{t-1}}\left(1+\Pi^D_t\right)$$

D.5 SOE LCP Exports to US (in USD)

$$\frac{\tilde{p}^D_{H,t}}{P^D_t} = \frac{\sigma}{\sigma-1}\frac{X^{HD}_{1,t}}{X^{HD}_{2,t}}$$

where

$$\begin{aligned}X^{HD}_{1,t} &= \Lambda^H_t \frac{w^H_t}{A^H_t} y^D_{H,t}(i) + \theta_p \beta \mathbb{E}_t X^{HD}_{1,t+1} \\ X^{HD}_{2,t} &= \Lambda^H_t S_{HD,t} y^D_{H,t}(i) + \theta_p \beta \mathbb{E}_t\left(\frac{X^{HD}_{2,t+1}}{1+\Pi^D_{t+1}}\right)\end{aligned}$$

and generic demand:

$$\begin{aligned}y^D_{H,t}(i) &= \frac{\nu^D_H}{n}\left(\frac{\tilde{p}^D_{H,t}(i)}{P^D_{H,t}}\right)^{-\sigma}\left(\frac{P^D_{H,t}}{P^D_t}\right)^{-\theta} Y^D_t \\ &= \frac{\nu^D_H}{n}\left(\frac{\tilde{p}^D_{H,t}/P^D_t}{P^d_{h,t}}\right)^{-\sigma}\left(P^d_{h,t}\right)^{-\theta} Y^D_t\end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned}\left(P^D_{H,t}\right)^{1-\sigma} &= (1-\theta_p)\left(p^D_{H,t}\right)^{1-\sigma} + \theta_p\left(P^D_{H,t-1}\right)^{1-\sigma} \\ \Rightarrow \left(P^d_{h,t}\right)^{1-\sigma} &= (1-\theta_p)\left(\frac{p^D_{H,t}}{P^D_t}\right)^{1-\sigma} + \theta_p\left(\frac{P^d_{h,t-1}}{1+\Pi^D_t}\right)^{1-\sigma}\end{aligned}$$

and also the dynamics of price dispersion:

$$\begin{aligned} D_{H,t}^{D} &\triangleq \int_{0}^{n} \frac{1}{n} \left(\frac{p_{H,t}^{D}}{P_{H,t}^{D}} \right)^{-\sigma} di \\ &= (1-\theta_p) \left(\frac{p_{H,t}^{D}/P_{t}^{D}}{P_{h,t}^{d}} \right)^{-\sigma} + \theta_p D_{H,t-1}^{D} \left(1+\Pi_{H,t}^{D} \right)^{\sigma} \end{aligned}$$

where

$$1+\Pi_{H,t}^{D} = \frac{P_{h,t}^{d}}{P_{h,t-1}^{d}} \left(1+\Pi_{t}^{D} \right)$$

D.6 CHN Household

- The definition of CHN nominal stochastic discount factor:

$$\Lambda_{t}^{C} = \left(C_{t}^{C} \right)^{-\rho}$$

- The CHN Euler equation for domestic-currency-denominated bond:

$$\Lambda_{t}^{C} = \beta(1+r_{t}^{C}) \mathbb{E}_{t} \left(\frac{\Lambda_{t+1}^{C}}{1+\pi_{t+1}^{C}} \right)$$

- The CHN Euler equation for USD-denominated bond:

$$\Lambda_{t}^{C} = \beta(1+r_{t}^{CD}) \mathbb{E}_{t} \left(\frac{S_{CD,t+1}}{S_{CD,t}} \frac{\Lambda_{t+1}^{C}}{1+\pi_{t+1}^{D}} \right)$$

- The CHN Intra-temporal Condition:

$$w_{t}^{C} = \kappa \left(C_{t}^{C} \right)^{\rho} \left(N_{t}^{C} \right)^{\eta}$$

- CHN EDEIR condition:

$$r_{t}^{CD} = r_{t}^{D} + \psi^{C} \left(\exp\left(b_{dt}^{c} - \bar{b}_{d}^{c} \right) - 1 \right) + \eta_{t}^{C,UIP}$$

where η_{t}^{C} denotes the UIP shocks.

- CHN budget constraint:

$$C_{t}^{C} + \frac{S_{CD,t}}{1+\pi_{t}^{D}} (1+r_{t-1}^{DC}) b_{d,t-1}^{h} = S_{CD,t} b_{d,t}^{c} + w_{t}^{C} N_{t}^{C} + \Gamma_{t}^{C}$$

- The definition of CHN real dividend:

$$\Gamma_{t}^{C} = \alpha \left(P_{c,t}^{c} \right)^{1-\theta} C_{t}^{C} + (1-\alpha) S_{CD,t} \left(P_{c,t}^{d} \right)^{1-\theta} C_{t}^{D} - w_{t}^{C} N_{t}^{C}$$

D.7 CHN Domestic Sales

$$\frac{p_{C,t}^C}{P_{C,t}^C} = \frac{\sigma}{\sigma - 1} \frac{X_{1,t}^C}{X_{2,t}^C}$$

where

$$X_{1,t}^C = \Lambda_t^C mc_t^C y_{C,t}^C(i) + \theta_p \beta \mathbb{E}_t X_{1,t+1}^C$$
$$X_{2,t}^C = \Lambda_t^C y_{C,t}^C(i) + \theta_p \beta \mathbb{E}_t \left(\frac{X_{2,t+1}^C}{1 + \Pi_{t+1}^C} \right)$$

and generic demand:

$$\begin{aligned} y_{C,t}^C(i) &= \frac{\nu_C^C}{\alpha(1-n)} \left(\frac{p_{C,t}^C}{P_{C,t}^C} \right)^{-\sigma} \left(\frac{P_{C,t}^C}{P_t^C} \right)^{-\theta} Y_t^C \\ &= \frac{\nu_C^C}{\alpha(1-n)} \left(\frac{p_{C,t}^C / P_t^C}{P_{c,t}^c} \right)^{-\sigma} \left(P_{c,t}^c \right)^{-\theta} Y_t^C \end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned} \left(P_{C,t}^C \right)^{1-\sigma} &= (1 - \theta_p) \left(p_{C,t}^C \right)^{1-\sigma} + \theta_p \left(P_{C,t-1}^C \right)^{1-\sigma} \\ \Rightarrow \left(P_{c,t}^c \right)^{1-\sigma} &= (1 - \theta_p) \left(\frac{p_{C,t}^C}{P_t^C} \right)^{1-\sigma} + \theta_p \left(\frac{P_{c,t-1}^c}{1 + \Pi_t^C} \right)^{1-\sigma} \end{aligned}$$

and also the dynamics of price dispersion:

$$\begin{aligned} D_{C,t}^C &\triangleq \int_n^{n+\alpha(1-n)} \frac{1}{\alpha(1-n)} \left(\frac{p_{C,t}^C(i)}{P_{C,t}^C} \right)^{-\sigma} di \\ &= (1 - \theta_p) \left(\frac{p_{C,t}^C / P_t^C}{P_{ct}^c} \right)^{-\sigma} + \theta_p D_{C,t-1}^C \left(1 + \Pi_{C,t}^C \right)^{\sigma} \end{aligned}$$

where:

$$1 + \Pi_{C,t}^C = \frac{P_{c,t}^c}{P_{c,t-1}^c} \left(1 + \Pi_t^C \right)$$

D.8 CHN PCP Exports to SOE (in RMB)

$$\frac{\hat{p}_{C,t}^H}{P_t^C} = \frac{E_{CH,t} p_{C,t}^H}{P_t^C} = \frac{\sigma}{\sigma - 1} \frac{\hat{X}_{1,t}^{CH}}{\hat{X}_{2,t}^{CH}}$$

where

$$\hat{X}_{1,t}^{CH} = \Lambda_t^C mc_t^C y_{C,t}^H(i) + \theta_p \beta \mathbb{E}_t \hat{X}_{1,t+1}^{CH}$$
$$\hat{X}_{2,t}^{CH} = \Lambda_t^C y_{C,t}^H(i) + \theta_p \beta \mathbb{E}_t \left(\frac{\hat{X}_{2,t+1}^{CH}}{1+\Pi_{t+1}^C} \right)$$

and generic demand:

$$\begin{aligned} y_{C,t}^H(i) &= \frac{\nu_C^H}{\alpha(1-n)} \left(\frac{E_{CH,t} p_{C,t}^H}{E_{CH,t} P_{C,t}^H} \right)^{-\sigma} \left(\frac{P_{C,t}^H}{P_t^H} \right)^{-\theta} Y_t^H \\ &= \frac{\nu_C^H}{\alpha(1-n)} \left(S_{HC,t} \frac{\hat{p}_{C,t}^H / P_t^C}{P_{c,t}^h} \right)^{-\sigma} \left(P_{c,t}^h \right)^{-\theta} Y_t^H \end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned} \left(\hat{P}_{C,t}^H \right)^{1-\sigma} &= (1-\theta_p) \left(\hat{p}_{C,t}^H \right)^{1-\sigma} + \theta_p \left(\hat{P}_{C,t-1}^H \right)^{1-\sigma} \\ \Rightarrow \left(\frac{\hat{P}_{C,t}^H}{P_t^C} \right)^{1-\sigma} &= (1-\theta_p) \left(\frac{\hat{p}_{C,t}^H}{P_t^C} \right)^{1-\sigma} + \theta_p \left(\frac{\hat{P}_{C,t-1}^H / P_{t-1}^C}{1+\Pi_t^C} \right)^{1-\sigma} \end{aligned}$$

and also the price dispersion:

$$\begin{aligned} \hat{D}_{C,t}^H &= \int_n^{n+\gamma^C \alpha(1-n)} \frac{1}{\gamma^C \alpha(1-n)} \left(\frac{\hat{p}_{C,t}^H(i)}{\hat{P}_{C,t}^H} \right)^{-\sigma} di \\ &= (1-\theta_p) \left(\frac{\hat{p}_{C,t}^H / P_t^C}{\hat{P}_{C,t}^H / P_t^C} \right)^{-\sigma} + \theta_p \hat{D}_{C,t-1}^H \left(1 + \hat{\Pi}_{C,t}^H \right)^{\sigma} \end{aligned}$$

where

$$1 + \hat{\Pi}_{C,t}^H = \frac{\hat{P}_{C,t}^H / P_t^C}{\hat{P}_{C,t-1}^H / P_{t-1}^C} \left(1 + \Pi_t^C \right)$$

D.9 CHN DCP Exports to SOE (in USD)

$$\frac{\tilde{p}_{C,t}^H}{P_t^D} = \frac{\sigma}{\sigma - 1} \frac{\tilde{X}_{1,t}^{CH}}{\tilde{X}_{2,t}^{CH}}$$

where

$$\tilde{X}_{1,t}^{CH} = \Lambda_t^C mc_t^C y_{C,t}^H(i) + \theta_p \beta \mathbb{E}_t \tilde{X}_{1,t+1}^{CH}$$
$$\tilde{X}_{2,t}^{CH} = \Lambda_t^H S_{CD,t} y_{C,t}^H(i) + \theta_p \beta \mathbb{E}_t \left(\frac{\tilde{X}_{2,t+1}^{CH}}{1+\Pi_{t+1}^D} \right)$$

and generic demand:

$$\begin{aligned} y_{C,t}^H(i) &= \frac{\nu_C^H}{\alpha(1-n)} \left(\frac{E_{HD,t} \tilde{P}_{C,t}^H(i)}{P_{C,t}^H} \right)^{-\sigma} \left(\frac{P_{C,t}^H}{P_t^H} \right)^{-\theta} Y_t^H \\ &= \frac{\nu_C^H}{\alpha(1-n)} \left(S_{HD,t} \frac{\tilde{p}_{C,t}^H / P_t^D}{P_{c,t}^h} \right)^{-\sigma} \left(P_{c,t}^h \right)^{-\theta} Y_t^H \end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned} \left(\tilde{P}_{C,t}^H \right)^{1-\sigma} &= (1-\theta_p) \left(\tilde{p}_{C,t}^H \right)^{1-\sigma} + \theta_p \left(\tilde{P}_{C,t-1}^H \right)^{1-\sigma} \\ \Rightarrow \left(\frac{\tilde{P}_{C,t}^H}{P_t^D} \right)^{1-\sigma} &= (1-\theta_p) \left(\frac{\tilde{p}_{C,t}^H}{P_t^D} \right)^{1-\sigma} + \theta_p \left(\frac{\tilde{P}_{C,t-1}^H / P_{t-1}^D}{1+\Pi_t^D} \right)^{1-\sigma} \end{aligned}$$

and also the dynamics of price dispersion:

$$\begin{aligned} \tilde{D}_{C,t}^H &= \int_{n+\gamma^C \alpha(1-n)}^{n+\alpha(1-n)} \frac{1}{(1-\gamma^C)\alpha(1-n)} \left(\frac{\tilde{p}_{C,t}^H(i)}{\tilde{P}_{C,t}^H} \right)^{-\sigma} di \\ &= (1-\theta_p) \left(\frac{\tilde{p}_{C,t}^H / P_t^D}{\tilde{P}_{C,t}^H / P_t^D} \right)^{-\sigma} + \theta_p \tilde{D}_{C,t-1}^H \left(1 + \tilde{\Pi}_{C,t}^H \right)^{\sigma} \end{aligned}$$

where

$$1 + \tilde{\Pi}_{C,t}^H = \frac{\tilde{P}_{C,t}^H / P_t^D}{\tilde{P}_{C,t-1}^H / P_{t-1}^D} \left(1 + \Pi_t^D \right)$$

D.10 CHN LCP Exports to US (in USD)

$$\frac{\tilde{p}_{C,t}^D}{P_t^D} = \frac{\sigma}{\sigma - 1} \frac{X_{1,t}^{CD}}{X_{2,t}^{CD}}$$

where

$$\begin{aligned} X_{1,t}^{CD} &= \Lambda_t^C \frac{w_t^C}{A_t^C} y_{C,t}^D(i) + \theta_p \beta \mathbb{E}_t X_{1,t+1}^{CD} \\ X_{2,t}^{CD} &= \Lambda_t^C S_{CD,t} y_{Ct}^D(i) + \theta_p \beta \mathbb{E}_t \left(\frac{X_{2,t+1}^{CD}}{1+\Pi_{t+1}^D} \right) \end{aligned}$$

and generic demand:

$$y_{C,t}^{D}(i) = \frac{\nu_C^D}{\alpha(1-n)} \left(\frac{\tilde{p}_{C,t}^{D}(i)}{P_{C,t}^{D}} \right)^{-\sigma} \left(\frac{P_{C,t}^{D}}{P_t^D} \right)^{-\theta} Y_t^D$$
$$= \frac{\nu_C^D}{\alpha(1-n)} \left(\frac{\tilde{p}_{C,t}^{D}/P_t^D}{P_{c,t}^{d}} \right)^{-\sigma} \left(P_{c,t}^{d} \right)^{-\theta} Y_t^D$$

which is subject to Calvo price process:

$$\left(P_{C,t}^{D} \right)^{1-\sigma} = (1-\theta_p) \left(\tilde{p}_{C,t}^{D} \right)^{1-\sigma} + \theta_p \left(P_{C,t-1}^{D} \right)^{1-\sigma}$$
$$\Rightarrow \left(P_{c,t}^{d} \right)^{1-\sigma} = (1-\theta_p) \left(\frac{\tilde{p}_{C,t}^{D}}{P_t^D} \right)^{1-\sigma} + \theta_p \left(\frac{P_{c,t-1}^{d}}{1+\Pi_t^D} \right)^{1-\sigma}$$

and also the dynamics of price dispersion:

$$D_{C,t}^{D} \triangleq \int_0^n \frac{1}{n} \left(\frac{\tilde{p}_{C,t}^{D}(i)}{P_{C,t}^{D}} \right)^{-\sigma} di$$
$$= (1-\theta_p) \left(\frac{\tilde{p}_{C,t}^{D}/P_t^D}{P_{c,t}^{d}} \right)^{-\sigma} + \theta_p D_{C,t-1}^{D} \left(1+\Pi_{C,t}^{D} \right)^{\sigma}$$

where

$$1+\Pi_{C,t}^{D} = \frac{P_{c,t}^{d}}{P_{c,t-1}^{d}} \left(1+\Pi_t^D \right)$$

D.11 USA Household

- The definition of USA nominal stochastic discount factor:

$$\Lambda_t^D = \left(C_t^D \right)^{-\rho}$$

- The USA Intra-temporal condition

$$w_t^D = \kappa \left(C_t^D \right)^{\rho} \left(N_t^D \right)^{\eta}$$

- The USA Euler equation for dollar-denominated bond:

$$\Lambda_t^D = \beta(1+r_t^D)\mathbb{E} \left(\frac{\Lambda_{t+1}^D}{1+\pi_{t+1}^D} \right)$$

D.12 USA Domestic Sales

$$\frac{p_{D,t}^{D}}{P_{D,t}^{D}} = \frac{\sigma}{\sigma-1} \frac{X_{1,t}^{D}}{X_{2,t}^{D}}$$

where

$$X_{1,t}^{D} = \Lambda_t^{D} mc_t^{D} y_{D,t}^{D}(i) + \theta_p \beta \mathbb{E}_t X_{1,t+1}^{D}$$
$$X_{2,t}^{D} = \Lambda_t^{D} y_{D,t}^{D}(i) + \theta_p \beta \mathbb{E}_t \left(\frac{X_{2,t+1}^{C}}{1+\Pi_{t+1}^{D}} \right)$$

and generic demand

$$\begin{aligned} y_{D,t}^{D}(i) &= \frac{\nu_D^{D}}{(1-\alpha)(1-n)} \left(\frac{p_{D,t}^{D}}{P_{D,t}^{D}} \right)^{-\sigma} \left(\frac{P_{D,t}^{D}}{P_t^{D}} \right)^{-\theta} Y_t^{D} \\ &= \frac{\nu_D^{D}}{(1-\alpha)(1-n)} \left(\frac{p_{D,t}^{D}/P_t^{D}}{P_{dt}^{d}} \right)^{-\sigma} \left(P_{d,t}^{d} \right)^{-\theta} Y_t^{D} \end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned} \left(P_{D,t}^{D} \right)^{1-\sigma} &= (1-\theta_p) \left(p_{D,t}^{D} \right)^{1-\sigma} + \theta_p \left(P_{D,t-1}^{D} \right)^{1-\sigma} \\ \Rightarrow \left(P_{d,t}^{d} \right)^{1-\sigma} &= (1-\theta_p) \left(\frac{p_{D,t}^{D}}{P_t^{D}} \right)^{1-\sigma} + \theta_p \left(\frac{P_{d,t-1}^{d}}{1+\Pi_t^{D}} \right)^{1-\sigma} \end{aligned}$$

and also the dynamics of price dispersion:

$$\begin{aligned} D_{D,t}^{D} &\triangleq \int_{n+\alpha(1-n)}^{1} \frac{1}{(1-\alpha)(1-n)} \left(\frac{p_{D,t}^{D}(i)}{P_{D,t}^{D}} \right)^{-\sigma} di \\ &= (1-\theta_p) \left(\frac{p_{D,t}^{D}/P_t^{D}}{P_{d,t}^{d}} \right)^{-\sigma} + \theta_p D_{D,t-1}^{D} \left(1+\Pi_{D,t}^{D} \right)^{\sigma} \end{aligned}$$

where:

$$1+\Pi_{D,t}^{D} = \frac{P_{d,t}^{d}}{P_{d,t-1}^{d}} \left(1+\Pi_t^{D} \right)$$

D.13 USA PCP Exports to SOE (in USD)

$$\frac{\tilde{p}_{Dt}^{H}}{P_t^{D}} = \frac{E_{DH,t} p_{Dt}^{H}}{P_t^{D}} = \frac{\sigma}{\sigma-1} \frac{\tilde{X}_{1,t}^{DH}}{\tilde{X}_{2,t}^{DH}}$$

where

$$\tilde{X}_{1,t}^{DH} = \Lambda_t^{D} mc_t^{D} y_{D,t}^{H}(i) + \theta_p \beta \mathbb{E}_t \tilde{X}_{1,t+1}^{DH}$$
$$\tilde{X}_{2,t}^{DH} = \Lambda_t^{D} y_{D,t}^{H}(i) + \theta_p \beta \mathbb{E}_t \left(\frac{\tilde{X}_{2,t+1}^{DH}}{1+\Pi_{t+1}^{D}} \right)$$

and generic demand at equilibrium:

$$\begin{aligned} y_{D,t}^H(i) &= \frac{\nu_D^H}{(1-\alpha)(1-n)} \left(\frac{E_{DH,t} p_{Dt}^H}{E_{DH,t} P_{D,t}^H} \right)^{-\sigma} \left(\frac{P_{Dt}^H}{P_t^H} \right)^{-\theta} Y_t^H \\ &= \frac{\nu_D^H}{(1-\alpha)(1-n)} \left(S_{HD,t} \frac{\tilde{p}_{D,t}^H / P_t^D}{P_{d,t}^h} \right)^{-\sigma} \left(P_{d,t}^h \right)^{-\theta} Y_t^H \end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned} \left(\tilde{P}_{D,t}^H \right)^{1-\sigma} &= (1-\theta_p) \left(\tilde{p}_{D,t}^H \right)^{1-\sigma} + \theta_p \left(\tilde{P}_{D,t-1}^H \right)^{1-\sigma} \\ \Rightarrow \left(\frac{\tilde{P}_{D,t}^H}{P_t^D} \right)^{1-\sigma} &= (1-\theta_p) \left(\frac{\tilde{p}_{D,t}^H}{P_t^D} \right)^{1-\sigma} + \theta_p \left(\frac{\tilde{P}_{D,t-1}^H / P_{t-1}^D}{1+\Pi_t^D} \right)^{1-\sigma} \end{aligned}$$

and also the price dispersion:

$$\begin{aligned} \tilde{D}_{D,t}^H &\triangleq \int_{n+\alpha(1-n)}^1 \frac{1}{(1-\alpha)(1-n)} \left(\frac{\tilde{p}_{D,t}^H(i)}{\tilde{P}_{D,t}^H} \right)^{-\sigma} di \\ &= (1-\theta_p) \left(\frac{\tilde{p}_{Dt}^H / P_t^D}{\tilde{P}_{D,t}^H / P_t^D} \right)^{-\sigma} + \theta_p \tilde{D}_{D,t-1}^H \left(1 + \tilde{\Pi}_{D,t}^H \right)^{\sigma} \end{aligned}$$

where

$$1 + \tilde{\Pi}_{D,t}^H = \frac{\tilde{P}_{D,t}^H / P_t^D}{\tilde{P}_{D,t-1}^H / P_{t-1}^D} \left(1 + \Pi_t^D \right)$$

D.14 USA PCP Exports to CHN (in USD)

$$\frac{\tilde{p}_{D,t}^C}{P_t^D} = \frac{E_{DC,t} p_{D,t}^C}{P_t^D} = \frac{\sigma}{\sigma - 1} \frac{\tilde{X}_{1t}^{DC}}{\tilde{X}_{2t}^{DC}}$$

where

$$\begin{aligned} \tilde{X}_{1t}^{DC} &= \Lambda_t^D m c_t^D y_{Dt}^C(i) + \theta_p \beta \mathbb{E}_t \tilde{X}_{1,t+1}^{DC} \\ \tilde{X}_{2t}^{DC} &= \Lambda_t^D y_{Dt}^C(i) + \theta_p \beta \mathbb{E}_t \left(\frac{\tilde{X}_{2,t+1}^{DC}}{1+\Pi_{t+1}^D} \right) \end{aligned}$$

and generic demand at equilibrium:

$$\begin{aligned} y_{D,t}^C(i) &= \frac{\nu_D^C}{(1-\alpha)(1-n)} \left(\frac{E_{DC,t} p_{D,t}^C}{E_{DC,t} P_{D,t}^C} \right)^{-\sigma} \left(\frac{P_{D,t}^C}{P_t^C} \right)^{-\theta} Y_t^C \\ &= \frac{\nu_D^C}{(1-\alpha)(1-n)} \left(S_{CD,t} \frac{\tilde{p}_{Dt}^C / P_t^D}{P_{d,t}^c} \right)^{-\sigma} \left(P_{d,t}^c \right)^{-\theta} Y_t^C \end{aligned}$$

which is subject to Calvo price process:

$$\begin{aligned}\left(\tilde{P}_{D,t}^{C}\right)^{1-\sigma} &= (1-\theta_p)\left(\tilde{p}_{D,t}^{C}\right)^{1-\sigma} + \theta_p\left(\tilde{P}_{D,t-1}^{C}\right)^{1-\sigma} \\ \Rightarrow \left(\frac{\tilde{P}_{D,t}^{C}}{P_t^D}\right)^{1-\sigma} &= (1-\theta_p)\left(\frac{\tilde{p}_{D,t}^{C}}{P_t^D}\right)^{1-\sigma} + \theta_p\left(\frac{\tilde{P}_{D,t-1}^{C}/P_{t-1}^{D}}{1+\Pi_t^D}\right)^{1-\sigma}\end{aligned}$$

and also the price dispersion:

$$\begin{aligned}\tilde{D}_{D,t}^{C} &\triangleq \int_{n+\alpha(1-n)}^{1} \frac{1}{(1-\alpha)(1-n)}\left(\frac{\tilde{p}_{D,t}^{C}(i)}{\tilde{P}_{D,t}^{H}}\right)^{-\sigma} di \\ &= (1-\theta_p)\left(\frac{\tilde{p}_{D,t}^{C}/P_t^D}{\tilde{P}_{D,t}^{C}/P_t^D}\right)^{-\sigma} + \theta_p \tilde{D}_{D,t-1}^{C}\left(1+\tilde{\Pi}_{D,t}^{C}\right)^{\sigma}\end{aligned}$$

where

$$1+\tilde{\Pi}_{D,t}^{C} = \frac{\tilde{P}_{D,t}^{C}/P_t^D}{\tilde{P}_{D,t-1}^{C}/P_{t-1}^{D}}\left(1+\Pi_t^D\right)$$

D.15 Price Indexes

- SOE CPI process:

$$1 = (1-\lambda)(P_{h,t}^{h})^{1-\theta} + \alpha\lambda(P_{c,t}^{h})^{1-\theta} + (1-\alpha)\lambda(P_{d,t}^{h})^{1-\theta}$$

- CHN CPI process:

$$1 = \alpha\left(P_{c,t}^{c}\right)^{1-\theta} + (1-\alpha)\left(P_{d,t}^{c}\right)^{1-\theta}$$

- USA CPI process:

$$1 = (1-\alpha)\left(P_{dt}^{d}\right)^{1-\theta} + \alpha\left(P_{ct}^{d}\right)^{1-\theta}$$

- SOE Import (from CHN) Price Index:

$$P_{c,t}^{h} = \left[(1-\gamma)(S_{HD,t}\tilde{P}_{C}^{H})^{1-\sigma_t} + \gamma(S_{HC,t}\hat{P}_{C,t}^{H})^{1-\sigma_t}\right]^{\frac{1}{1-\sigma_t}}$$

- SOE Import (from USA) Price Index:

$$P_{Dt}^{H} = S_{HDt}\hat{P}_{DH,t}$$

- CHN Import (from USA) Price Index:

$$P_{Dt}^{C} = S_{CDt}\hat{P}_{Dt}^{C}$$

D.16 Market Clearing

- SOE product market clearing:

$$Y_t^H = C_t^H$$

- CHN product market clearing:

$$Y_t^C = C_t^C$$

- USA product market clearing:

$$Y_t^D = C_t^D$$

- SOE labor market clearing:

$$A_t^H N_t^H = (1-\lambda) D_{Ht}^H \left(P_{ht}^h\right)^{-\theta} Y_t^H + \alpha\lambda D_{Ht}^C \left(P_{ht}^c\right)^{-\theta} Y_t^C + (1-\alpha)\lambda D_{Ht}^D \left(P_{ht}^d\right)^{-\theta} Y_t^D$$

- CHN labor market clearing:

$$A_t^C N_t^C = \alpha \left(D_{Ct}^C\right) \left(P_{ct}^c\right)^{-\theta} Y_t^C + (1-\alpha) D_{Ct}^D \left(P_{ct}^d\right)^{-\theta} Y_t^D$$

- USA labor market clearing:

$$A_t^D N_t^D = (1-\alpha) D_{Dt}^D \left(P_{dt}^d\right)^{-\theta} Y_t^D + \alpha D_{Dt}^C \left(P_{dt}^c\right)^{-\theta} Y_t^C$$

D.17 Monetary Policy

- SOE exchange rate policy:

$$(E_{HDt})^{1-\xi} (E_{HCt})^{\xi} = 1$$

- CHN monetary policy:

$$\frac{1+r_t^C}{1+\bar{r}^C} = \left(\frac{1+r_{t-1}^C}{1+\bar{r}^C}\right)^{\rho_R} \left[\left(\frac{Y_t^C}{\bar{Y}^C}\right)^{\rho_Y} \left(\frac{1+\pi_t^C}{1+\bar{\pi}^C}\right)^{\rho_\pi}\right]^{1-\rho_R} \exp(\eta_t^{C,MP})$$

- USA monetary policy

$$\frac{1+r_t^D}{1+\bar{r}^D} = \left(\frac{1+r_{t-1}^D}{1+\bar{r}_t^D}\right)^{\rho_R} \left[\left(\frac{Y_t^D}{\bar{Y}^D}\right)^{\rho_Y} \left(\frac{1+\pi_t^D}{1+\bar{\pi}^D}\right)^{\rho_\pi}\right]^{1-\rho_R} \exp(\eta_t^{D,MP})$$

D.18 Exogenous Process

- SOE TFP Process:

$$\log(A_t^H) = (1-\rho^{H,TFP}) \log(\bar{A}^H) + \rho^{H,TFP} \log(A_{t-1}^H) + \epsilon_t^{H,TFP}$$

- CHN TFP Process:

$$\log(A_t^C) = (1-\rho^{C,TFP})\log(\bar{A}^C) + \rho^{C,TFP}\log(A_{t-1}^C) + \epsilon_t^{C,TFP}$$

- USA TFP Process:

$$\log(A_t^D) = (1-\rho^{D,TFP})\log(\bar{A}^D) + \rho^{D,TFP}\log(A_{t-1}^D) + \epsilon_t^{D,TFP}$$

- SOE Markup Shock Process:

$$\log(\sigma_t^H) = (1-\rho_\sigma)\log(\sigma) + \rho_\sigma\log(\sigma_{t-1}^H) + \epsilon_\sigma^H$$

- CHN Markup Shock Process:

$$\log(\sigma_t^C) = (1-\rho_\sigma)\log(\sigma) + \rho_\sigma\log(\sigma_{t-1}^C) + \epsilon_\sigma^C$$

- USA Markup Shock Process:

$$\log(\sigma_t^D) = (1-\rho_\sigma)\log(\sigma) + \rho_\sigma\log(\sigma_{t-1}^D) + \epsilon_\sigma^D$$

- CHN UIP Shock Process:

$$\eta_t^{C,UIP} = \rho^{C,UIP}\eta_{t-1}^{C,UIP} + \epsilon_t^{C,UIP}$$

- SOE UIP Shock Process:

$$\eta_t^{H,UIP} = \rho^{H,UIP}\eta_{t-1}^{H,UIP} + \epsilon_t^{H,UIP}$$

- CHN monetary policy shock process:

$$\eta_t^{C,MP} = \rho^{C,MP}\eta_{t-1}^{C,MP} + \epsilon_t^{C,MP}$$

- USA monetary policy shock process:

$$\eta_t^{D,MP} = \rho^{D,MP}\eta_{t-1}^{D,MP} + \epsilon_t^{D,MP}$$

D.19 Production

- SOE aggregate production:

$$Z_t^H = A_t^H N_t^H$$

- CHN aggregate production:

$$Z_t^C = A_t^C N_t^C$$

- USA aggregate production:

$$Z_t^D = A_t^D N_t^D$$

- SOE marginal cost:

$$mc_t^H = \frac{w_t^H}{A_t^H}$$

- CHN marginal cost:

$$mc_t^C = \frac{w_t^C}{A_t^C}$$

- USA marginal cost:

$$mc_t^D = \frac{w_t^D}{A_t^D}$$

D.20 Close the Model

- Real exchange rate and nominal exchange rate: SOE currency v.s. RMB:

$$\frac{S_{HC,t}}{S_{HC,t-1}} = \frac{E_{HC,t}}{E_{HC,t-1}} \frac{1+\pi_t^C}{1+\pi_t^H}$$

- Real exchange rate and nominal exchange rate: SOE currency v.s. USD:

$$\frac{S_{HD,t}}{S_{HD,t-1}} = \frac{E_{HD,t}}{E_{HD,t-1}} \frac{1+\pi_t^D}{1+\pi_t^H}$$

- Definition of RMB v.s. USD:

$$S_{CDt} = \frac{S_{HDt}}{S_{HCt}}$$

- Conditional Welfare Function:

$$\mathcal{W}_t = \frac{\left(C_t^H\right)^{1-\rho}}{1-\rho} - \kappa \frac{\left(N_t^H\right)^{1+\eta}}{1+\eta} + \beta \mathbb{E}_t \mathcal{W}_{t+1}$$

E Steady State

Type-I parameters (calibrated from the literature)

We follow common practice in the literature when calibrating a first group of parameters. Since China and the United States are assumed to have identical population sizes in the model, we set the relative population weight to

$$\alpha = 0.5.$$

Following established calibrations (e.g. De Paoli (2009); Gali & Monacelli (2005)), we set the openness parameter and other preference / frictions parameters as

$$\lambda = 0.4, \qquad \theta_p = 0.66, \qquad \beta = 0.99.$$

The inverse of the intertemporal elasticity and the inverse of the Frisch elasticity are taken as conventional values in the literature:

$$\rho = 2, \qquad \eta = 2.$$

The elasticity of substitution across varieties (and the steady-state markup parameter) is set as in De Paoli (2009),

$$\sigma = 10.$$

The benchmark trade elasticity is set to

$$\theta = 5,$$

which corresponds to the upper range considered in De Paoli (2009). Given fixed intertemporal substitution, a larger trade elasticity implies that the small open economy's optimal monetary policy is more inclined toward an exchange-rate pegging regime rather than merely stabilizing domestic prices; therefore a relatively high trade elasticity is chosen to match our calibration of the SOE monetary authority's currency-basket peg rule.

Finally, for the sensitivity coefficients of the interest-rate risk premium to external debt in the EDIER condition we follow Gopinath et al. (2020) and set symmetric sensitivities for the SOE and China:

$$\psi^H = \psi^C = 0.001.$$

Collecting these first-class parameter values:

$$\alpha = 0.5, \quad \lambda = 0.4, \quad \theta = 5, \quad \sigma = 10, \quad \rho = 2, \eta = 2, \quad \beta = 0.99, \quad \theta_p = 0.66, \quad \psi^H = \psi^C = 0.001.$$

The remaining unknown parameters will be treated as second-class parameters and will be determined by matching selected first moments:

$$\{\bar{\pi}^H, \bar{\pi}^C, \bar{\pi}^D, \bar{b}_d, \bar{b}_e, \bar{A}^H, \bar{A}^C, \bar{A}^D, \kappa\}.$$

Type-II parameters (to match first moments)

Modern central banks typically target zero inflation in steady state. Accordingly, we set the steady-state inflation rates to zero:

$$\bar{\pi}^H = \bar{\pi}^C = \bar{\pi}^D = 0.$$

Using China as the normalization benchmark, we assume that steady-state labor corresponds to 8 hours per day, i.e. the normalized labor supply is

$$\bar{N}^C = \frac{1}{3}.$$

Given the production and labor-leisure structure, the steady-state disutility-of-labor coefficient κ can be written in general as

$$\kappa = \frac{w^C}{(N^C)^\eta (C^C)^\rho},$$

and, with $\bar{N}^C = 1/3$, this becomes

$$\kappa = \frac{w^C}{(1/3)^\eta (C^C)^\rho}.$$

We normalize the level of aggregate output in China in steady state. Denote the steady-state per-capita nominal output by $\bar{Z}^i$ for country i. Setting China's output normalization to unity,

$$\bar{Z}^C = 1,$$

and given $\bar{N}^C = 1/3$, the corresponding steady-state total factor productivity (TFP) for China is

$$\bar{A}^C = \frac{\bar{Z}^C}{\bar{N}^C} = 3.$$

Let ξ_{HC} denote the relative weight of per-capita nominal output of the SOE to China. Then steady-state output levels can be expressed as

$$Z^C = \bar{Z}^C, \qquad Z^H = \xi_{HC}\, S_{HC}\, Z^C, \qquad Z^D = \frac{Z^H}{\xi_{HD}\, S_{HD}}.$$

Thus $\bar{A}^C$ and $\bar{A}^D$ will be determined jointly with the labor supply and the steady-state real exchange rate when solving for the full steady state.

For the steady-state real external debt stocks, we impose zero debt-to-output ratios in steady state:

$$\frac{E_{HD}\, \bar{B}_D^H}{\bar{P}^H \bar{Y}^H} = S_{HD}\, \frac{\bar{b}_h^c}{\bar{Y}^H} = 0, \qquad \frac{E_{CD}\, \bar{B}_D^C}{\bar{P}^C \bar{Y}^C} = S_{CD}\, \frac{\bar{b}_d^c}{\bar{Y}^C} = 0,$$

so that the steady-state real holdings of external dollar debt are set to zero.

Analytical and Numerical Steady States

Under zero-inflation steady state one can obtain closed-form solutions for several variables:

$$\bar{\sigma}_t = \sigma, \qquad \bar{\tau}^H = \bar{\tau}^{DH} = \bar{\tau}^C = \bar{\tau}^{DC} = \bar{\tau}^D = \frac{1}{\beta} - 1.$$

The remainder of the steady state must be computed numerically. Concretely, we search over the two unknowns

$$x = \left(p_c^c,\, S_{HC}\right)$$

to close the labor-market equilibrium conditions for the SOE and the US (country D):

$$0 = Z^H - \Big[(1-\lambda)D_H^H(P_h^h)^{-\theta}C^H + \alpha\lambda D_H^C(P_h^c)^{-\theta}C^C + (1-\alpha)\lambda D_H^D(P_h^d)^{-\theta}C^D\Big], \tag{E.1}$$

$$0 = Z^D - \Big[(1-\alpha)D_D^D(P_d^d)^{-\theta}C^D + \alpha D_D^C(P_d^c)^{-\theta}C^C\Big]. \tag{E.2}$$

To solve the system (E.1)–(E.2) we express all model variables as functions of the two unknowns p_c^c and S_{HC}.

Define the steady-state markup parameter

$$\mu = \frac{\sigma}{\sigma - 1}.$$

China's steady-state marginal cost can be written as

$$\mathrm{mc}^C = \frac{p_c^c}{\mu}.$$

The price index for US imports of Chinese goods and associated aggregator terms can then be expressed as

$$P_d^c = \left(\frac{1}{1-\alpha}\Big(1 - \alpha(p_c^c)^{\,1-\theta}\Big)\right)^{\frac{1}{1-\theta}},$$

and

$$S_{CD} = \Big((1-\alpha)(P_d^c)^{\,1-\theta} + \alpha\Big(\mu\,\mathrm{mc}^C\Big)^{\,1-\theta}\Big)^{\frac{1}{1-\theta}}.$$

Using the above, the optimal pricing rules and price indices associated with China (for prices relevant to the SOE) are given by

$$\hat{p}_h^c = \mu\,\mathrm{mc}^C, \qquad \hat{P}_h^c = \hat{p}_h^c,$$

$$\tilde{p}_h^c = \frac{\mu\,\mathrm{mc}^C}{S_{CD}}, \qquad \tilde{P}_h^c = \tilde{p}_h^c,$$

$$P_h^c = \mu S_{HC}\,\mathrm{mc}^C, \qquad \hat{p}_c^d = \frac{\mu\,\mathrm{mc}^C}{S_{CD}}.$$

(Notation: hats and tildes denote different pricing objects in the model as in the main text.)

Similarly, for the US side we define

$$\mathrm{mc}^D = \frac{\hat{p}_d^c}{\mu}, \qquad p_d^d = \mu\,\mathrm{mc}^D, \qquad P_d^d = p_d^d.$$

For the SOE we have

$$S_{HD} = S_{HC}\, S_{CD}, \qquad \bar{p}_h^d = \mu\, \mathrm{mc}^D, \qquad \bar{P}_h^d = \bar{p}_h^d,$$

and the SOE domestic price index for home goods satisfies

$$P_h^b = \left(\frac{1 - \alpha\lambda \left(P_h^c\right)^{1-\theta} - (1-\alpha)\lambda \left(P_h^d\right)^{1-\theta}}{1-\lambda} \right)^{\frac{1}{1-\theta}},$$

with $p_h^h = P_h^h$ and

$$\mathrm{mc}^H = \frac{p_h^h}{\mu}.$$

Total consumption in the US can be written compactly by defining auxiliary blocks. Define

$$\begin{aligned}
\text{block1} &= Y^C - \frac{\beta - 1}{\beta} \cdot \frac{\alpha (p_c^c)^{-\theta}}{1 - \alpha (p_c^d)^{1-\theta}}\, S_{CD}\, b_d^c, \\
\text{block2} &= (1-\alpha)\, (p_c^d)^{-\theta}, \\
\text{block3} &= \frac{(1-\alpha)\alpha\, S_{CD}\, (p_c^c)^{-\theta}\, (p_c^d)^{1-\theta}}{1 - \alpha (p_c^d)^{1-\theta}}.
\end{aligned}$$

Then US consumption is

$$C^D = \frac{\text{block1}}{\text{block2} + \text{block3}}.$$

Using market-clearing conditions, China's total consumption can be expressed as

$$C^C = C^D \cdot \frac{\frac{\beta-1}{\beta} S_{CD} b_d^c + (1-\alpha) S_{CD} (p_c^{d,\mathrm{LCP}})^{1-\theta}}{1 - \alpha (p_c^d)^{1-\theta}}.$$

SOE total consumption is obtained from

$$\begin{aligned}
\text{block4} &= 1 - (1-\lambda)(p_h^h)^{1-\theta}, \\
\text{block5} &= \frac{\beta - 1}{\beta} S_{HD} b_d^h + \alpha\lambda S_{HC} (p_h^c)^{1-\theta} C^C + (1-\alpha)\lambda S_{HD} (\bar{p}_h^d)^{1-\theta} C^D,
\end{aligned}$$

and hence

$$C^H = \frac{\text{block5}}{\text{block4}}.$$

Given $\bar{N}^C = 1/3$ and the production function, the Chinese steady-state TFP and real wage

are

$$\bar{A}^C = \frac{Z^C}{\bar{N}^C}, \qquad w^C = \mathrm{mc}^C \, \bar{A}^C.$$

Accordingly the disutility-of-labor coefficient is

$$\kappa = \frac{w^C}{(\bar{N}^C)^\eta (C^C)^\rho}.$$

For the SOE and the US, steady-state labor, TFP and real wages are given by

$$N^H = \left(\frac{m^H Y^H}{\kappa (C^H)^\rho}\right)^{\frac{1}{\eta+1}}, \quad A^H = \frac{Y^H}{N^H}, \quad w^H = m^H A^H,$$

$$N^D = \left(\frac{m^D Y^D}{\kappa (C^D)^\rho}\right)^{\frac{1}{\eta+1}}, \quad A^D = \frac{Y^D}{N^D}, \quad w^D = m^D A^D.$$

From the dynamic process of price dispersion and the zero-inflation steady state we obtain steady-state price dispersion terms. For the SOE, for example:

$$\begin{aligned}
D_H^H &= \frac{(1-\theta_p)\left(\frac{p_h^h}{P_h^h}\right)^{-\sigma}}{1-\theta_p(1+\pi^H)^\sigma}, \\
\widehat{D}_H^C &= \frac{(1-\theta_p)\left(\frac{\hat{p}_H^C}{\widehat{P}_h^C}\right)^{-\sigma}}{1-\theta_p(1+\pi^C)^\sigma}, \\
\widetilde{D}_H^C &= \frac{(1-\theta_p)\left(\frac{\tilde{p}_H^C}{\widetilde{P}_H^C}\right)^{-\sigma}}{1-\theta_p(1+\pi^C)^\sigma}, \\
D_H^C &= \frac{(1-\gamma_H)(S_{CD}\widehat{P}_h^C)^{-\sigma}\widetilde{D}_H^C + \gamma_H(\widehat{P}_H^C)^{-\sigma}\widehat{D}_H^C}{(P_h^C)^{-\sigma}}.
\end{aligned}$$

Finally, the domestic demand for home and imported varieties for the SOE can be written as

$$C_H^H = \left(\frac{p_h^h}{P_h^h}\right)^{-\sigma}(P_h^h)^{-\theta} C^H,$$

$$\widehat{C}_H^C = \left(\frac{\hat{p}_H^C}{P_h^C}\right)^{-\sigma}(P_h^C)^{-\theta} C^C,$$

$$\widetilde{C}_H^C = \left(\frac{S_{CD}\,\tilde{p}_H^C}{P_h^c}\right)^{-\sigma}(P_h^c)^{-\theta} C^C.$$

E.1 Bilateral RMB Invoicing Share

We consider a symmetric, zero-inflation deterministic steady state with zero net foreign assets ($\bar{b}_d^h = 0$). Under these symmetric conditions, all price dispersion terms evaluate to unity ($D = 1$), and all steady-state relative prices and real exchange rates converge to 1 (i.e., $S_{HC} = S_{HD} = 1$, and $P_{ct}^h = P_{ht}^c = 1$).

Based on the CES aggregation, the SOE's generic demand for imports from China is given by:

$$Y_{Ct}^H = \nu_C^H \left(\frac{P_{Ct}^H}{P_t^H} \right)^{-\theta} Y_t^H \tag{E.3}$$

Under the symmetric calibration, the preference weight of the SOE for Chinese goods is parameterized by China's relative size and the SOE's openness, such that $\nu_C^H = \alpha\lambda$. Evaluating this at the steady state where the relative price $\frac{P_{Ct}^H}{P_t^H} = 1$, the steady-state real volume of imports is $Y_C^H = \alpha\lambda\bar{Y}^H$. Using the SOE's steady-state domestic price as the numeraire, the real value of bilateral imports from China, denoted as V_{Imp}, is:

$$V_{\text{Imp}} = P_{ct}^h Y_C^H = \alpha\lambda\bar{Y}^H \tag{E.4}$$

To determine the SOE's exports, we examine the SOE's labor market clearing condition (see Appendix D):

$$A_t^H N_t^H = (1-\lambda) D_{Ht}^H \left(P_{ht}^h\right)^{-\theta} Y_t^H + \alpha\lambda D_{Ht}^C \left(P_{ht}^c\right)^{-\theta} Y_t^C + (1-\alpha)\lambda D_{Ht}^D \left(P_{ht}^d\right)^{-\theta} Y_t^D \tag{E.5}$$

The second term on the right-hand side rigorously defines the per-capita demand for SOE goods originating from China. Notice that the population parameter n naturally cancels out in the derivation of this per-capita demand, leaving a well-defined export term. Evaluating this term at the steady state ($D_{Ht}^C = 1$ and $P_{ht}^c = 1$), the real volume of exports to China is $Y_H^C = \alpha\lambda\bar{Y}^C$. Converting this into the SOE's numeraire using the steady-state real exchange rate ($S_{HC} = 1$), the real value of bilateral exports to China, V_{Exp}, is:

$$V_{\text{Exp}} = S_{HC} P_{ht}^c Y_H^C = \alpha\lambda\bar{Y}^C \tag{E.6}$$

Given the symmetric calibration of preferences, identical labor supply elasticities, and identical steady-state markups across countries, the steady-state consumption and output levels are perfectly equalized across the global economy:

$$\bar{Y}^H = \bar{Y}^C = \bar{Y} \tag{E.7}$$

Substituting this equality into Equations (E.4) and (E.6), it strictly follows that:

$$V_{\text{Imp}} = V_{\text{Exp}} = \alpha\lambda\bar{Y} \equiv V \tag{E.8}$$

This confirms that the symmetric steady state inherently features bilateral trade balance.

Since relative prices are unity in the steady state, the invoicing share parameters γ^C and γ^H directly represent the value shares of RMB-denominated trade in imports and exports, respectively. Therefore, the total real value of RMB-denominated trade is $\gamma^C V_{\text{Imp}} + \gamma^H V_{\text{Exp}}$. The aggregate bilateral RMB invoicing share, γ^{Total}, is defined as the ratio of RMB-denominated trade to total bilateral trade:

$$\begin{aligned} \gamma^{\text{Total}} &= \frac{\gamma^C V_{\text{Imp}} + \gamma^H V_{\text{Exp}}}{V_{\text{Imp}} + V_{\text{Exp}}} \\ &= \frac{\gamma^C V + \gamma^H V}{2V} \\ &= \frac{\gamma^C + \gamma^H}{2} \end{aligned} \tag{E.9}$$

As dictated by our empirical cross-sectional calibration, the invoicing share in imports is approximately four times that in exports, yielding $\gamma^H = 0.25\gamma^C$. Substituting this structural constraint into the arithmetic mean yields the functional form used in our quantitative mapping:

$$\gamma^{\text{Total}} = \frac{\gamma^C + 0.25\gamma^C}{2} = 0.625\gamma^C \tag{E.10}$$

This proves that the total RMB invoicing exposure of the SOE is an exact linear scaling of the import invoicing parameter γ^C.

F Additional Quantitative Results

F.1 Impulse Responses

To better demonstrate the transmission channels of the optimal policy, we present impulse responses (IRFs) under the optimal currency basket weight for the RMB. These responses, which vary with the RMB's invoicing share, are analyzed for two distinct foreign shocks: a contractionary Chinese monetary policy shock (Figure F.1) and a positive Chinese TFP shock (Figure F.2).

A contractionary monetary policy shock in China generates two opposing forces on the SOE's import prices. On one hand, the contraction in China lowers the marginal cost of Chinese production, which tends to reduce the price of SOE imports. On the other hand, the shock triggers a significant appreciation of the RMB.

The net effect on the SOE's real economy is strictly determined by its currency exposure. As shown in Figure F.1, when the invoicing share is high ($\gamma^C = 20\%$), the xchange rate valuation effect dominates, causing the import price index to rise. This leads to a qualitative shift in consumption behavior: while total consumption increases under dollar invoicing ($\gamma^C = 0\%$) due to lower marginal costs, it falls under higher RMB invoicing as imported goods become prohibitively expensive. Regarding exports, although the SOE currency's depreciation relative to the RMB supports an export boom, a higher RMB invoicing share dampens this expansion. This occurs because local currency pricing (LCP) in exports impedes the expenditure-switching effect, thereby muting the overall growth in aggregate output.

A similar logic applies to a positive Chinese TFP shock (Figure F.2), which serves as a supply-side expansion. The shock reduces the marginal cost of production in China but simultaneously causes the RMB to appreciate. For the SOE, a higher RMB invoicing share acts as a buffer that prevents the economy from fully benefiting from China's productivity gains.

When $\gamma^C = 0\%$, the SOE enjoys the full extent of cheaper Chinese products, leading to a sharp drop in the import price index and a surge in both imports and total consumption. However, as γ^C increases to 20%, the RMB appreciation increasingly *offsets* the price decline at the Chinese factory gate. Consequently, the import price index drops much less significantly, resulting in more restrained growth in imports and consumption. On the export side, the SOE faces increased competition as Chinese products become more efficient. While the SOE currency's depreciation helps maintain competitiveness, the benefit tends to be weaken when exports are more invoiced in RMB.

The impulse responses to US disturbances (Figures F.3 and F.4) exhibit dynamics analogous to those observed under Chinese shocks. Under a contractionary US monetary policy shock (RD), the SOE with the lowest RMB invoicing share ($\gamma^C = 0\%$)and thus the highest US dollar (USD) exposuredisplays the most pronounced fluctuations in its bilateral trade indices with China. Consequently, the SOE currency closely tracks the currency associated with the exogenous disturbance, thereby exacerbating relative price misalignment against the non-shocked partner. These findings confirm that currency exposure serves as a primary source of terms-of-trade externalities: a high degree of integration with the shock-originating country-whether via RMB or USDamplifies international price distortions and underscores the welfare

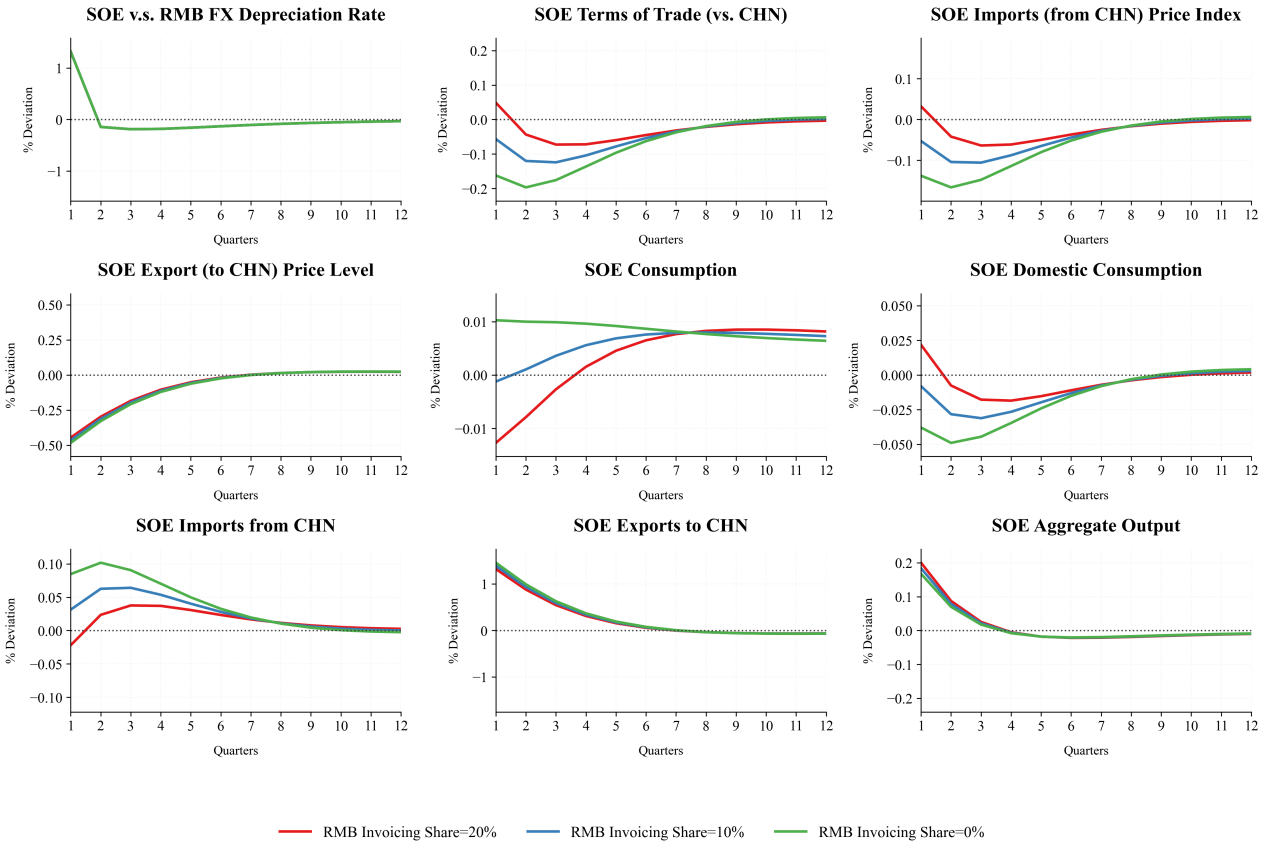


Figure F.1: Impulse Response Functions to Positive China Monetary Policy Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation China monetary policy shock under varying RMB invoicing shares.

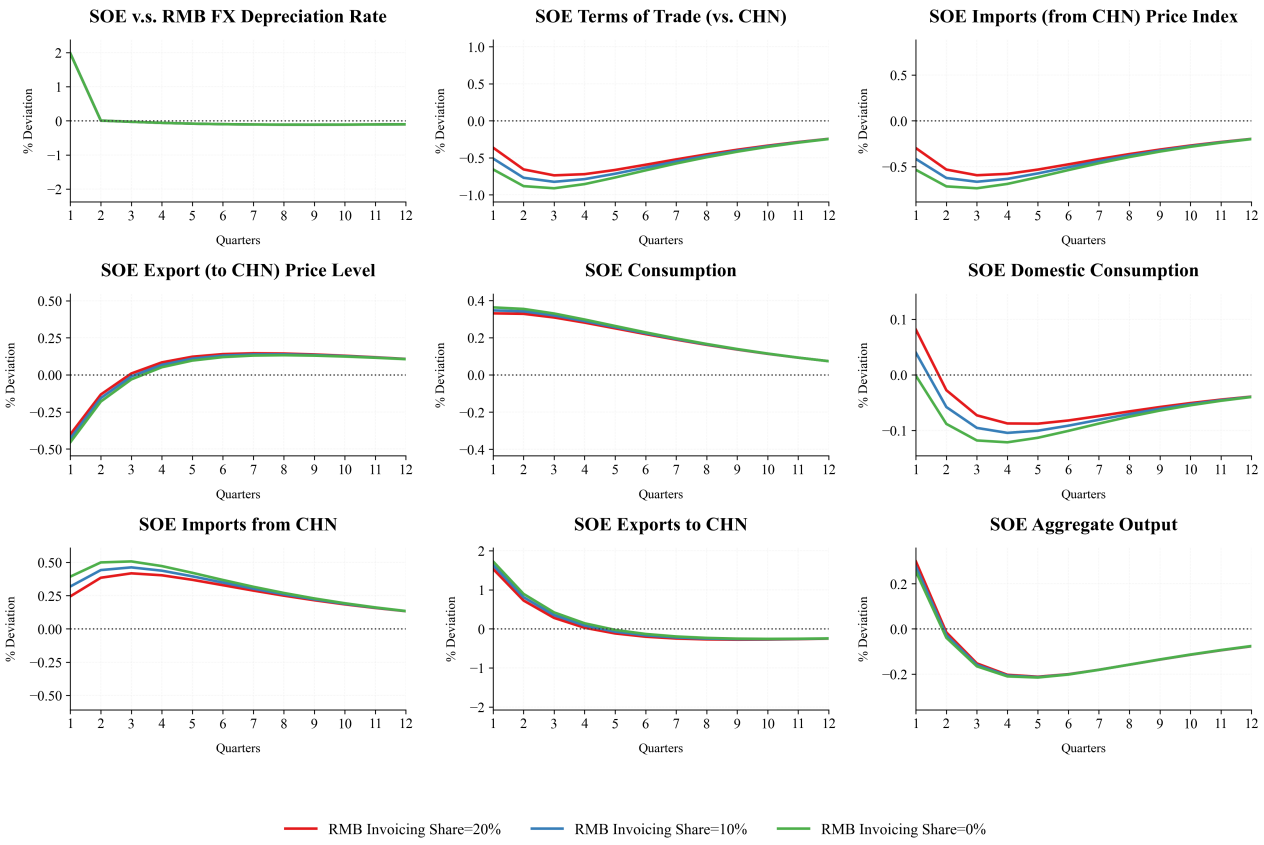


Figure F.2: Impulse Response Functions to Positive China TFP Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation China TFP shock under varying RMB invoicing shares.

imperative of endogenously adjusting policy basket weights to mitigate external shocks.

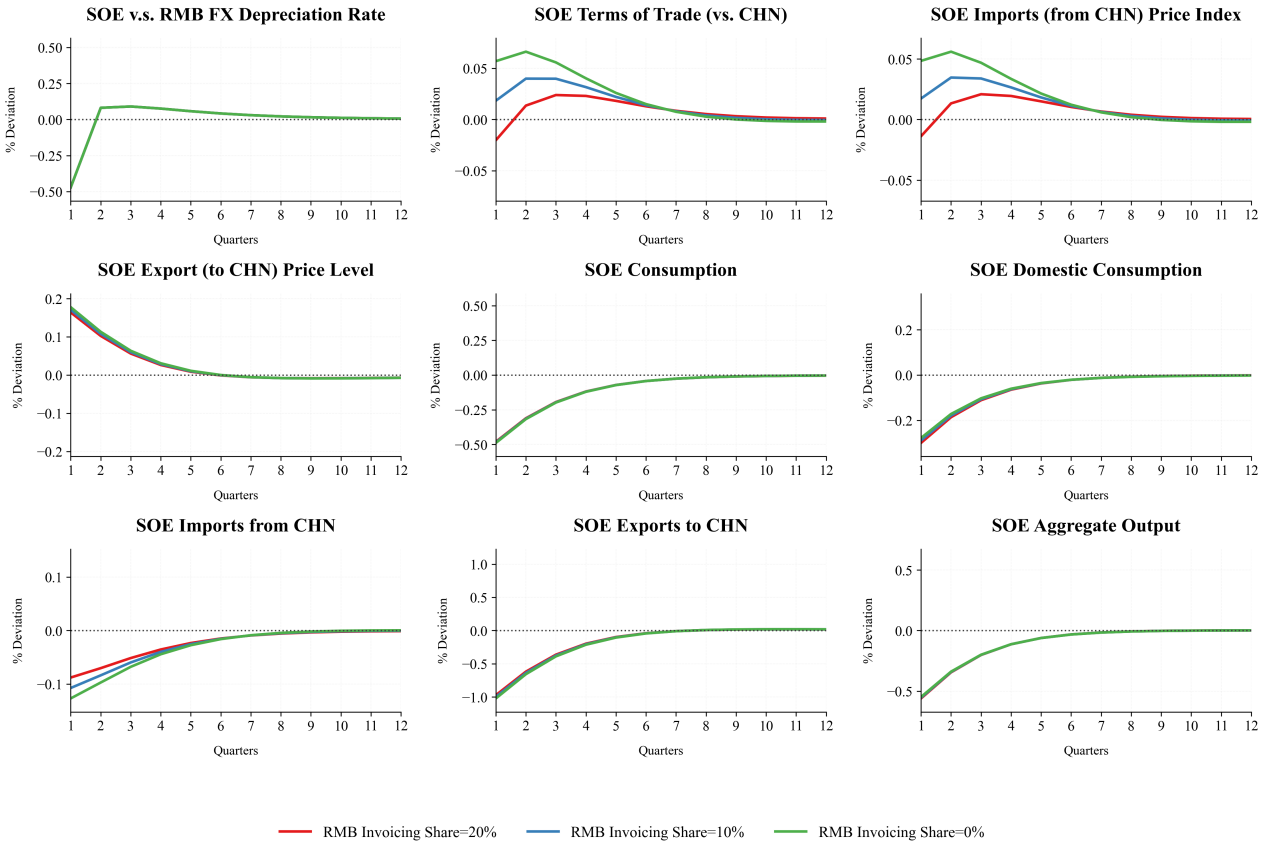


Figure F.3: Impulse Response Functions to Positive USA Monetary Policy Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation USA monetary shock under varying RMB invoicing shares.

As shown in F.5, We also presents the impulse response of UIP shock from China to show how financial frictions in FX market would reinforce the incentive of monetary authority to peg on RMB.

The introduction of RMB invoicing significantly alters the transmission of the Chinese UIP shock into the SOE's real economy. Without RMB invoicing, the depreciation of RMB induced by UIP shock leads to the appreciation of the SOE currency, triggering an inefficient expenditure-switching that harms domestic production. As the RMB invoicing share rises, the SOE's terms of trade become structurally sensitive to the RMB's nominal volatility. To minimize this distortion, the monetary authority has a strong incentive to increase the policy weight α, ensuring the SOE currency tracks the RMB's trajectory to maintain stable bilateral relative prices.

The role of the optimal policy weight is further elucidated by the impulse responses to markup shocks originating from China and the USA. A positive shock to the elasticity of substitution σ induces a contraction in the price markup, effectively acting as a positive supply-side disturbance that lowers the originating country's factory-gate prices.

The impulse responses reveal that while the structural transmission of markup shocks is symmetrical in terms of currency exposure, the macroeconomic outcomes are asymmetrical.

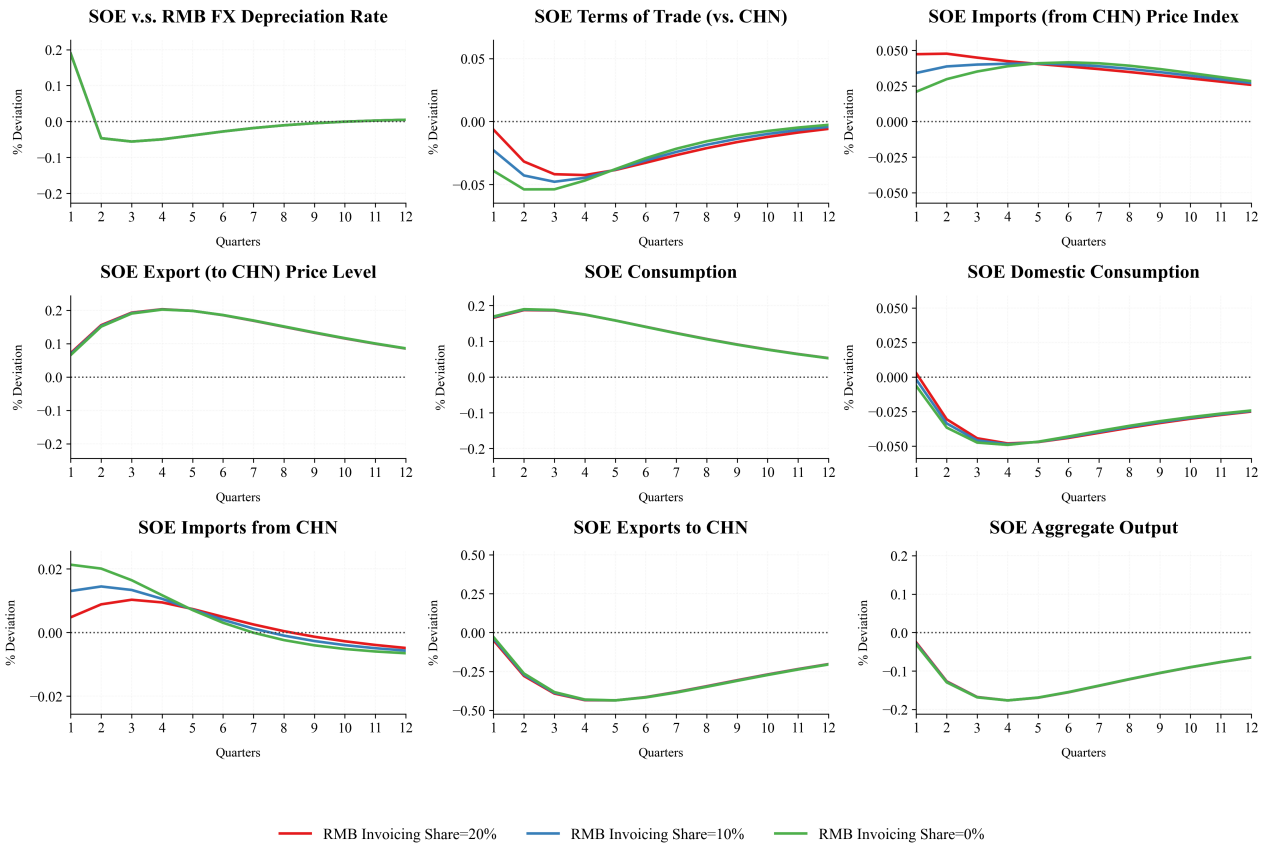


Figure F.4: Impulse Response Functions to Positive USA TFP Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation USA TFP shock under varying RMB invoicing shares.

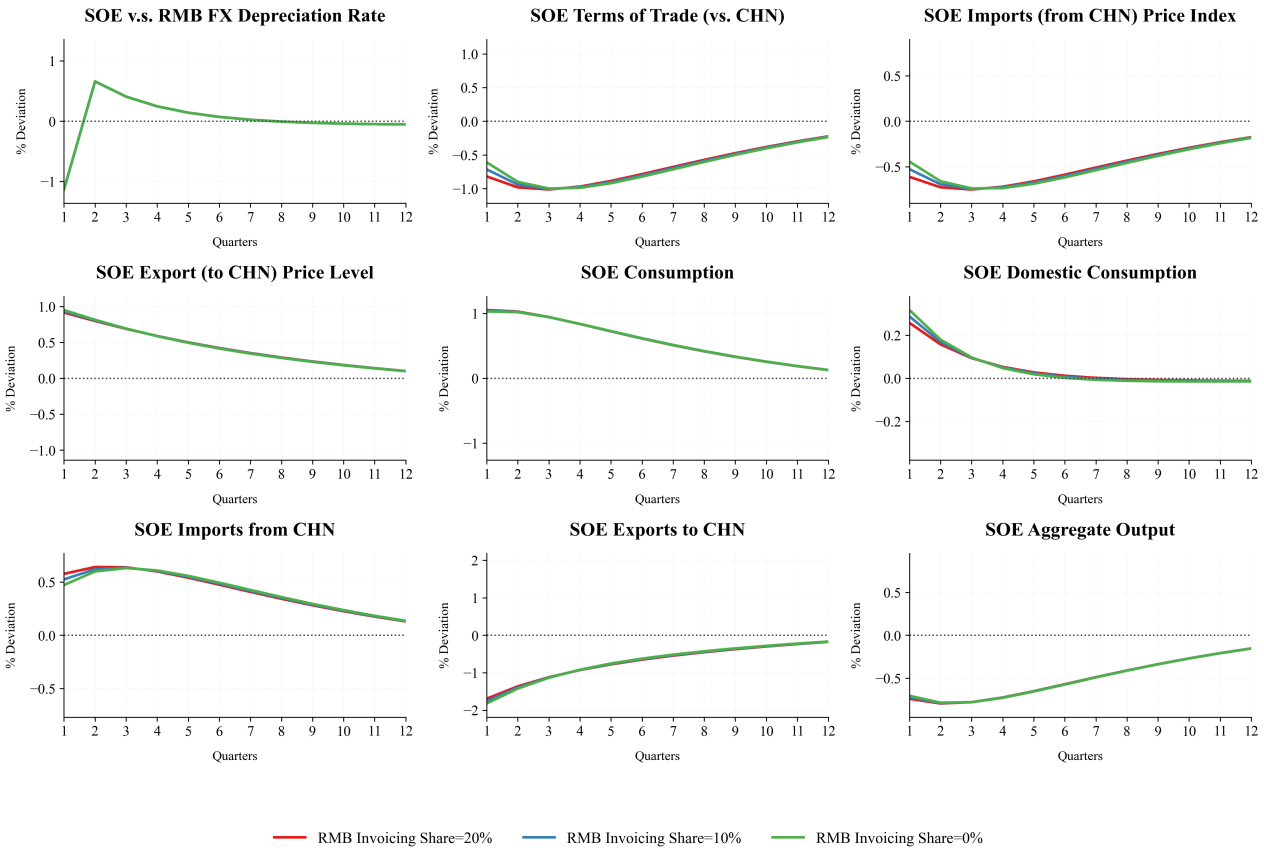


Figure F.5: Impulse Response Functions to Positive China UIP Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation China UIP shock under varying RMB invoicing shares.

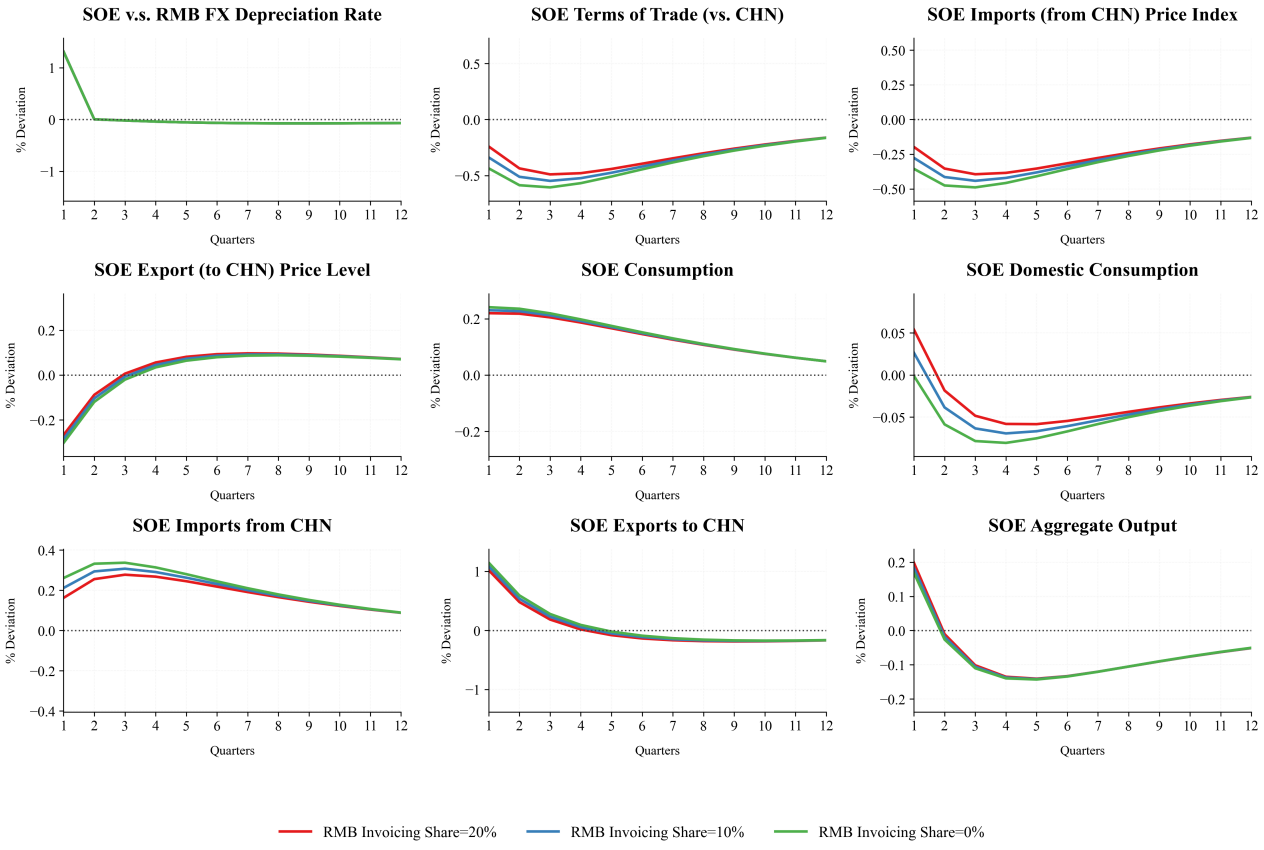


Figure F.6: Impulse Response Functions to Positive China markup Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation China markup shock under varying RMB invoicing shares.

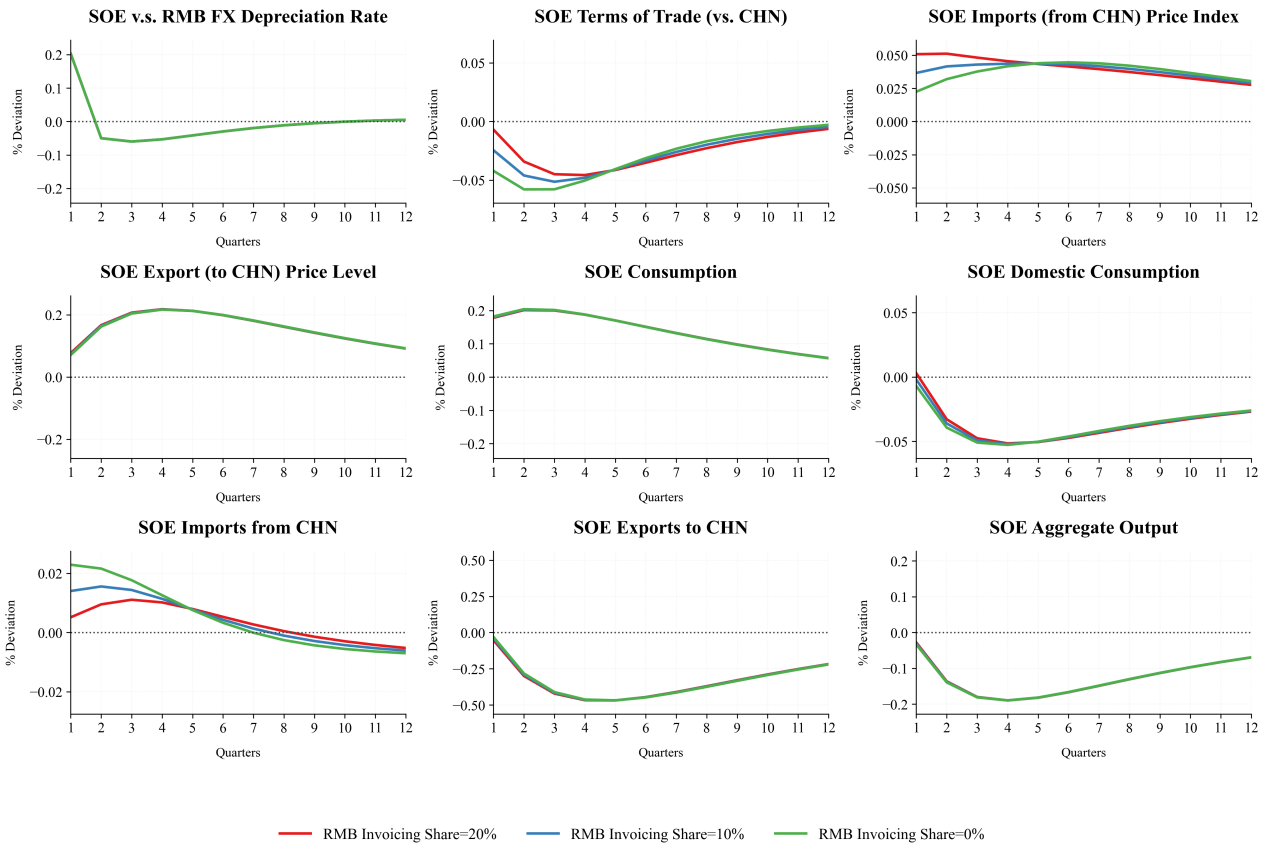


Figure F.7: Impulse Response Functions to Positive USA markup Shocks

Note: This figure illustrates the impulse responses of key endogenous variables to a one-standard-deviation USA markup shock under varying RMB invoicing shares.

Symmetrically, the sensitivity of the SOE's trade price indices is dictated by the degree of alignment between the invoicing share and the policy weight.

However, a critical asymmetry emerges in the response of aggregate output. While a positive Chinese markup shock expands SOE output by reducing import costs and boosting bilateral demand, a US markup shock yields a contractionary effect. This disparity is likely driven by the US dollar's role as the global pricing anchor; a reduction in US markups induces a global expenditure-switching toward US goods and away from the SOE, a process further exacerbated by the SOE's heavy reliance on the USD as a policy anchor. Consequently, the SOE faces a more complex trade-off when hedging against US disturbances compared to Chinese ones.

F.2 Additional Figures

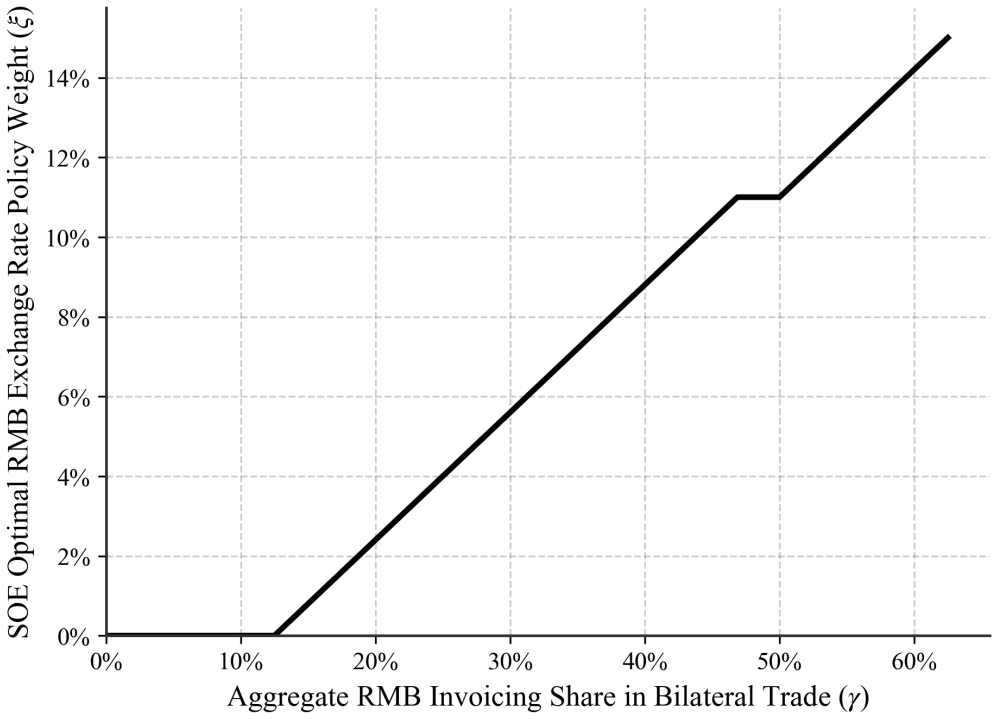


Figure F.8: Optimal RMB Weight in Response to RMB Invoicing Share (Debt-GDP Ratio = 10%)

Note: This figure illustrates the quantitative relationship between the exogenous RMB invoicing share and the optimal RMB exchange rate policy weight that maximizes household welfare under the assumption of non-zero foreign debt position for SOE and CHN. The foreign debt position ratio is calibrated as 10%. The non-zero foreign debt position assumption does not change the qualitative relationship between RMB invoicing share and SOE optimal RMB exchange rate policy weight.

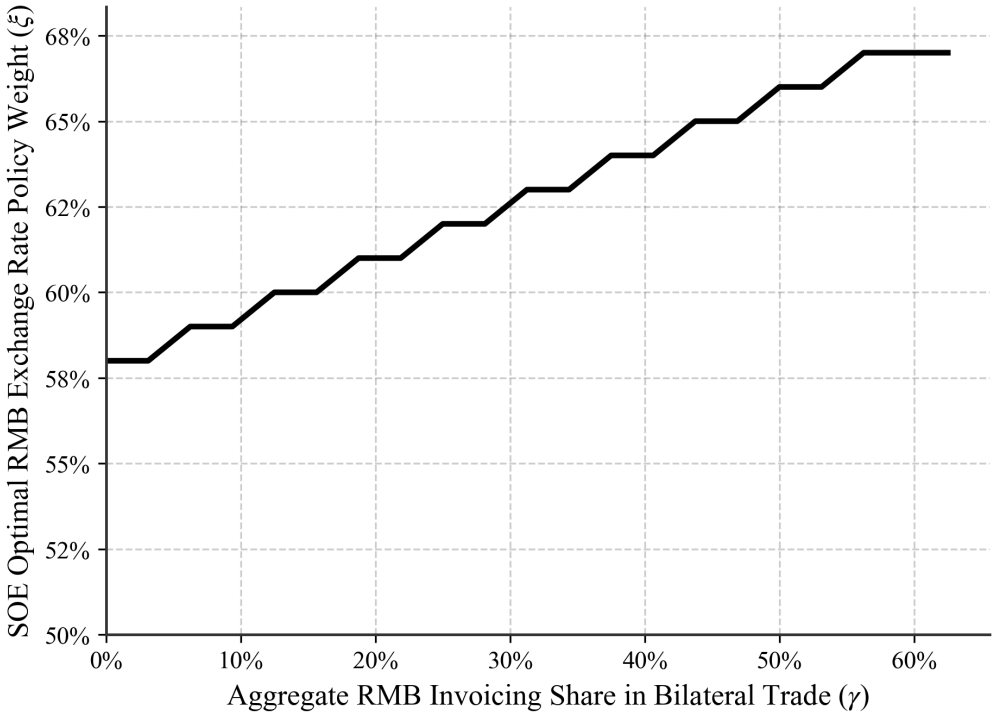


Figure F.9: Optimal RMB Weight in Response to RMB Invoicing Share (Complete Market)

Note: This figure illustrates the quantitative relationship between the exogenous RMB invoicing share and the optimal RMB exchange rate policy weight that maximizes household welfare under the assumption of complete asset market. The complete market setting does not change the qualitative relationship between RMB invoicing share and SOE optimal RMB exchange rate policy weight.

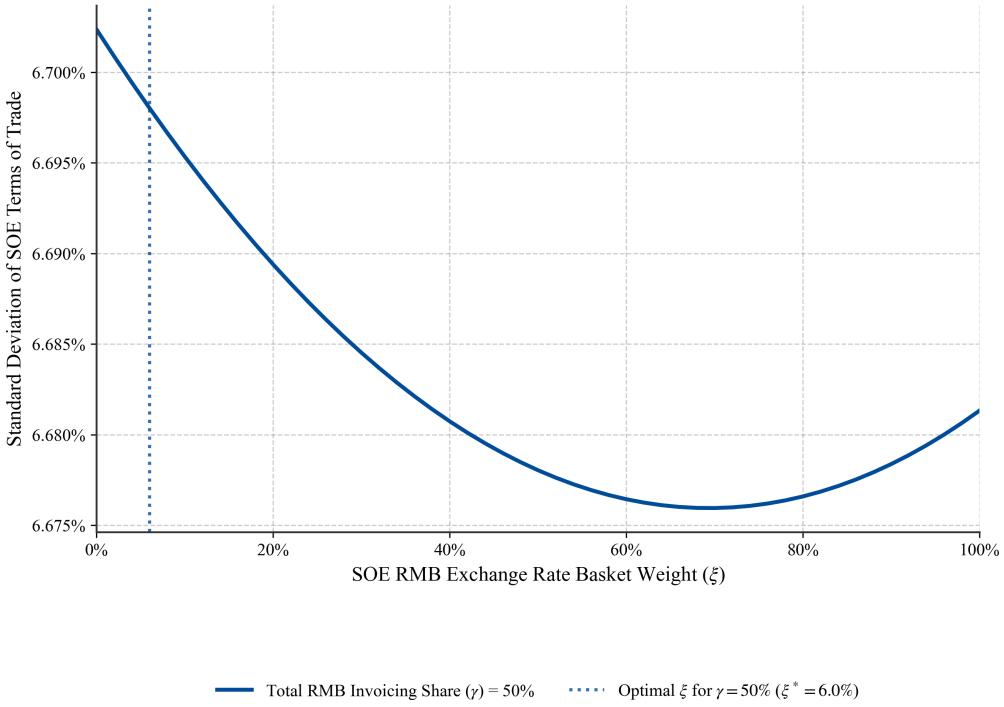


Figure F.10: Standard Deviation for the Terms of Trade (ToT) of SOE v.s. RMB Exchange Rate Weight

Note: This figure illustrates the relationship between the standard deviation for the terms of trade and SOE RMB exchange rate basket weight given symmetric invoicing share (when RMB invoicing share is 50%).